SESSION
2016-2017

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of ECE

Course structure for

B.Tech ECE

BS-15.411 Business Support System – Intelligent Network (BSS-IN) 3-0-0-3

Total Lecture: 42

Prerequisites: Linux Basic, Database Basic, TCP/IP Basic.

1	**Introduction to Telecom Market** Customer and Vendors, How Adds and promotion benefits, Statistics (Postpaid/Prepaid).	**[2]**
2	**Unit 2: GSM Basic and Evolution** Architecture, Call Flows (Cover RAN/CORE/IN), OSI/SS7 Basic, Evolution (2G to 5G)	**[4]**
3	**Unit 3: Intelligent Network Overview** Common Charging Architecture - High Level Common Architecture, Charging Mechanisms, Charging Functions- Offline Charging Funtions; Offline Charging Funtions; Architecture Mapping ,Charging Principles; Charging data generation and quota supervision; Charging information utilization, OCS - Required Functionality, OCS - Reference Model/Architecture, OCS Rating Function, OCS Functionality Message Flows, OCS CDRs, Policy Control And Charging; Reference Architecture;Policy Control Requirements; Reference Points; Functional Entities; PCC Rules; QoS Rules; PCC Procedure and Flows, Refill And voucher management, Subscriber/Customer management - Customer Care	**[11]**
4	**Unit 4**: **Billing Mediation and Provisioning Basic** CDR, UDR, TAP files, RAP files, NRTRDE, Billing System architecture (Mediation, usage and tariff database, formatting and rating processes, invoice generation),Types of usage (duration, volume, QoS, day and time, number of events, type of service),Types of rating (batch rating, pre-event rating, post-event rating, backwards rating, prepaid balance management, spending control/unbilled limit), Standard rating functions (staircase, offset, linear), Parameters of billing (usage & recurring &onetime charges, discounts & fees & taxes),Types of billing (regular, on-demand, immediate, simulation, information), Different product features (supports MVNO, real-time discounts, cross discounts, shared balances, multiple balances), Different marketing tools (business partners, bundles and counters, F&F, free units, discounts), Typical Telecom Environment: Multivendor environment, Std Protocols & proprietary Interfaces, Integration challenges, File Mediation fundamentals: ASN.1, Need, Typical Use Cases, Architecture, Event Mediation fundamentals: Diameter, 3GPP, Need, Typical Use Cases, Architecture Provisioning fundamentals: MML, CAI, CAI-3G etc, Need, Typical Use Cases, Architecture	**[14]**
5	**Protocols/Tools** TCP/IP/SCTP; Stack Description ; Connection Flow; Messages Flow; Use Cases ,SIGTRAN/SS7; Stack Description; Connection Flow; Messages Flow; Use Cases, DIAMETER; Stack Description; Connection Flow ;Messages Flow; Use Cases, CAMEL ; Stack Description; Connection Flow ;Messages Flow ;Use Cases	**[9]**
6	**3PP Services integration with BSS** Integration With CRBT/MoMo, IVR Services, Practical Example/Use Cases.	[2]
	Assessment	[2]

Comment [D88]: Skills Development

CS -14.203 **Data Structures** **Total Lectures: 40**

Credit : 3-0-0-3

Prerequisite(s): CS-14.101, CS-14.111

Objective(s): To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures.

1. **Introduction:** Basic Terminology, Elementary Data Organization, Algorithm, Efficiency of an Algorithm, Time and Space Complexity, Asymptotic Notations, Time-Space Trade- Off, Abstract Data Types. **[4]**
2. **Array:** Definition, Single and Multidimensional Arrays, Representation of Arrays: Row Major Order, and Column Major Order, Application of Arrays, Sparse Matrices and Their Representations. **[4]**
3. **Searching & Sorting:** Sequential Search, Binary Search, Comparison and Analysis, Hash Function, Collision Resolution Strategies, Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort. **[6]**
4. **Linked list:** Singly Linked Lists, Doubly Linked List, Circular Linked List, Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List. **[6]**
5. **Stack:** Primitive Stack Operations: Push and Pop Array and Linked List Implementation of Stack, Application of Stack: Prefix and Postfix Expressions, Evaluation of Postfix Expression, Recursion, Tower of Hanoi Problem. **[4]**
6. **Queue:** Queue Operations, Circular Queues, Array and Linked List Implementation of Queues, Dequeue and Priority Queue. **[4]**
7. **Tree:** Binary Trees, Binary Tree Representation, Tree Traversal Algorithms: Inorder, Preorder and Postorder, Threaded Binary Trees, Huffman Algorithm, Binary Search Trees AVL Trees. **[6]**
8. **Graph:** Terminology, Sequential and Linked Representations of Graphs: Adjacency Matrices, Adjacency List, Adjacency Multi List, Graph Traversal: Depth First Search and Breadth First Search, Spanning Trees. **[6]**

Comment [D1]: Skills Development

Comment [D2]: Skills Development

Comment [D3]: Skills Development

Comment [D4]: Skills Development

Comment [D5]: Skills Development

Outcome(s): Upon completion of the course the student should

- be knowledgeable of certain abstract data types (ADT).
- be able to make a critical assessment of different implementations of an ADT.
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems.

Text Books:

1. Lipschutz, "Data Structures" Schaum's Outline Series, TMH, 2006.

Reference Books:

1. Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI, 2nd Edition, 2009.
2. Horowitz and Sahani, Fundamentals of Data Structures, Galgotia Publication, 1999.
3. Jean Paul Trembley and Paul G. Sorenson, An Introduction to Data Structures with applications, McGraw Hill, 2nd Edition, 2003.
4. G. A. V. Pai, Data Structures and Algorithms, TMH, 2008.

CS-14.202 **Java Programming** **Total Lectures: 40**

Credit : 3-0-0-3

Prerequisites: CS14.101, CS-14.205.

Objectives: The objective of this Course is to:

- Cover issues related to the definition, creation and usage of classes, objects and methods. Become comfortable with object-oriented programming and learn to think in terms of objects.
- Discuss the principles of inheritance and polymorphism. The concepts would be demonstrated through problem analysis assignments.
- Provide the foundation of good programming skills by discussing key issues of the design of object-oriented software, including programming design patterns and documentation.
- Cover the basics of APIs as well as allow students to explore the Java Abstract Programming Interface.

5. **Overview:** Introductionto java, importance of Java, interactive development environments: Eclipse/Net Beans, basics of OOP. **[4]**
6. **Data Types, Variable, and Arrays:** primitive data types, type casting,arrays, operators and control structures. Identifiers, constants and literals. **[6]**
7. **Classes and Objects:** Class fundamentals, declaring objects, assigning object referencevariables, introducing methods, constructors, the this keyword, garbage collection, the finalize() method, overloading methods, using objects as parameters and return type, introducing access control, understanding static, introducing final, introducing nested and inner classes, exploring the string class, using command-line arguments. **[9]**
8. **Inheritance:** Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final in inheritance, the object class. **[4]**
9. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, user defined exception. **[6]**
10. **Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, thread priorities, managing threads, Thread class built-in functions **[4]**
11. **I/O and String Handling:** I/O basics, reading console input, writingconsole output, the Print Writer class, reading and writing files, string constructors, operations on String, String tokenizing, String Buffer **[7]**

Comment [D37]: Employability

Comment [D38]: Employability

Comment [D39]: Employability

Outcomes: Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP

EC 15.311 **Telecommunication Switching Systems** **Total Lectures: 40**

3-0-0-3

Objectives:

1. To acquire knowledge on simple telephone communication and basics of switching system.
2. To get acquainted with electromechanical switching systems.
3. To gain knowledge on digital switching systems, stored program control system, traffic engineering, telephone networks and ISDN.
4. To apply the knowledge of Telecommunication Switching in designing switching systems.

Prerequisite: NONE

1. **Introduction to Switching Systems:** Introduction, simple telephone communication, basics of switching system [4]
2. **Electromechanical Switching Systems: Introduction to Strowger switching system,** Crossbar switching systems, single stage and multistage switching systems, common control, pulse dialling, tone dialling. [6]
3. **Digital Switching Systems:** Stored Program Control, centralised SPC, distributed SPC, software architecture, application software, space division, and time division switching, time multiplexed space division, time multiplexed time division switching and combination switching. [10]
4. **Traffic Engineering:** Erlang's equation, blocking probability and B-D equation. [4]
5. **Telephone Networks:** Subscriber loop, digital subscriber loop, high speed digital transmission over subscriber line, wire-in, wire-less media, coaxial cables, optical fibre cables, microwave propagation, satellite transmission, numbering plan, charging plan, Inchannel signalling, common channel signalling. [10]
6. **ISDN and ATM Standards:** ISDN architecture, channels, interfaces, protocol, B-ISDN architecture, frame relay, ATM protocols [6]

Comment [D53]: Skills Development

Comment [D54]: Skills Development

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of telecommunication Switching Systems.
2. Able to describe different mechanical and electronic switching systems, telephone networks.

Able to design various switching systems.

Text Books:

1. Telecommunication Switching Systems and Networks, Thiagarajan Viswanathan, PHI
2. Telecommunication Switching, Traffic and Networks, J. E. Flood, Pearson Education

EC 15.314 **FUNDAMENTALS OF MEMS** **Total Lectures: 40**
3-0-0-3

Objective: The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques. This enables them to design, analysis, fabrication and testing the MEMS based components.

Pre-requisite: Knowledge of materials and VLSI is highly desired.

1.	**Introduction:** MEMS Roadmaps, Benefits of Miniaturization, Benefits of Scaling.	**[2]**
2.	**Fabrication Process:** oxidation, film deposition, lithography, etching, ion implantation, diffusion.	**[8]**
3.	**Micromachining:** Surface Micromachining: basic process flow, release, stiction, material choices, residual stress, stringers and planarization, MUMPS, Summit, electroplating, 3D out-of-plane. Bulk Micromachining: wet etch based, dissolved wafer process, SOI MEMS, Scream, Hexsil MEMS, sealed cavity deep RIE.	**[6]**
4.	**Process Integration:** interleaved, MEMS-first, MEMS-last, bonded integration, wafer-to-wafer transfer, fluidic assembly.	**[4]**
5.	**Mechanics of Materials for MEMS:** stress, strain, material properties, measurement & characterization of mechanical parameters.	**[3]**
6.	**Microstructural Elements:** bending moment and strain, flexural rigidity, residual stress, boundary conditions, spring combinations.	**[3]**
7.	**Energy Methods:** application to clamped-clamped beam under axial load, resonance frequency determination, free-free beam, disk, ring, lumped-element mechanical equivalent circuits.	**[4]**
8.	**Circuit Modeling of MEMS:** resonator equivalent circuits, thermal circuits, fluidic circuits.	**[3]**
9.	**Electronic and Mechanical Noise:** electronic noise sources, Brownian motion noise, circuit noise calculation procedure, SNR, dynamic range.	**[3]**
10	**Micromechanical Circuits:** general filter topologies, insertion loss (noise figure), shape factor, design with k and q values, termination impedance, resonator and couplers, circuit modeling of coupled resonators, systematic micromechanical filter design procedure, oscillators, RF MEMS switches.	**[4]**

Comment [D79]: Skills Development

Comment [D80]: Skills Development

Outcome: 1. Be familiar with the important concepts applicable to MEMS, their fabrication.
2. Be fluent with the design, analysis and testing of MEMS.
3. Apply the MEMS for different applications.

Text Books:

1. Senturia's "Microsystem Design"
2. Kovacs' "Micromachined Transducers Sourcebook"
3. Jaeger's "Introduction to Microelectronic Fabrication"
4. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.

References Books:

1. Gaberiel M. Rebiz, "RF MEMS Theory, Design and Technology", John Wiley & Sons,2003
2. Charles P. Poole, Frank J. Owens, "Introduction to nanotechnology" John Wiley & sons, 2003.
3. Julian W. Gardner, Vijay K Varadhan, "Microsensors, MEMS and Smart devices", John Wiley & sons, 2001.

EC 15.315 **BASICS OF ROBOTICS** **Credit : 3-0-0-3**
Total Lectures: 40

• To introduce the basic concepts, parts of robots and types of robots.
• To make the student familiar with the various drive systems for robot, sensors and their applications in robots.

Prerequisite: Nil

Unit I- Introduction **[8]**

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system.

Unit II - End Effectors And Robot Controls **[8]**

Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.

Unit III-Robot Transformations And Sensors **[8]**

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors.

Unit IV-Robot Cell Design And Applications **[8]**

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot.

Unit V-Micro/Nano Robotics System **[8]**

Micro/ Nanorobotics system overview-Scaling effect-Top down and bottom up approach-Actuators of Micro/Nano robotics system-Nanorobot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nanorobot in targeted drug delivery system.

Outcomes: The Student must be able to understand the basics of Robot.

Text Books:

1. Niku Saeed B., Introduction to Robotics: Analysis, Systems, Applications, PHI, New Delhi 2001
2. John J.Craig, “Introduction to Robotics”, Pearson, 2009.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.

Comment [D58]: Skills Development

Comment [D59]: Skills Development

Comment [D60]: Employability

Comment [D61]: Employability

EC 15.316 **ROBOTICS AND CONTROLS** **Total Lectures: 40**
Credit : 3-0-0-3

OBJECTIVES:

- . To get exposure about basic robot kinematics, dynamics, control and programming.

Prerequisite: Basics of Robotics

UNIT I Introduction **[4]**

Definition, Structure, Classification and Specifications of Robots, Industrial Robots.

UNIT II Robot Elements and Control **[4]**

Manipulators, Drives, Sensors, End Effectors, Configuration, Force/Torque Relationship, Trajectory Planning, Position Control, Feedback System, Digital Control.

UNIT III Modeling of Robots **[10]**

Comment [D81]: Skills Development

Coordinate Frames, Mapping and Transformation; Direct Kinematic Model; Inverse Kinematics; Manipulator Differential Motion; Static Analysis; Jacobian.

UNIT IV Manipulator Dynamics **[10]**

Acceleration of a rigid body, mass distribution, Newtons equation, iterative Newton Euler dynamic formulation, Lagrangian formulation of manipulator dynamics, Bond graph modeling of manipulators, Trajectory Planning.

UNIT V Linear and Non Linear Control of Manipulators **[12]**

Comment [D82]: Skills Development

Control law partitioning, trajectory following control, multi input multi output control systems, Cartesian based control scheme. Force Control of manipulators: hybrid position/force control.

Outcomes: The Student must be able to design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.

Text Books:

1. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2. Mittal R. K. and Nagrath I. J., “Robotics and Control”, Tata McGraw Hill, New Delhi 2003.

Reference Books:

1. Ghosal Ashitava, “Robotics: Fundamental Concepts and Analysis”, Oxford University Press 2006.
2. Schilling R. J., “Fundamentals of Robotics Analysis and Control”, Prentice Hall Inc 1990.

EC 15.413 **Advanced Embedded System** **Total Lectures: 40**

3-0-0-4

Objective:

1. To teach the Fundamentals on design attributes of functional units of a Processor
2. To discuss on Hardware software partitioning in system design
3. To teach intra & Inter processor Communications
4. To discuss strategies for processor Communications

Understanding of necessity of operating system in advanced embedded systems.

Prerequisite: EC 14.202 Microprocessor Programming and Interfacing, EC 14.306 Microcontroller and Embedded System

7.	Introduction to Embedded Hardware and Software: Terminology – Gates – Timing diagram – Memory – Microprocessor buses – Direct memory access – Interrupts – Built interrupts – Interrupts basis – Shared data problems – Interrupt latency - Embedded system evolution trends – Interrupt routines in an RTOS environment.	[8]
8.	System Modelling with Hardware/Software Partitioning: Embedded systems, Hardware/Software Co-Design, Co-Design for System Specification and modelling- Single-processor Architectures &,Multi-Processor Architectures, comparison of Co- Design Approaches, Models of Computation, Requirements for Embedded System Specification, Hardware/Software Partitioning Problem, Hardware/Software Cost Estimation, Generation of Partitioning by Graphical modelling, Formulation of the HW/SW scheduling, Optimization.	[8]
9.	Hardware/ Software Co-Synthesis: The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation, Distributed System Co-Synthesis.	[8]
10.	Memory and Interfacing: Memory: Memory write ability and storage performance – Memory types – composing memory – Advance RAM interfacing communication basic – Microprocessor interfacing I/O addressing – Interrupts – Direct memory access – Arbitration multilevel bus architecture – Serial protocol – Parallel protocols – Wireless protocols – Digital camera example.	[8]
11.	Concurrent Process Models and Hardware Software Co-Design: Modes of operation – Finite state machines – Models – HCFSL and state charts language – state machine models – Concurrent process model – Concurrent process – Communication among process –Synchronization among process – Implementation – Data Flow model. Design technology – Automation synthesis – Hardware software co-simulation – IP cores – Design Process Model.	[8]

Comment [D89]: Skills Development

Comment [D90]: Employability

Outcomes: After completing this module, students will be expected to be able to:

1. Implement a RTOS based embedded system and uunderstand the embedded systems design process.
2. Define a specification for an embedded system.
3. Design an embedded system based on a specification.
4. Discuss methods for implementing reliable embedded systems to solve various problems.

EC 15.415 **ROBOT PROGRAMMING** **Total Lectures: 40**
Credit : 3-0-0-3

OBJECTIVES: To study the use of robot programming for various applications.

Prerequisite: Nil

UNIT I - Basics of Robot Programming **[8]**

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands- Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.

UNIT II - Val Language **[8]**

Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications.

UNIT III - Rapid Language **[8]**

RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command based programming. Move master command language- Introduction, syntax, simple problems.

UNIT IV - Practical Study of Virtual Robot **[8]**

Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studio online software- Introduction, Jogging, components, work planning, program modules, input 13 RB-2013 SRM and output signals-Singularities-Collision detection-Repeatability measurement of robot-Robot economics.

UNIT V - VAL-II and AML **[8]**

VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commands-Data processing.

Outcomes: Upon completion of this course the students can able to understand the basic of Robot programming.

Text Books:

1. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
2. Deb. S. R. “Robotics technology and flexible automation”, Tata McGraw Hill publishing company limited, 1994.

Reference Books:

1. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “*Robotics control, sensing, vision and intelligence”*, McGraw Hill Book co, 1987.
2. Craig. J. J. “*Introduction to Robotics mechanics and control”*, Addison-Wesley, 1999.

Comment [D91]: Skills Development

Comment [D92]: Employability

EC 16.305 **Semiconductor Physics** **Total Lectures: 40**

3-1-0-4

Course Objective

The aim of the course is to develop physics and engineering strategies of semiconductor materials and to discuss their functionalities in modern electronic and optoelectronic devices.

Prerequisites : Basic Modern physics , Optics

1	Introduction to solid state materials - crystal structure - Reciprocal lattice - Brillouin zone and rules for band (*k* - space) representation. Dynamics of electrons in periodic potential: Kronig - Penny and nearly free electron models - Real methods for band structure calculations; Bandgaps in semiconductors - Holes and effective mass concept - Properties of conduction and valance bands.	[8]
2	Fermi distribution and energy - Density of states - Valance and conduction band density of states - intrinsic carrier concentration - intrinsic Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors - Bandgap Engineering.	[8]
3	Scattering Mechanism: electron - electron and electron - phonon scattering. Macroscopic transport: Carrier transport by Diffusion - Carrier transport by Drift: Low field, High field and very high field (Impact ionization) - Einstein relation.	[8]
4	Electron - hole pair generation and recombination: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons : Origin, electronic levels and properties Radiative and nonradiative recombination (Shockley - Read - Hall and Auger) processes. Carrier transport - continuity equations. Optical constants: Kramers - Kronig relations.	[8]
5	Optical processes in semiconductor, choice of materials for LED, LED power and efficiency, LED structures - Planar LED, Dome LED, Surface Emitting LED, Edge Emitting LED, Optical detection principle, quantum efficiency, Photoconductor, p-n photodiode, p-i-n photodioe, APD, Heterojunction diode, optocouplers.	[8]

Comment [D51]: Skills Development

Comment [D52]: Skills Development

Course Outcome

This course will provide the students with a basic understanding of the physics and principles of semiconductor material and the operation of the most important semiconductor devices in modern microelectronics and photonics.

EC-14. 403 **Antenna and Wave Propagation** **Total Lectures: 40**

3-0-0-3

Objective: To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications and RADAR.

Pre-requisite: EC-14.208 Principles of Electromagnetics

1. **Introduction**: Basic properties of transmitting, and receiving antenna, gain, bandwidth, and polarization, Effective aperture and Friss transmission formula. [4]
2. **Physical Concept of Radiation:** Retarded potentials hertzian dipole, antenna parameters, radiation pattern, gain, directivity, effective aperture, reciprocity and radiation from dipoles of arbitrary length. [6]
3. **Theory of Array Antenna: A**rrays of point sources, Endfire and Broadside arrays, Log-periodic, Yagi-uda arrays, Analysis of Rhombic antenna. Design of Rhombic Antennas, Loop Antenna: Radiation from small loop and its radiation resistance. Helical antenna: Normal and axial mode operation. synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method [10]
4. **Frequency Independent Antenna:** Slot, horn antenna, parabolic antenna, aperture antennas and microstrip antenna:Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas. [8]
5. **Wave Propagation:** Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, Sky wave propagation- propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, troposphere propagation, Super refraction. [7]
6. **Antennas for Mobile Satellite System:** Antenna for aeronautical mobile systems, cell-site and mobile antenna, adaptive antennas. [5]

Outcomes: After completion of the course, students will be able to

- select the appropriate portion of electromagnetic theory and its application to antennas.
- distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.
- assess the need for antenna arrays and mathematically analyze the types of antenna arrays.
- distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.
- outline the factors involved in the propagation of radio waves using practical antennas.

Text Books:

1. C. A. Balanis, Antenna Theory and Design, 3rd Ed, John Wiley & Sons, 2005.
2. W. L. Stutzman, and G. A. Thiele, Antenna Theory and Design, 2nd Ed, John Wiley & Sons, 1998.
3. R. S. Elliot, Antenna Theory and Design, Revised edition, Wiley-IEEE Press, 2003.

Reference Books:

1. R. E. Collin, Antennas and Radio Wave Propagation, McGraw-Hill, 2014.
2. K.D. Prasad, Antenna and Wave Propagation, 3rd Ed., Satya Prakashan, New Delhi, 2003

Comment [D84]: Skills Development

EC-14.201 **Electronic Devices and Circuits** **Total Lectures: 40**
3-1-0-4

Objective To acquire fundamental knowledge of operation, design and application of various Electronic devices and circuits.

Prerequisite Basic Electronics and Physics of electron.

1. **Junction Diode:** Junction breakdown**,** Current components in a p-n diode, Quantitative analysis of p-n diode characteristics and equivalent circuit, diode resistance, interconnections of diodes, transition and diffusion capacitance. [6]

2. **Transistors**: Operation of transistor, transistor current components, transistor circuit configurations, transistor biasing schemes and operating point stabilization, hybrid-pi model of BJT, low and high frequency models of JFET, MOS Devices - NMOS, PMOS and CMOS [11]

3. **Small Signal Amplifiers at Low Frequency:** Coupling schemes for multistage amplifiers, frequency response of coupled amplifier, RC coupled transistor amplifier, transformer coupled transistor amplifier, cascode circuits, Differential amplifier, Darlington amplifier. [7]

4. **Power Amplifiers:** Power amplifier circuits, class-A, class-B, class-AB, class-C, push pull amplifiers- class-A, class-B, Class- AB, complementary symmetry push-pull and quasi-complementary symmetry, push-pull amplifiers. [8]

5. **Oscillators:** Classification criterion for oscillation, tuned collector, Hartley, Colpitts, RC phase shift, Wien bridge and crystal oscillators, astable, monostable and bistable multivibrators, Schmitt trigger [8]

Outcome: After completion of this course, students would be able to understand the working phenomena and applications of various electronic devices and circuits. Knowledge gained from this course would also be utilized to design different electronic circuits and devices.

Text Books:
1. Millman J. & Halkias C.C., "Electronic Devices and Circuits" McGraw Hill.
2. Thomas L. Floyd, "Electronic Devices", Pearson Education.
3. Robert L. Boylestad & Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education.

Reference Book: Bell, David A., "Operational Amplifiers & Linear ICS" Prentice Hall of India.

Comment [D6]: Skills Development

Comment [D7]: Skills Development

Comment [D8]: Skills Development

Comment [D9]: Skills Development

EC-14.202 **Microprocessor Programming and Interfacing** **Total Lectures: 40**
3-0-0-3

Objective: To develop an in-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques.

Pre-requisite: The students should have good background on digital circuits (should have attended the course Switching Circuits and Logic Design).

1. **The Microcomputer:** Evolution of microprocessor, address bus and data bus, introduction to machine language and assembly language, logic devices for interfacing: 74244, 74245, 74373 **[3]**
2. **The 8085 Processor:** Architecture, pin diagram and description of various signals, read, write and op-code fetch cycles, interrupt structure, instruction set and Assembly language programming. [12]
3. **The 8086 Microprocessor Architecture :** Architecture, details of sub-blocks such as EU, BIU; memory segmentation and physical address computations, pin diagram and description of various signals, minimum and maximum mode of operations, supporting chips viz. 8284, 8288 and memory mapping [8]
4. **Programming of 8086:** Addressing modes of 8086, instruction set of 8086, assembly language programming, counters and time delays, stack structure of 8086 and subroutine. [7]
5. **Interfacing of 8085 / 8086 with Programmable Chips:** Interfacing of 8255 Programmable peripheral interface, 8251 USART, 8253/8254 Programmable Interval Timer and Direct Memory Access Controller 8237/8257 DMA, 8259 Programmable Interrupt Controller. [10]

Outcome: **Upon completion of this course, the student will be able to:**

1. The student will learn the internal organization of some popular microprocessors and microcontrollers.
2. The student will learn hardware and software interaction and integration.
3. The students will learn the design of microprocessors/microcontrollers-based systems.

Text Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Application with the 8085; Penram International Publishing (India).
2. A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals; TMH.

Reference Books:

1. D. V. Hall, Microprocessors and Interfacings; TMH, second Edition.
2. B. P. Singh and Renu Singh, Advanced Microprocessors and Microcontrollers; New Age International Publishers, Third Edition.A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals; TMH.

Comment [D20]: Skills Development

Comment [D21]: Skills Development

Comment [D22]: Skills Development

Comment [D23]: Skills Development

EC-14.203 **Digital Electronics** **Total Lectures: 40**
3-1-0-4

Objective: The aim of this course is to present the principles and techniques of combinational and sequential digital logic design and optimization at a gate level. The use of transistors for building gates is also introduced.

Pre-requisite: Basic Electronics course in First Year.

1 **Number Systems and Codes:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic. [2]

2 **Introduction to Boolean Algebra:** Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [2]

3 **Logic Gates:** Diode and transistor as a switch, basic logic gates, derived logic gates, block diagrams and truth tables, logic diagrams from Boolean expression and vice versa, converting logic diagram to universal logic, positive logic, negative logic and mixed logic. [5]

4 **Simplification of Boolean Functions:** K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method. [5]

5 **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]

6 **Sequential Circuits:** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters. [10]

7 **Logic Families:** Logic gate characteristics (propagation delay, speed, noise margin, fan-in, fan-out, power dissipation), standard logic families (RTL, DCTL, TTL, ECL, MOS) [5]

8 **Programmable Logic:** Introduction to programmable logic array (PLA), programmable array logic (PAL). [1]

Comment [D10]: Skills Development

Comment [D11]: Skills Development

Comment [D12]: Skills Development

Comment [D13]: Skills Development

Comment [D14]: Skills Development

Outcome: Graduates will have knowledge of digital systems. They will understand how to analyze and design digital logic circuits, and be familiar with digital ICs.

Text Books: 1. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Patparganj, Delhi, 4thEdition, 2009.
2. Floyd, T. L. and Jain, R.P., "Digital Fundamental", Pearson Education, Patparganj, Delhi, 8thEdition, 2009.
3. Tocci, R. J., Widmer, N. and Moss, G., "Digital System: Principles and Applications", Pearson Education, Patparganj, Delhi, 10thEdition, 2007.

EC-14.204 **Integrated Circuit and Applications** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: EC-14.201(Electronics Devices and Circuits)

1.	**Differential Amplifier:** Operational amplifier, bipolar and FET differential amplifiers, constant current source, current mirror, level translator, block diagram of operational amplifier, frequency response and stability, operational amplifier parameters, offset compensation techniques.	**[6]**
2.	**Application of Op-amp:** Inverting and non-inverting amplifiers, voltage follower, integrator and differentiator circuits, instrumentation amplifier, current to voltage converter and voltage to current converter, voltage to frequency conversion, analog simulation of differential equations using operational amplifiers.	**[7]**
3.	**Oscillators:** Phase shift, Wein bridge, quadrature, square wave, triangular wave, sawtooth wave and voltage controlled oscillator.	**[5]**
4.	**Active Filters:** Low pass, high pass, band pass and band reject filters, designing of second order filters using Butterworth approximations, higher order filters and state variable filters.	**[6]**
5.	**ICs and Applications:** Clipping and clamping circuits, comparator, LM-311 comparator, schmitt trigger, log and antilog amplifiers, half and full wave rectification, IC-8038, IC LF-398, IC-555.	**[6]**
6.	**Voltage Regulator and PLL:** Voltage regulator IC-723, switching regulators, regulator IC series 78xx, 79xx, building blocks of PLL, IC-565 and its applications, four-quadrant multiplier and its applications.	**[10]**

Comment [D24]: Skills Development

Comment [D25]: Skills Development

Comment [D26]: Skills Development

Comment [D27]: Skills Development

Comment [D28]: Skills Development

Comment [D29]: Skills Development

Outcome: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Gayakwad R. A., "Op-Amps and Linear Integrated Circuits", PHI, New Delhi, 3rd Edition.
2. Singh B. P. and Singh Rekha, "Electronic Devices and Integrated Circuits", Pearson Education, Patparganj, Delhi.
3. Coughlin R. F. and Driscoll F. F., "Operational Amplifiers & Integrated Circuits", Pearson Education, Patparganj, Delhi.

Reference Books:

1. Franco S., "Design with Operational Amplifiers and Analog Integrated Circuits", Pearson Education, Patparganj, Delhi.

EC-14.206 **Consumer Electronics** **Total Lectures: 40**

3-1-0-4

Objective: This subject will introduce the students with working principles, block diagram and advance features of consumer electronics appliances. Also this will familiarize students with latest advancements in Electronic manufacturing industry. Knowledge so gained would also help in troubleshooting and maintaining different electronic gadgets and appliances.

Pre-requisite: Basic understanding of electric circuits and components and some knowledge of basic electronic devices such as diodes, transistors etc.

1. **Introduction to Electronics Engineering:** Review of basic electrical & electronic circuits and components. Difference in electrical and electronic engineering. Introduction to electronics industry in India and the world; consumer electronics gadgets classification and applications. Introduction to ESDM (Electronic System Design & Manufacturing). **[4]**
2. **Audio devices and systems:** Characteristics of sound signal: level and loudness, pitch, frequency response, fidelity and linearity, Reverberation. Audio level metering, decibel level in acoustic measurement. Microphone: working principle, sensitivity, response. Loud speaker: working principle, characteristic impedance, and watt capacity, loud speaker types. Sound recording: Optical recording, stereophony. Audio system: CD player, home theatre sound system. Digital console: block diagram, working principle, applications. FM tuner: concepts of digital tuning, ICs used in FM tuner TDA 7021T. PA system: planning, speaker impedance matching, Characteristics, power amplifier. **[12]**
3. **Television and Video Systems:** Monochrome TV standards, scanning process, aspect ratio, persistence of vision and flicker, picture resolution. Composite video signal: horizontal and vertical sync details. Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance. PAL system, channel bandwidth. Digital TVs: - LCD, LED, PLASMA, HDTV, 3-D TV, projection TV, DTH receiver. CD and DVD player: working principles. **[10]**
4. **Home and Office Appliances:** FAX and Photocopier Microwave Oven: types, technical specifications Washing Machine: wiring diagram, electronic controller for washing machine, technical specifications, types of washing machine, fuzzy logic Air conditioner and Refrigerators: Components features, applications and technical specification. Digital camera and cam coder. **[10]**
5. **Advanced trends in Electronic manufacturing industry:** Basics of semiconductor technology and integrated circuits. Introduction to embedded intelligence in electronic gadgets: microcontroller based systems; different ICs used in the systems such as 8051, Op-Amp, 555 timer, and Digital ICs. **[4]**

Outcome: After the completion of the course, students are able to acquire required learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

i. Troubleshoot different types of microphones, audio systems and colour TV receiver.
ii. Maintain various electronic home appliances.

Text Books:

1. Audio video systems : principle practices & troubleshooting ; Bali R. and Bali S.P. ; Khanna Book Publishing Co. (P) Ltd. , 2010
2. Consumer Electronics; S.P. Bali ; Pearson Education India, 2010
3. Audio video systems ; Gupta R. G. ; Tata Mc Graw Hill, New Delhi, 2010
4. Colour Television & Video Technology; A. K. Maini ; CSB Publishers

Reference Books:

1. Modern Television Practices ; Gulati R. R. ; New Age International Publication, New Delhi, 2010
2. Standard Handbook on Audio Engineering ; Whitaker Jerry & Benson Blair ; McGraw Hill Professional ; 2010
3. VCR-principles, maintenance & repair by S.P. Sharma, Tata Mc Graw Hill, New Delhi

Comment [D30]: Skills Development

Comment [D31]: Skills Development

Comment [D32]: Skills Development

EC-14.208 **Principles of Electromagnetics** Total Lectures: 40

3-0-0-3

Objective: To develop the understanding of basics concepts of electromagnetic field theory and its applications.

Pre-requisite: Basic understanding of laws of Physics and Mathematics

1. **Introduction**: Transformation of a point and a vector in different coordinate systems, Differential length, area, volume Physical meaning of gradient, divergence and curl, Laplacian of a scalar, Divergence theorem, Stoke's theorem, review of electrostatic and magneto static fields. [8]
2. **Time Varying Fields and Maxwell's Equations:** Faraday's law of electromagnetic induction, Maxwell's equations in integral and differential form, potential functions, electromagnetic boundary conditions. [8]
3. **Electromagnetic Waves:** Introduction, Helmholtz wave equation, Wave equations and their solutions for free space, lossy dielectric, Lossless dielectrics and good conductor medium, Poynting vector and the flow of power. Reflection of plane wave at dielectric media and conducting surfaces for normal incidence. [10]
4. **Transmission lines:** Types of transmission lines, transmission line parameters, two conductor transmission line equations, input impedance, standing wave ratio and power of transmission lines, smith chart, transmission line impedance matching techniques. [6]
5. **Guiding Structures:** General wave behaviors along uniform guiding structure, rectangular and circular wave guides, wave propagation in rectangular and cylindrical cavity resonators. [8]

Comment [D33]: Skills Development

Outcome: After completion of this course, students would be understanding the concept of electric and magnetic fields, both static and dynamic, and gain insight in various application areas like transmission lines and waveguides.

Text Books:

1 Matthew N. O. Sadiku, Principles of Electromagnetics (Fourth Edition); Oxford University Press.

2 William H. Hayt: Engineering Electromagnetic, TMH.

3 Raju, Electromagnetic field theory and Transmission lines, Pearson Education.

4 John D. Kraus: Electromagnetics, McGraw Hill.

Reference Books:

1 David J. Griffiths, Introduction to Electrodynamics (Third Edition); Pearson Education.

2 M. L. Sisodia and G. S. Raghuvanshi, Microwave Circuits and Passive Devices, New Age Publication.

EC-14.210 **Comprehensive I** **Total Lectures: 40**
0-0-0-3

Objective To acquire intensive knowledge and proficiency in some special field of knowledge.

Prerequisite Basic concepts of all prior program related courses such as, principles of semiconducting materials and devices, digital logic systems and theories of circuits and networks.

1. Comparative study of BJT and MOS transistors in respect of operation, circuit configuration, biasing stability, high and low frequency models, small-signal amplifiers and oscillator design issues.
2. Boolean function implementation using logic gates, comparative studies of RTL, DTL, TTL and ECL logic families in respect of speed, noise and power dissipation, logic function design based on PLA and PAL.
3. Application of Laplace transformation to network equations, steady-state and transient response of low-pass, high-pass and band-pass networks, hybrid and transmission parameters of two-port networks, RL, RC, and RLC network synthesis.

Comment [D36]: Skills Development

Outcome: After completion of this course, students would be able to understand the principles of entire field of major subjects till the second year of study.

Text Books:

1. Millman J. & Halkias C.C., "Electronic Devices and Circuits" McGraw Hill.
2. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Patparganj, Delhi, 4th Edition, 2009.
3. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", John Wiley and Sons, Inc., 1960.

Reference Book:

1. Robert L. Boylestad& Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education.
2. Karim, M.A. and Chen. X., "Digital Design: Basic Concepts and Principles", CRC Press Taylor & Francis Group, Printed in India by Saurabh Printers, 2nd Indian reprint, 2010.
3. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", Tata McGraw-Hill, 2007.

EC-14.301 **Signal Processing and Applications** **Total Lectures: 40**
3 – 1 – 0 – 4

Objective:

- To understand the fundamental characteristics of continuous- and discrete-time signals and systems in terms of both the time and transform domains and to develop the mathematical skills to solve problems involving convolution and sampling.
- The students would be familiar with different methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors. The course emphasizes intuitive understanding and practical implementations of the theoretical concepts.

Pre-requisite: None

1. **Representation and classification of Signals**: Signal classification - Continuous and discrete time, Periodic - aperiodic, even - odd, energy - power, Deterministic - random, real valued - complex exponential, sinusoidal, time scaling, time shifting, Sampling and discrete time processing of continuous-time signals, Concept of frequency in continuous-time and discrete-time signals. **[06]**
2. **Basics of Systems and Transformation**: Properties of systems – linearity, time invariant, causal, stable, inverse, static and dynamic, system impulse response, convolution, correlation, Transformation - Fourier series, continuous time and discrete time Fourier transform, Laplace transform, z-transform, its properties, limitations and inverse transforms, pole – zero concept, computation of impulse response and transfer function using transforms. **[06]**
3. **Analysis of Continuous time and discrete time systems:** Block diagram representation, linear time-invariant (LTI) systems, interconnection of LTI Systems, discrete time systems and their types, systems with finite and infinite duration impulse response, recursive and non-recursive structures, system realizations in direct , transpose, cascade and parallel forms. **[08]**
4. **DFT, FFT and DCT Algorithms:** Discrete Fourier transform (DFT), linear convolution using DFT, efficient computation of the DFT - Fast Fourier transform (FFT) algorithms, radix-2 & 4 FFT algorithms, discrete cosine transform (DCT) - DCT-1 and DCT-2, energy compaction property of DCT. **[06]**
5. **Digital Filter Design:** Review of analog filters – comb and notch types, Design of infinite Impulse Response (IIR) filter from analog filters - Bilinear and Impulse invariant transformation, Finite Impulse Response (FIR) filter - amplitude & phase responses, linear phase filters, transversal filters, windowing techniques, comparison between IIR and FIR filters. **[08]**
6. **Applications of signal processing:** DTMF signal detection, spectral analysis of deterministic and random signals, musical sound processing, signal compression and radar application. **[06]**

Outcome: After completion of the course, students will be able to

- Understand the process of sampling and spectral characteristics of periodic and aperiodic signals using Fourier analysis and determine the response of LTI system using Fourier analysis convolution.
- Understand the meaning and implications of the properties of signals and systems, and represent discrete-time signals analytically and visualize them in the time domain.
- Understand the Transform domain and its significance and problems related to computational complexity.
- Design discrete time filters, compute different errors in design process.

Text Books:

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edition.
2. Signals and Systems – Tarun Kumar Rawat, Oxford Higher Education, 2010
3. Digital Signal Processing – A Computer Based Approach, S. K. Mitra, 3rd Ed, McGraw-Hill.

Comment [D40]: Skills Development

Comment [D41]: Skills Development

Comment [D42]: Skills Development

Comment [D43]: Skills Development

EC-14.302 **Microwave Engineering** **Total Lectures: 40**

3-0-0-3

Objective: To acquire fundamental knowledge of Microwave and apply in engineering applications.

Pre-requisite: Electromagnetic Field Theory.

1. **Introduction:** **[03]**
   Microwaves, Generation: Brief idea of microwave tubes and microwave solid state devices, properties and applications.

2. **Microwave Circuits:** **[07]**
   Equivalent voltage and current definition in waveguides, concept of impedance, impedance matrix, admittance matrix, scattering matrix and transmission matrix**.**

3. **Microwave Passive Devices:** **[10]**
   Excitation of waveguides through probes, loops and apertures. Terminations: matched loads and short, attenuators, phase shifters, two hole directional coupler, E-plane tee, H-plane tee, magic tee, microwave propagation in ferrites, isolators and circulators.

4. **Microwave Active Devices:** **[14]**
   Reflex Klystron, Two cavity Klystron, Travelling Wave Tubes, Magnetrons, Gyrotron, construction, operation and practical applications of Gunn diode, Tunnel diode and IMPATT diode**.**

5. **Microwave Measurements:** **[06]**
   Detection of microwaves, measurement of microwave power, impedance, frequency, VSWR, Q-factor and scattering parameters.

Comment [D62]: Skills Development

Comment [D63]: Skills Development

Outcome: After completion of the course, students would be able to apply microwave concepts and equations in engineering and solve voltage and current equations.

Text Books:

1. David M. Pozar, Microwave Engineering (Third Edition), John Willey & sons.
2. Samuel Y. Liao, Microwave devices and Circuits (Third Edition), Pearson Education.
3. Annapurna Das &Sisir K Das, Microwave Engineering (Second Edition), McGraw-Hill Companies.

Reference Book:

1. Matthew N. O. Sadiku, Principles of Electromagnetics (Fourth Edition), Oxford University Press

EC-14.303 **Principles of Analog Communication** **Total Lectures: 40**
3-1-0-4

Objective:
- To develop a fundamental understanding on communication systems with emphasis on analog modulation techniques.
- To appreciate the mathematical concepts that form the foundations of analog communication

Pre-requisite: Signals and Systems, Statistics and Probability Theory

1. **Linear Modulation Techniques:** Basic blocks of communication systems, Review of signals and systems, Linear Modulation, Time domain and frequency domain description of AM (DSB-FC), DSB-SC, SSB and VSB signals. Generation and detection of linear modulation techniques, Super-heterodyne receivers and design. **[12]**
2. **Angular Modulation Techniques:** Basic concepts, Frequency Modulation Spectrum Analysis of FM Wave, Generation and detection of narrow band and wide band frequency modulation, Phase modulation, FM detection techniques-phase locked loops, Commercial broadcasting systems. **[8]**
3. **Sources of Noise and their characterization:** Random Variables, Random process and their characterization. Noise in Analog communication System. SNR calculations for synchronous detection of DSB and SSB and envelope detection of AM, SNR calculations for angle modulation system. Pre-emphasis and de-emphasis. Threshold effect in angle modulation. **[8]**
4. **Multiplexing and Multiple Access Techniques:** Frequency division Multiplexing, time division multiplexing, multiple access techniques. **[5]**
5. **Sampling and Pulse Modulation:** Sampling theorem – ideal and natural sampling and reconstruction, Pulse-Amplitude Modulation, Pulse-Time Modulation. **[7]**

Comment [D44]: Skills Development

Comment [D45]: Skills Development

Comment [D46]: Skills Development

Outcome:

1) Apply the basic knowledge of signals and systems and understand the basics of communication system and analog modulation techniques.
2) Evaluate the communication system performance in the presence of noise and summarize the merits and demerits of all the conventional analog modulation system.
3) Understand the basics of different of multiplexing and multiple access techniques and their application in cellular networks.
4) Understand the fundamentals of digital transmission of analog signals.
5) Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for modulators, demodulator and communication systems using CAD tool.

Text Books:

1) B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford university press, 4th Edition.
2) P. K. Ghosh, Principles of Analog and Digital Communication, Orient Black Swan Publishers Pvt. Ltd., 1st Edition
3) Taub and Schilling, Principles of Communication Systems, TMH.
4) E. Ziemer William H. Tranter, Principles of Communication, John Wiley & Sons 5th Edition.

Reference Books:

1) S. Haykins, Communication Systems (4/e), Wiley.
2) *Kennedy, Davis, Electronic Communication Systems (4/e), McGraw Hill.*

EC-14.304 **Principles of Digital Communication** **Total Lectures: 40**
3-1-0-4

Objective: The objective of this course is to introduce the students to the basic concepts of digital communication. The aim of this course is to study the fundamental aspects of digital communication systems. The understanding of the fundamentals of digital communication by studying theory, numerical and implementation of circuits.

Pre-requisite: The basics of Communication Systems and Techniques.

1. **Model of a Communication System:** Introduction, advantages of digital communication over analog communication, probability theory random process and random variables. **[6]**
2. **Digital Communication Techniques:** Sampling theorem and techniques, uniform and non-uniform quantization techniques, PCM, DPCM, DM, and ADM, compression standards, time division multiplexing and synchronization, Digital multiplexing hierarchy, Electrical representation of binary sequences Bandwidth requirement of PCM. **[10]**
3. **Information Theory and Coding:** Channel capacity, Shannon capacity, source entropy, Shannon-Fano, Huffman coding, linear block codes and syndrome decoding, cyclic codes, BCH codes, convolution, Viterbi coding and decoding. **[10]**
4. **Digital Modulation Techniques:** Base-band transmission, inter-symbol interference and adaptive equalization, digital modulation and demodulation techniques, bandwidth consideration of different digital modulation schemes, matched filter and probability of error analysis, carrier and timing recovery techniques. **[14]**

Comment [D64]: Skills Development

Comment [D65]: Skills Development

Outcome:

- The students can understand the concepts of digital communication.
- They acquire and apply the knowledge to implement the concepts for designing an efficient communication system.
- They become able to identify, analyse and implement new ideas in digital communication systems for proposing alternate solutions.

Text Books:

1. B. P. Lathi, “Modern Digital and Analog communication Systems”, Oxford University Press, 2010.
2. P. K. Ghosh, Principles of Analog and Digital Communication, Orient Black Swan Publishers Pvt. Ltd., 1st Edition
3. H. Taub, D L Schilling, Goutom Saha, “Principles of Communication”, TMH.

Reference Books:

1. Simon Haykin, “Communication Systems”, Wiley India.
2. H P HSU and D Mitra, “Analog and Digital Communications”, TMH
3. John G. Proakis, “Digital Communications”, McGraw-Hill International.

EC-14.306 **Microcontroller and Embedded Systems** **Total Lectures: 40**
3-0-0-3

Objective: The objective of this course is to teach students design and interfacing of microcontroller-based embedded systems. The course covers fundamentals, The 8051 Architecture, Assembly Language Programming, Instruction set, Serial Communication and Interfacing techniques of 8051 Microcontroller.

Pre-requisite: Programming skills and fundamental knowledge of microcontrollers, microprocessors and digital design.

1. **Introduction to Microcontrollers, Architecture and Memory Interfacing:** Overview of the 8051 family, 8051 Microcontroller's Architecture, Pin configuration, Common memory types and Tradeoffs, External Memory interfacing. **[7]**
2. **Programming of 8051:** Addressing modes of 8051, instruction set of 8051, assembly language programming of 8051, stack structure of 8085, delays, and subroutines, Applications of interrupts, timer/counter and serial port, Components of Integrated Development Environment for software development. **[16]**
3. **Interfacing of 8051:** Interfacing of 8051 with sensors, Keyboard, ADC, DAC, LCD, Stepper Motor and D.C motor. **[8]**
4. **Introduction to Embedded systems and processors:** Introduction and Examples of Embedded Systems, Concept of Embedded System. Design challenge, Processor technology, IC technology, Design technology, Trade-offs: Custom single purpose processor hardware, general-purpose processor: introduction, basic architecture, operation, super-scalar architecture, application specific instruction set processors, microcontrollers, digital signal processors, selection of embedded processor. **[6]**
5. **Software aspect of embedded system:** Challenges and issues in embedded software development, Software and hardware requirements, Real time system, Real time operating systems, Kernel, architecture: mutex, semaphore, testing and verification. **[3]**

Comment [D66]: Employability

Comment [D67]: Employability

Comment [D68]: Skills Development

Comment [D69]: Employability

Outcome: Upon completion of this course, the student will be able to:

1. Program, build and test a microcontroller system.
2. Interface a microcontroller system to user controls and other electronic systems.
3. Describe the internal architecture of microcontroller systems, including counters, timers, ports, and memory.
4. Understand and design embedded systems and real-time systems.
5. For real-time systems:
   - Identify the unique characteristics of real-time systems.
   - Explain the general structure of a real-time system.
   - Define the unique design problems and challenges of real-time systems.

Text Books:

1. M. A. Mazidi, The 8051 Microcontroller & Embedded Systems; Pearson Education.
2. I. Scott McKenzie and Raphael C.W. Phan; The 8051 Microcontroller; Pearson Education.
3. Raj Kamal, Embeded System; Tata Mcgraw-Hill.

Reference Books:

1. David E Simon, An Embedded Software Primer; Pearson Education.

EC-14.401 **VLSI Design** **Total Lectures: 40**
3-1-0-4

Objective:	The educational objectives of the VLSI design course are: **1.** Graduates who desire to pursue an engineering career in VLSI Design arena will be widely employed in positions they find appropriate and desirable. **2.** Graduates who desire to pursue higher degrees will be successful in gaining mission and advancing in programs they find appropriate and desirable.
Pre-requisite:	EC-14.201 Electronics Devices and Circuits, EC-14.203 Digital Electronics.

1.	**Basic VLSI Design Issues:** IC design techniques- hierarchical design, design abstraction and computer-aided design	[4]
2.	**MOS Transistor Theory:** Current-voltage characteristics of MOSFETS, threshold voltage and body effect, MOSFET design equations, second order effects, MOSFET capacitances	[8]
3.	**NMOS and CMOS Inverter:** NMOS and CMOS inverters, W/L ratio for NMOS and CMOS inverters, β_n/β_p ratio, noise margin, NMOS and CMOS Voltage transfer Characteristics, CMOS delay and power dissipation	[8]
4.	**MOS Inverter's Switching Characteristics:** Calculation of delay times, Inverter design with delay constraints	[6]
5.	**Stick Diagram & Layout:** Stick diagrams, CMOS design style, design rules: lambda based design rules, layout design	[8]
6.	**Basic VLSI Circuit Design Techniques:** Inverter equivalent of series and parallel MOS circuits, logic design with delay and power constraints, worst case design, complex logic design	[6]

Outcomes:

- Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing fundamental areas of VLSI design.
- Ability to apply in-depth knowledge of VLSI design principles, systems, and devices to the solution of real time problems.
- Ability to design and evaluate a component or system to meet desired needs within the field of VLSI design.
- Ability to function as a member of a multidisciplinary team in the solution of engineering problems such as providing CAD solution for device fabrications.

Text Books:

1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI, 3rd Ed., 2011
2. Neil H.E. Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 4th Ed., 2011
3. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design, Tata Mc-Graw-Hill, 3rd Ed., 2003

Reference Books:

1. Jab M. Rabaey, Anantha Chandra Kasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI, 2nd Ed., 2012
2. Michal John Sebastian Smith, Application-Specific Integrated Circuits, Pearson Education, 6th Ed., 2009

Comment [D83]: Employability

EC-14.433 **Industrial Training Seminar** **Credits: 2**

Industrial training plays a very important role for engineering graduates of all disciplines. As an engineering student, training can help to implement the concepts that students have learnt in their classes.

Objective: To enhance the knowledge of the students on different cutting edge technologies which have become important part of respective industries.

Industrial training offers the following:

1. Experience of industrial environment/conditions to girls students.
2. Enable the students to learn engineering techniques by observation and practice.
3. Show how theory presented in class is applied in practice.
4. Provide contact with practicing engineers.
5. Familiarize the student with practices and problems faced by companies employing engineers.
6. Give the student the responsibility of completing a piece of work.
7. Enable and accord industry opportunity to shape and participate in the development of future human resources.

Comment [D87]: Employability

Training Outcomes and Assessment

1. Ability to acquire and apply fundamental principles of science and engineering.
2. Capability to communicate effectively
3. Ability to identify, formulate and model problems and find engineering solution based on a systems approach.
4. Ability to conduct research in the chosen fields of engineering.
5. Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.
6. Ability to be a multi-skilled engineer with good technical knowledge, management, leadership and entrepreneurship skills.
7. Awareness of the social, cultural, global and environmental responsibility as an engineer.
8. Capability and enthusiasm for self-improvement through continuous professional development and life-long learning.

EC-14.441 **Principles and Practices of Management** **Total lectures : 26**
Credits : 2-0-0-2

Prerequisite(s): None

Objective(s):

1. To expose the students to fundamental concepts of management and its processes in organizations.
2. To describe the various skills necessary for effective managers.
3. To explain the Individual and Group Behavior along with various leadership Styles

1. **Planning and Organizing** [5]
   Management: Concept, Nature and functions; Planning: Concept, Missions, Objective and Strategies, Steps in Planning; Organizing: Concept, Formal an Informal Organization, Decentralization of Authority, Delegation of Authority, Principles of Organizing, Line and Staff Authority.
2. **Staffing and Controlling** [4]
   Staffing: Definition, Recruitment, Selection, Placement, Promotion, Separation, Performance Appraisal; Controlling: Concepts and Process, Controlling as a Feedback System, Requirements for Effective Control.
3. **Motivation** [4]
   Concept; Theories and Process of Motivation: Maslow's Need-Hierarchy Theory, Herzberg's Hygiene Theory, Goal-Setting Theory, Vroom's Expectancy Theory.
4. **Personality** [3]
   Concept and Determinates, Types and Traits, Personality Attributes Influencing Organizational Behavior, Locus of Control, Machiavellianism, Self-Esteem, Self-Monitoring, Risk-Taking.
5. **Group Behavior and Interpersonal Relationship** [6]
   Groups: Concept and Classification, Stages of Group Development, Rolesand Norms, Group Decision-Making: Group versus Individual, Group Decision Making Techniques and Process, Interpersonal Relationships, Understanding Self and Others, Developing Interpersonal Relationships, Transactional Analysis, Johari Window.
6. **Leadership** [4]
   Concept and Functions; Theories of Leadership: Traits, Behavioral, Situational/Contingency; Inspirational approaches to Leadership: Charismatic Leadership, Transformational Leadership, Transactional Leadership, and Contemporary Leadership.

Outcome(s): By studying this Course, students would be able to understand various Management functions, individual and group behavior. They would also know various styles of Leadership and its applicability. The course would help the students in understanding various organizational contexts and help them understand organizational systems in a better way.

Text Books:

1. Koontz, Harold and Weihrich, Heinz, Essentials of Management: An International, Innovation and Leadership Perspective, 10th Edition, McGraw Hill Private Limited, India, 2015
2. Robbins, Stephen P., Timothy Judge and Neharika Vohra, Organizational Behavior, 12th Ed., Pearson Education, 2011.

Reference Books:

1. Prasad L. M., Principles and Practice of Management, 9th Edition, Sultan Chand & Sons, 2015
2. Aswathappa K. Organizational Behavior, Eighth Edition, Himalaya Publishing House.
3. James A. F. Stoner, Freeman A. Edward, and Daniel A. Gilbert Jr., Management, Pearson Education
4. Fred Luthans, Organisational Behaviour, 11th Ed., Mc - Graw Hill, 2009

Comment [D86]: Entrepreneurship

EC-15.312 **Advance Radio Access Network (ARAN)** **Total Lectures: 40**

3-0-0-3

Objective:
To acquire skills on different legacy and advance RAN's Architecture, Design & Optimization along with latest industries concepts on 5G, IOT, Volte, RAN Cloud etc.

Prerequisite:
Digital Modulation Techniques & Data Transmission, Antenna and Wave Propagation, Basics of Mobile Communication

1.	**Introduction to RAN:** Telecom E2E approach, RAN Life Cycle,RF basics, Microwave Theory, Propagation Models, Modulation Theory, Antenna Theory. Latest Industry Concepts – 5G, IOT, Volte, RAN Cloud	[4]
2.	**RAN Overview**:Introduction to Cellular Concepts, Introduction to Power Control, Introduction to Protocol Stacks, GSM, WCDMA, LTE (Overview, Architecture, Air Interface), Generalized Call Flows	[12]
3.	**RAN Design:**RF Design Overview, Initial Radio Network Design (Link Budget, Radio Network Dimensioning & Nominal Design), Final Radio Network Design, Radio Planning Tools & IBS Introduction, Radio Propagation Model Tuning, LRAN Initial Radio Network Design (Sample Report)	[12]
4.	**RAN Optimization:**Pre Launch Optimization (Process Overview, Introduction to Drive Testing (Data Collection Methodology, Data Post Processing),Post Launch Optimization, (Process Overview, Introduction to Counters and OSS, KPI Improvement Methodology)	[12]

Outcome: After completion of this course, students would be able to understand the industry level ways of working of RAN with different design and optimization techniques. Students will get heads up in terms of upcoming advance technologyconcepts.

Text Books:

1. Ericsson Academy (Ericsson Internal)
   - Air Interface
   - Protocol and Procedures
   - GSM, UMTS, LTE Fundamentals
   - RAN Design & Performance Management.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2007.
3. Theodore S. Rappaport, "Wireless Communication", Pearson Education, Asia, New Delhi, 2002.

Reference Books:

1. John G. Prokis and Masoud Salehi," Digital Communication", McGraw-Hill, Fifth edition.

Comment [D78]: Employability

EC-15.313	System Design Using HDL	Total Lectures: 40
		3-0-0-3

Objective: To acquire fundamental knowledge of designing of digital systems using VHDL.Students will acquire practical working knowledge of creating digital circuits using commercial Computer-Aided-Design (CAD) tools.

Pre-requisite: Knowledge of digital logic and digital circuits are highly desired.

1. **Programmable Logic Design:** ASIC, ROM, PLA, PAL, CPLD and FPGA. **[3]**
2. **VHDL Based Design:** An overview of VHDL, Role of VHDL in system design, Introduction to CAD tools for system design, Introduction to Xilinx IDE software. **[3]**
3. **VHDL Fundamentals:** Entity and architecture declaration, Introduction to behavioral, dataflow and structural models, package, package declarations and package body. **[6]**
4. **Basic Elements of VHDL:** Data objects – constant, variable and signal, Data types – scalar and composite, Predefined Operators – logical, relational, shift, adding and multiplying, Overloading – literal and operator. **[4]**
5. **VHDL Statements:** Process, variable assignment, signal assignment, sequential statements, conditional statements, loop**,** if, case, next statements, assertion and report statements, signal drivers and signal assignment statements, conditional signal assignments, select and generic. **[10]**
   Subprograms: Application of functions and procedures, Overloading and signal assignments, Component declaration, Component instantiation.
6. **Combinational Circuit Design:** VHDL models of combinational circuits such as Adder, Multiplexer, De-multiplexer, Encoder, Decoder, Code converters, Comparators, Parity generators, Multipliers and implementation of Boolean functions. **[7]**
7. **Sequential Circuit Design:** VHDL Models of sequential such as edge triggered D flip flop, T flip flop and J K flip flop, serial in serial out register, serial in parallel out register, parallel in parallel out register, counter, memory, ALU. **[7]**

Comment [D55]: Employability

Comment [D56]: Skills Development

Comment [D57]: Employability

Outcome: After completion of the course, students would be able to:

- Identify, formulate, and solve engineering problems
- To use the technique, skills, and modern engineering tools necessary for engineering practice.

Text Books:

1. J. Bhaskar, VHDL Primer, Pearson Education Asia, 3rd Ed.
2. Douglas L. Perry, VHDL Programming by Examples, Tata McGraw Hill, 4th Ed.
3. Yogesh Misra, Digital System Design Using VHDL, Dhanpat Rai & Co., 1st Ed.

EC-18.402 **Wireless Networks** **Total Lectures: 40**
3-1-0-4

Objective: To acquire fundamental knowledge of various types of wireless networks and apply them to wireless communication applications.

Pre-requisite: EC-14.303 Principles of Analog Communication, EC-14.304 Principles of Digital Communication

1. **Introduction:** Introduction to wireless networks, Wireless communication systems – Paging system, cordless telephone system, cellular telephone system [4]

2. **Basics of cellular communication systems**: Frequency reuse, channel assignment, call handoff, interference and system capacity, Mobile radio propagation – path loss and fading, 2G, 2.5 G and 3G wireless networks**.** [10]

3. **Multiple Access Techniques**: Frequency Hopped Multiple Access, Code Division Multiple Access, Hybrid Spread Spectrum Multiple Access, Packet Radio, Carrier Sense Multiple Access, Reservation Protocol [10]

4. **Equalization, Diversity and Channel Coding**: Fundamentals of equalization, Linear equalization, Nonlinear equalization, Diversity techniques – space diversity, time diversity, frequency diversity, polarization diversity, RAKE receiver, Block code and convolution code. [8]

5. **Wireless Networking**: Wireless local area network, RF and IR WLAN, advantages and applications, IEEE 802.11, IEEE 802.16, HYPERLAN, Bluetooth, WiMax, Ultra Wide Band communication. [8]

Comment [D93]: Skills Development

Comment [D94]: Skills Development

Comment [D95]: Skills Development

Outcome: After completion of the course, students would be able to apply wireless communication concepts and ideas to engineering applications and to develop high performance wireless communication network.

Text Books:

1. T. S. Rappaport, Wireless Communication, Principles and Practice, 2nd Ed, Pearson Education, 2009
2. Upena Dalal, Wireless Communication, Oxford University Press, 1st Ed., 2009.
3. J. Schiller, Mobile communications, Addison-Wesley.

Reference Book:

1. William C. Y. Lee, Mobile cellular telecommunication – Analog and Digital systems, McGraw Hill, 2nd Ed, 2006

EC-18.442 **Engineering Economics** **Total Lectures: 26**
Credit: 2-0-0-2

Prerequisite(s): Nil

Objective(s):
1. Provide students with fundamental concepts of engineering economics.
2. Provide students with economical methods to compare and evaluate alternatives based on present, annual, rate of return, and benefit over cost analyses.
3. Emphasize practical engineering-based applications and the use of real data examples.

1. **Introduction**: Definitions, Scope; Microeconomics vs. Macroeconomics; Engineering and engineering economics; Principles of engineering economics. [2]
2. **Theory of Demand & Supply**: Determinants, law of demand, law of supply, equilibrium, elasticity of demand. [3]
3. **Economics Applied to Industries**: Theory of production; production function, Law of variable proportions, Returns to scale, Theory of cost; Various concepts of cost: Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost, average cost, marginal cost, total cost etc; Break even analysis. [6]
4. **Market Structures& Pricing Techniques:** Meaning of Market, Types of Market- perfect competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets). [5]
5. **Replacement analysis and depreciation**: Replacement Analysis Decision Map, Basic aspects of depreciation, Deterioration & Obsolescence, and its methods [3]
6. **Optimization technique**: Optimization under constraints and without constraints, optimal resource allocation, optimization under risk and uncertainty. [4]
7. **Capital budgeting**: Concept; under certainty and uncertainty, Techniques; Discounting &compounding techniques, IRR, NPV, PBP, Profitability index, Accounting rate of return. [3]

Comment [D96]: Skills Development

Comment [D97]: Skills Development

Outcome(s):
1. Understand major principles of economic analysis for decision making among alternative courses of action in engineering.
2. Apply cost estimation and alternative analysis techniques for engineering applications.
3. Recognize the economic impact of engineering solutions.
4. Calculate depreciations and understand the impact of inflation.
5. Perform breakeven analysis for a single project and between two alternatives.

Text Books:
1. Salvatore, Dominick. Managerial Economics, Prentice Hall of India, 6th Ed.
2. D. N. Dwivedi, Managerial Economics, OUP, Vikas Publication, 7th Ed.

Reference Books:
1. Suma Damodran, Managerial Economics, OUP, 2nd Ed.

EE-14.201 **Network Analysis & Synthesis** **Total Lectures: 40**
3-1-0-4

Objective: This course helps in analysis of A.C & D.C circuits and it also help to design the circuit models for the minor and major projects.

Prerequisite: Knowledge of Laplace transformation

1. **Development of Circuit Concept:** Introduction, capacitance, inductance and resistance parameters, approximation of a physical system as a circuit, reference directions for current and voltage, voltage and current sources, active element conventions, dot convention for coupled circuits, topological description of networks, linear graphs of a network and its parts, loops and trees, incidence matrix, cut-set matrix and tie-set matrix. [8]
2. **Network Equations**: Kirchhoff's laws, minimum number of network equations, source transformations, formulation of network equations, loop variable analysis & node variable analysis and duality. [6]
3. **Analysis of RLC Circuits**: Laplace transformation, some basic theorems for the Laplace transformation, transient response of RL, RC and RLC circuits using Laplace transform with D.C input and A.C. with sinusoidal input, partial fraction expansion, solution of problems by Laplace transformation. [8]
4. **Network Theorems**: Superposition and reciprocity theorems, Thevenin's and Norton's theorems, Millman's theorem, Tellegen's theorem, and maximum power transfer theorem, application of these theorems to networks with a.c and d.c excitation. [8]
5. **Two Port Network** Two port parameters, impedance, admittance, hybrid, inverse hybrid, transmission parameters, relationship between various parameters, reciprocity and symmetry of two port network, inter connection of two port networks. [6]
6. **Synthesis of Passive Network**: Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [6]

Comment [D15]: Skills Development

Comment [D16]: Skills Development

Comment [D17]: Skills Development

Comment [D18]: Skills Development

Comment [D19]: Skills Development

Course outcome: Upon successful completion of this course, students should be able to:

1. Gain fundamental knowledge of the basic electrical elements such as resistance, capacitors and inductances.
2. Understand circuit representation as graphs and implementation of KVL and KCL in the circuits and to solve the circuit problems by Laplace transformation method and also by applying various networks theorems.
3. Analyze small RLC circuits by hand. Use network techniques, like node analysis and loop analysis, to write equations for large linear circuits.
4. Apply Thevenin and Norton theorems and concept of linearity and superposition to analyze and design circuits and networks.

Text Books

1. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", John Wiley and Sons, Inc., 1960.
2. A. Chakrabarti, "Circuit Theory – Analysis and Synthesis", Dhanpat Rai & Co., 2001. International Editions, 1993.
3. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", Tata McGraw-Hill, 2007.
4. W. H. Hyatt Jr. and J. E. Kemmerly, "Engineering Circuits Analysis", McGraw-Hill.

EE-14.204 **Electrical Measurement and Instrumentation** **Total Lectures: 40**
3-0-0-3

Objective: To make students conversant with concepts of measurement and various electrical and electronics instruments, transducers and bridges.

Pre-requisite: Basic Electrical engineering, Basic Electronics engineering

1	**Concepts of Measurements:** Introduction, accuracy and precision, repeatability, errors in measurement, sources of errors, types of errors, statistical analysis of measurement data, graphical representation of measurement, data as distributions, Gaussian graph and precision indices.	[6]
2	**Analog Instruments:** Types of operating torques in an analog instrument, Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Shunts and multipliers. Applications of instruments for measurement of single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment.	[6]
3	**Bridge:** DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, Weins bridges.	[6]
4	**Electronic Instruments for Measuring Basic Parameters:** Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, Q meter, Vector Impedance meter, signal analyzers- wave analyzers, harmonic distortion analyzers and spectrum analyzers.	[6]
5	**Potentiometers:** DC and AC potentiometers, Principles, Standardization and application.	[5]
6	**Transducers:** Introduction , Classification, Selection Criteria, Characteristics, Construction, Working Principles and applications of following Transducers- RTD, Thermocouples, Thermistors, LVDT, RVDT, Strain Gauges, Tachogenerators, Piezoelectric Transducers, Ultrasonic Flow Meters.	[6]
7	**Oscilloscopes:** CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay.	[5]

Comment [D47]: Skills Development

Comment [D48]: Skills Development

Comment [D49]: Skills Development

Comment [D50]: Skills Development

Outcome: Students will be able to understand electrical and electronic measuring devices and instrumentation like bridges, transducers, CRO etc.

Text Books:

1. Albert D. Helfrick, Wiliam D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning Private Limited, 2011.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai and Co., 2005.

Reference Books:

1. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill, II Edition 2004.
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2007.
3. A.J. Bouwens, 'Digital Instrumentation', Tata McGraw Hil.,1997
4. E.O. Doebelin, 'Measurement Systems – Application and Design', Tata McGraw Hill publishing company, 2007.

EE-14.303 **Control System Engineering** **Total Lectures: 40**
3-1-0-4

Objective: The student gains the knowledge of the fundamental principles of analog and digital control system engineering, time response and frequency response analysis with its practical implementation. This course helps in understanding the design of Compensator and PID controller for the Automatic control of Industry.

Pre-requisite: MA-14.201 Applied Mathematics, EE-14.201 Network Analysis & Synthesis

1.	**Introduction:** Introduction to control systems, digital control system, types of control systems and their examples, mathematical modeling of systems (mechanical and electrical).	[10]
2.	**Reduction Techniques:** Block diagram reduction and signal flow graph representation of systems.	[10]
3.	**Domain Analysis:** Time domain and frequency domain analysis of systems.	[7]
4.	**Stability:** Concept of stability and algebraic criteria (Hurwitz's and Routh's stability criterion).	[4]
5.	**Plotting Techniques:** Root locus techniques, Bode plots, polar plots Nyquist criterion and Nichol's chart.	[7]
6.	**State Variables:** State variable analysis and design.	[2]

Outcome: After completion of the course,

- The student will be able to get acquainted of analog and digital control system.
- The student will analyze and to design and development of automatic controller for industrial application.
- The student will gain the knowledge of stability analysis and improvement of stability for control system.
- This course becomes very beneficial for the graduates who wish to work in core sectr industry as most of the core sector is state-of-art control.
- This course becomes very beneficial for the 4th year student who will choose elective paper in Digital control system and other control system elective.

Text Books:

1. K. Ogata, "Modern Control Engineering," Pearson Education/Prentice Hall of India, 2003.
2. I. J. Nagrath and M. Gopal, "Control System Engineering," New Age International Publishers, 2003.
3. M. N. Bandyopadhyay, "Control Engineering Theory and Practice," Prentice Hall of India, 2003.

Reference Books:

1. Syed Hasan Saeed, "Automatic Control Systems (with MATLAB Programs)," S. K. Kataria & Sons, Publisher of Engineering & Computer Books.
2. Samarjit Ghosh, " Control Systems: Theory and Applications," Pearson Education, Second Edition, 2009

Comment [D85]: Skills Development

EE-14.304 **Power Electronics** **Total Lectures: 40**

3-0-0-3

Objective:

- To introduce to students the theory and applications of power electronics systems for high efficiency, renewable and energy saving conversion systems
- To prepare students to know the characteristics of different power electronics switches, drivers and selection of components for different applications
- To develop students with an understanding of the switching behavior and design of power electronics circuits such as DC/DC, AC/DC, DC/AC and AC/AC converters

Prerequisite: Network Analysis, Basics of Electronics Engineering, Engineering Mathematics

1. **Introduction:** Review of power semiconductor devices, SCR, Static and dynamic characteristics, Turn-on and Turn-off methods and circuits, Ratings and protection of SCRs, Series and parallel operation of thyristor, Other members of thyristor family. [8]
2. **Phase Controlled Converters:** Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits, Single phase dual converters and their operation with circulating and non-circulating currents. [10]
3. **AC Voltage Controllers:** Types of single-phase voltage controllers, Single-phase voltage controller with R and RL type of loads, gate pulse requirements to trigger the SCRs of ac voltage controllers. [5]
4. **Cyclo-converters:** Principles of operation, Single phase to single phase step up and step down cycloconverters. Three phase to single phase cycloconverter. [5]
5. **DC Choppers:** Principle of chopper operation, Control strategies, Types of choppers, Step up and step down choppers, Types of choppers and operations. [5]
6. **Inverters:** Single phase VSI: half bridge and full bridge inverters and their steady state analysis, Series and parallel inverters, three phase bridge inverters with 180 degree and 120 degree modes of operation. Current source inverters, CSI with R load (qualitative approach). [7]

Comment [D70]: Skills Development

Comment [D71]: Skills Development

Comment [D72]: Skills Development

Comment [D73]: Skills Development

Outcome:

- The student will be able to understand the principle of operation of commonly employed powerelectronic converters
- The student will be capable of analyzing non-linear circuits with several power electronic switches
- The student will be equipped to take up advanced courses in Power Electronics and its application areas

Text Books:

1. Rashid, M., Power Electronics, Prentice Hall of India Private Limited (2006).
2. P. S. Bimbhra, Power Electronics, Khanna publishers.

Reference Books:

1. Mohan, N., Undel, T. M. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley and Sons (2007).

MA 14.201 **Applied Mathematics** **Total Lecture: 40**
3-1-0-4

Objective: To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1. Linear Programming: Introduction**,** Graphical method (bounded & unbounded solutions); Simplex method, Artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). **[12]**

2. Numerical Methods: Solution of system of equations (Gauss elimination and Gauss - Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector Runge-Kutta methods). **[10]**

Comment [D20]: Skills Development

3. Complex Analysis: Function of complex variable, analytic function, Cauchy- Riemann equations(without proof), integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula(without proof), zeros and singularities of complex functions, residues. **[06]**

4. Integral Transform: Laplace transform and inverse Laplace transform First and Second Shifting theorems, Convolution theorem (without proof), Solution of ordinary differential equations with initial conditions by Laplace transforms. Fourier series of periodic functions, even and odd functions, Fourier half-range series; Basics of Fourier transforms. **[12]**

Comment [D21]: Skills Development

Outcome: After completion of the course, students would be able to apply the knowledge of linear programming , numerical methods ,complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. Grewal B.S. & Grewal J.S., Higher Engineering Mathematics, Khanna publishers, 39th Edition: 2005.
3. Taha H.A., Operation Research: An Introduction, Pearson.
4. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.

Reference Books:

1. Jain R.K. & S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 2003.
2. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
3. James B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Babu Ram, Engineering Mathematics, Pearson, Year 2010.

MA 14.202 **Statistics and Probability Theory** **3-1-0-4**
Total Lecture: 40

Prerequisite: Basic Mathematics

Objective: To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

1	Introductory Ideas: Recapitulation of Basic Probability theory; Law of addition and law of multiplication ;conditional probability; total probability; Bayes' theorem and it's applications.	[06]
2	Random Variables and Distribution: Discrete and continuous random variables; types of distribution; probability mass and density functions; mean, variance and standard deviation of distribution.	[04]
3	Theoretical Probability Distribution: Discrete types (Binomial) and Continuous type (Normal,Students'); applications of basic ideas to these distributions.	[08]
4	Sampling Theory: Sampling distribution of mean and variance; central limit Theorem.	[04]
5	Testing of Hypothesis: Simple and Composite hypothesis; Type I and Type II errors; tests of significance and level of significance.	[04]
6	Correlation and Regression: Simple, partial and multiple correlations; linear regression.	[06]
7	Queuing Theory and Queuing Models: Birth and death process; pure birth and pure death process; Classification of queuing models: M/M/1, M/M/1/N, M/M/S and M/M/S/N.	[08]

Comment [D34]: Skills Development

Comment [D35]: Skills Development

Outcome: After completion of the course, students would be able to apply the knowledge of Statistics and Probability in engineering and solve curriculum problems.

Text Books:

1. A.P.Baisnab and Manoranjan Jas, Elements of Probability and Statistics, 2003, TMH.
2. Pugalararasu, Probability and Queuing Theory, TMH.
3. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, June 2002.
4. Gupta & Kapoor, Fundamental of Applied statistics, SCS Publisher, Jan 2001.
5. B.V. Ramana, Higher Engineering Mathematics, TMH, 2006.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH.
2. Palaniammal, Probability and Random Processes, PHI.
3. Spiegel, Probability and Statistics (Schaum's outline Series), TMH.
4. Miller and Freund's, Mathematical Statistics with Applications, 7e, Pearson.
5. Richard A. Jonson, Probability and Statistics for Engineers, Pearson.

RM 17.101 **Research Methodology** **2-0-0-2**

1	**Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research.	[2]
2	**Problem Formulation:** Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature.	[2]
3.	**Research Design:** Research Framework, Meaning & Significance of Research Designs, Features of a good Research Design, Types of Research Design.	[4]
4.	**Data for research:** Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis.	[6]
5.	**Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAb, Network Simulators, ETAP, Solid Works, MultiSim.	[6]
6.	**Thesis Writing:** Contents, Referencing Styles, Ani Plagiarism Policy, Literature Review, Motivation, Objectives, research gap, Methodology, Research Deasin and Analysis, Results, Findings, Implications, Contributions, Significance of research, Scope for future work and conclusion.	[6]

Comment [D74]: Skills Development

Comment [D75]: Skills Development

Comment [D76]: Skills Development

Comment [D77]: Skills Development

Text Books:

1. R. Pannershelvam, "Research Methodology" Prentice Hall India, New Delhi, 11th Edition, 2013.
2. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International (p) Limited, Publishers New Delhi, 2nd edition, 2008.
3. William G.Zikmund, "Business Research Methods", Cengage Learning New Delhi, 9th edition,2009.
4. Mark Saunders, "Research Methods for Business Students" Pearson Education New Delhi, 5th edition, 2013.
5. Donald R Cooper, "Business Research Methods" Tata McGraw-Hill Publishing Company Limited New Delhi, 9th edition, 2008.
6. Dr.A.K.Phophalia, "Modern Research Methodology: New Trends and Techniques" Paradise Publishers Jaipur, 1st edition, 2010.
7. Pankaj Madan, "Research Methodology", Global Vision Publishing House, New Delhi, 1st edition, 2010.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of EE

Course structure for

B.Tech EE

EE-14.201 **Network Analysis & Synthesis** **Total Lectures: 40**
3-1-0-4

Objective: This course helps in analysis of A.C & D.C circuits and it also help to design the circuit models for the minor and major projects.

Prerequisite: Knowledge of Laplace transformation

1. **Development of Circuit Concept:** Introduction, capacitance, inductance and resistance parameters, approximation of a physical system as a circuit, reference directions for current and voltage, voltage and current sources, active element conventions, dot convention for coupled circuits, topological description of networks, linear graphs of a network and its parts, loops and trees, incidence matrix, cut-set matrix and tie-set matrix. [8]
2. **Network Equations**: Kirchhoff's laws, minimum number of network equations, source transformations, formulation of network equations, loop variable analysis &node variable analysis and duality. [6]
3. **Analysis of RLC Circuits**: Laplace transformation, some basic theorems for the Laplace transformation, transient response of RL, RC and RLC circuits using Laplace transform with D.C input and A.C. with sinusoidal input, partial fraction expansion, and solution of problems by Laplace transformation. [8]
4. **Network Theorems**: Superposition and reciprocity theorems, Thevenin and Norton theorems, Millman theorem, Tellegen theorem, and maximum power transfer theorem, application of these theorems to networks with a.c and d.c excitation. [8]
5. **Two Port Network**: Two port parameters, impedance, admittance, hybrid, inverse hybrid, transmission parameters, relationship between various parameters, reciprocity and symmetry of two port network, inter connection of two port networks. [6]
6. **Synthesis of Passive Network**: Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [6]

Course Outcome: Upon successful completion of this course, students should be able to:

- Gain fundamental knowledge of the basic electrical elements such as resistance, capacitors and inductances.
- Understand circuit representation as graphs and implementation of KVL and KCL in the circuits and to solve the circuit problems by Laplace transformation method and also by applying various networks theorems.
- Analyze small RLC circuits by hand. Use network techniques, like node analysis and loop analysis, to write equations for large linear circuits.
- Apply Thevenin and Norton theorems and concept of linearity and superposition to analyze and design circuits and networks.

Text Books:

1. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", Pearson, 3rd Edition, 2016.
2. A. Chakrabarti, "Circuit Theory – Analysis and Synthesis", Dhanpat Rai & Co., 6th Edition, 2010.

Reference Books:

1. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", McGraw-Hill, 5th Edition, 2015.
2. W. H. Hyatt Jr. and J. E. Kemmerly, "Engineering Circuits Analysis", McGraw-Hill, 7th edition, 2010.

EE-14.202 **Electrical Machines-II** **Total Lectures: 42**

3-1-0-4

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction and performance of A.C machines and synchronous machines.

Pre-requisite: Electrical Machine-I

1. **Basic Concept of A.C. Rotating Machines:** Introduction to Armature winding, Integral slot and fractional slot winding, Distribution factor (K_d), Pitch factor (K_p) and winding factor (K_w). Production of rotating magnetic field, EMF and torque equations, Effect of tooth harmonics and methods of reduction. [4]
2. **Synchronous Generator:** Construction, Cylindrical rotor and salient pole rotor, Principle of operation, Excitation system, Effect of winding factor on EMF, Armature reaction, Circuit model, Phasor diagram, O.C. and S.C. tests, Short-circuit ratio, Determination of voltage regulation by synchronous impedance, MMF and zero power factor methods. [7]
3. **Performance Characteristics of Synchronous Generator:** Two reaction theory, Phasor diagram, Power-angle characteristic of synchronous generators, Synchronizing power and torque, Synchronizing methods, Parallel operation of synchronous generator, Effect of change in excitation and mechanical power input on load sharing, Operation of alternator on infinite bus bars, Slip test. [6]
4. **Synchronous Motor:** Construction, Principle of operation, Equivalent circuit, Phasor diagram, Circuit model, Effect of change in excitation on armature current and power factor, Starting of synchronous motor, Synchronous condenser, Hunting, Applications. [6]
5. **Induction Motor:** Introduction, Construction, Principle of operation, Slip and rotor frequency, Comparison with transformer, Equivalent circuit model, Representation of mechanical load, No load and blocked rotor tests. Torque and power output, Losses and efficiency, Separation of losses. [7]
6. **Performance Characteristics of Three-Phase Induction Motor:** Circle Diagram, Torque-slip characteristics, Effect of rotor resistance, Starting torque and maximum torque, Starting and speed control methods, Cogging and crawling, Introduction to induction generator, Applications. [6]
7. **Single-Phase Induction Motor & special machines:** Introduction, Double revolving field theory, Cross field theory, Torque-speed characteristic, Equivalent circuit model, Starting methods, Applications, Stepper Motor, and Reluctance motor. [6]

Outcome: The students shall develop an insightful knowledge on various ac motors and ac generators.

Text Books:

1. D.P. Kothari and I.J. Nagrath,. "Electric Machines", McGraw-Hill,2nd Edition, 2004
2. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 5th Edition, 2013.

Reference Books:

1. A.E. Fitzgerald, Charles Kingsley and Stephen D.U Electric Machinery, Mc Graw-Hill, 2nd Edition, 2003.
2. J.B. Gupta, Theory and Performance of Electrical Machines, S.K. Kataria and Sons, 3rd Edition, 2002

EE-14.203 **Electrical Machines-I** **Total Lectures: 43**

3-1-0-4

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction details and performance of D.C machines and Transformer.

Pre-requisite: Electrical Engineering course of First Year.

1. **Basic Concepts of Electrical Machines:** Introduction, Electromagnetic induction, flux linkage, statistically and dynamically induced emf, Classification and description of electrical machines, Heating and cooling of electrical machines. [4]
2. **Elements of Rotating Machines**: Introduction, Basic Components, Rotor, Stator and field excitation. Generator and motor action, EMF and torque equations, Leakage flux, Losses and efficiency, Rating and loss dissipation, Electrical and mechanical degrees. [5]
3. **Introduction to D.C. Machines:** Constructional parts of d.c. machines and their function, Principle of operation, Armature winding- Lap and wave, Simplex and duplex, Method of excitation, Classification, Derivation of emf and torque equations, Process of commutation, Armature reaction, Interpoles, Compensating winding and equalizer rings. [6]
4. **D.C. Generator**: Operating characteristics- Magnetization, Internal and external characteristics, Critical resistance and critical speed, Process of building up of voltage, Causes of failure of voltage build-up and remedies, Parallel operation of d.c. generators, Applications. [6]
5. **D.C. Motor**: Basic equation for voltage, Power, Torque and speed, Condition for maximum power, Operating characteristics- Torque-current, Speed-current and Torque-speed characteristics. Comparison, Starters, Speed control methods, testing of d.c. machines-Swinburne, Hopkinson's and Series field tests. Calculation of efficiency, Applications. [6]
6. **Transformers**: Principle of operation, Construction and practical considerations, Ideal and physical transformer, emf equation, Transformation ratio, Phasor diagram. Performance analysis, Equivalent circuit, Losses and efficiency, Condition for maximum efficiency, Determination of equivalent circuit parameters by O.C. and S.C. tests, Per unit calculation, Polarity test, Voltage regulation, All day efficiency. [10]
7. **Transformer Connections and Operation**: Back-to-back test, Parallel operation, Autotransformer, 3-phase transformer, Vector group, Three-phase transformer connections- Star-star, Delta-delta, Star-delta, Delta-star, Zig-zag connections, Scott connection, Open delta connection, Transformer cooling. [6]

Outcome: Graduates will have the knowledge of DC Electric motor, DC Generator and Transformer. They will understand how these motors are operated for applications.

Text Books:

1. D.P. Kothari and I.J. Nagrath,. "Electric Machines", McGraw-Hill, 2nd Edition, 2004.
2. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 5th Edition, 2013.

Reference Books:

1. A.E. Fitzgerald, Charles Kingsley and Stephen D.U Electric Machinery, Mc Graw-Hill, 2nd Edition, 2003.
2. J.B. Gupta, Theory and Performance of Electrical Machines, S.K. Kataria and Sons, 3rd Edition, 2002.

EE-14.204 **Electrical Measurement and Instrumentation** **Total Lectures: 40**
3-0-0-3

Objective: To make students conversant with concepts of measurement and various electrical and electronics instruments, transducers and bridges.

Pre-requisite: Basic Electrical engineering, Basic Electronics Engineering

1. **Concepts of Measurements:** Introduction, accuracy and precision, repeatability, errors in measurement, sources of errors, types of errors, statistical analysis of measurement data, graphical representation of measurement, data as distributions, Gaussian graph and precision indices. [6]
2. **Analog Instruments:** Types of operating torques in an analog instrument, Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Shunts and multipliers. Applications of instruments for measurement of single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment. [6]
3. **Bridge:** DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, Weins bridges. [6]
4. **Electronic Instruments for Measuring Basic Parameters:** Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, Q meter, Vector Impedance meter, signal analyzers- wave analyzers, harmonic distortion analyzers and spectrum analyzers. [6]
5. **Potentiometers:** DC and AC potentiometers, Principles, Standardization and application. [5]
6. **Transducers:** Introduction , Classification, Selection Criteria, Characteristics, Construction, Working Principles and applications of following Transducers- RTD, Thermocouples, Thermistors, LVDT, RVDT, Strain Gauges, Tacho-generators, Piezoelectric Transducers, Ultrasonic Flow Meters. [6]
7. **Oscilloscopes:** CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay. [5]

Outcome: Students will be able to understand electrical and electronic measuring devices and instrumentation like bridges, transducers, CRO etc.

Text Books:

1. Albert D. Helfrick, Wiliam D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning Private Limited, 2011.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai and Co., 2005.

Reference Books:

1. H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, 2nd Edition, 2004.
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2nd Edition 2007.
3. A.J. Bouwens, 'Digital Instrumentation', McGraw Hil, 2nd Edition, 2002.
4. E.O. Doebelin, 'Measurement Systems – Application and Design', McGraw Hill publishing company, 3rd Edition, 2007.

EE-14.210 **Comprehensive-I**

0-0-0-3

Objective: This course provides the:

1. The fundamental principles in electric circuit theory and to be able to extend these principles into a way of thinking for problem solving in mathematics, science, and engineering.
2. To expose the students to the concepts of various types of electrical machines and applications of electrical machines.
3. Build a foundation of basic knowledge required for electrical power engineers.
4. Understand the sources of energy and their contributions to the energy and power needs of the nation and the world.

Pre-requisites: Network Analysis, Electrical Machine-I, Electrical Machine-II, Power Plant Engineering, Electrical Measurement & Instrumentation

1 **Network Analysis:** Kirchoff's Laws in the frequency domain and impedance combinations, Nodal and mesh analysis for phasor circuits, Power in the Unbalanced three-phase systems, Application of the Laplace transform to electric circuits and the transfer function

2 **Special Machines:** Tacho-generator, AC and DC servomotor, Linear induction motor, Single phase motor, Double field revolving theory, Capacitor start capacitor run motors, Shaded pole motor, Repulsion type motor, Universal motor, Stepper motor.

3 **Electrical Measurement and Instrumentation:** Instrumentation amplifiers- single differential amplifier and three amplifier configurations, D/A and A/D converters, and concepts of a measurement channel and its components, Data acquisition and distribution configurations, analyze sample and hold circuits and multiplexers, Transducer interfacing techniques, passive and active transducer measurement requirements, Error analysis in the measurement channel, types of errors; consider transducer errors, transducer output linearization, instrumentation amplifier errors, filter errors, A/D converter errors, sample and hold and multiplexer errors.

4 **Power Generation System:** Steam power plant generation cycles, Nuclear Power Generation Safety considerations in the nuclear industry. Developments in nuclear fusion. Decommissioning problems of nuclear sites. Nuclear waste disposal systems, Fuel Cells-Definition and principles of operation. Losses and efficiency. Possible fuels. Fuel-cell technologies and applications, Combined Heat and Power (CHP) schemes, Application of CHP systems for the provision of heating, cooling and electric power. Selection criteria of CHP prime-movers.

Outcome: Upon completion of this course, the students should be able to:

1. Use network techniques, to analysis large circuits.
2. Understand constructional details, principle of operation of Special Machines.

Text Books:

1. I.J Nagrath, "Electric Machines", McGraw hill Edition.4th Ed. 2010.
2. F. F. Kuo "Network Analysis & Synthesis", John Wiley & Sons, 2nd Ed., 1999.

Reference Books:

1. M. G Say, "Alternating Current Machines", ELBS & Piman, London, 2nd Ed 1984.
2. D Roy Choudhury., "Networks and Systems", New Age International Publishers, 2nd Ed 2010.
3. A K Sawhney, "A course in Electrical & Electronic Measurements & Instruments", Dhanpat rai, 3rd Edition, 2005.

EE-14.301 **Transmission & Distribution** **Total Lectures: 40**

3-1-0-4

Objective:
1. To learn the fundamentals of power system for designing a system that meets specific need.
2. To understand the factors affecting Insulators and also in Under Ground cables.
3. To calculate the various parameters in Distribution System.

Pre-requisite: Network Analysis& Synthesis

1. **Introduction:** Structure of a power system, Effect of Transmission voltage, Load factor, diversity factor, plant capacity factor, plant utilization factor, different types of tariffs, per unit quantities and its advantages, Impedance and Reactance Diagram. [5]

2. **Transmission Line Parameter:** Configuration, Type of conductors, Resistance of line, Skin & Proximity Effects, Calculation of Inductance and capacitance of single phase, three phase, Single circuit and double circuit transmission lines. [7]

3. **Performance of Transmission Lines:** Representation of short, medium and long transmission lines, Ferranti effect, SIL, Tuned Power Line, Power flow through transmission lines. [6]

4. **Insulator and Corona:** Overhead lines insulators type of insulators and their applications Potential distribution over a string of insulators, Methods of Equalizing the potential, Phenomenon of Corona, Corona Loss, Factors affecting Corona, Methods of reducing corona. [6]

5. **Mechanical Design of Transmission Lines:** Catenary curve, Calculation of sag and Tension, Effects of wind and ice Loadings, Sag Templates, Vibration dampers. [5]

6. **Underground Cables:** Types of Insulation for Cable, Sheath, Armour and Covering, Classification of cables, Effective Conductor Resistance, Inductive Reactance, Capacitance of single phase and three phase cables, Grading of Cables, Problems with Underground cables. [5]

7. **Distribution:** Comparison of various Distribution systems, type of Primary Distribution systems and Secondary Distribution systems, Choice of transmission voltage, Kelvin's law, Limitation of Kelvin's law. Necessity of neutral grounding, various methods of neutral grounding. [6]

Outcome: At the end of this course the student is expected to have understood the following:
- Basic principles of supply systems.
- Mechanical & electrical design of overhead lines.
- Performance of transmission lines.

Text Books:
1. Wadhwa C.L. "Electrical Power Systems Electronics", New Age International Publishers, 4th Edition, 2011.
2. Gupta, B.R., "Power System Analysis and Design" S.Chand and Co., Ltd, 2nd Edition, 2005.

Reference Books:
1. Grainger, J.J. and William D. Stevenson Jr., "Power System Analysis", McGraw Hill, 3rd Edition,2005.
2. AbhijitChakrabarti, SunitaHalder "Power System Analysis: Operation and Control", Prentice Hall of India, 2nd Edition, 2008.

EE-14.302 **Power System Analysis** **Total Lecture: 40**

3-1-0-4

Objective:
- To know the necessity of load flow in a regulated system.
- To examine the need of various analysis like fault analysis, short circuit analysis stability analysis, steady state and transient analysis.

Prerequisite: Transmission & distribution

1. **Load Flow Studies:** Bus admittance(Y bus) and Impedance (Z bus) matrices and their formation. Power flow in a transmission system, bus classification, Load flow equations and solution techniques-Gauss iterative method, Gauss-Seidel method, Newton-Raphson method, comparison of load flow solution techniques. [9]
2. **Fault Calculation and Network:** Symmetrical fault, Significance of Positive, Negative and Zero Sequence Components, Fault calculation, Sequence Networks, Unsymmetrical fault analysis – Single Line to Ground faults, Line to Line fault, Double line to Ground fault. [9]
3. **Power System Stability:** Steady state stability and transient stability- stability problem, rotor dynamics and swing equation, power angle equation and diagram, equal area criterion and its application, critical clearing angle, fault clearing time, factors influencing transient stability, methods of improving stability. [8]
4. **Economic Load Dispatch:** Station performance and operating characteristics, Incremental rate theory, optimal Load distribution within generating station and between various generating stations in a region, Transmission loss equation, Calculation of losses and Generation scheduling and dispatch. [8]
5. **Power System Control:** Load Frequency control:Load Frequency Problems, Speed Governing System, Reasons for Limits on Frequency. Excitation systems, Automatic Voltage Regulators, SCADA and Computer control. [6]

Outcome:
- Apply the load flow application to various power system problems like minimization of transmission line losses, minimization of the total fuel cost etc.,
- Analyze the economic dispatch problem in thermal power plant
- Design a power system solution based on the problem requirements and realistic constraint.

Text Books:
1. Grainger,J.J. and William D. Stevenson Jr., "Power System Analysis", McGraw Hill, 4th Edition,2005.
2. Wadhwa.C.L. "Electrical Power Systems Electronics", New Age International Publishers, 3rd Edition, 2011.

Reference Books:
1. Ashfaq Husain "Electrical Power Systems", CBS Publishers and Distributors, 4th Edition, 1996.
2. AbhijitChakrabarti, SunitaHalder "Power System Analysis: Operation and Control", Prentice Hall of India, 2nd Edition, 2008.

EE-14.303 **Control Systems Engineering** **Total Lectures: 40**

3-1-0-4

Objective: The student gains the knowledge of the fundamental principles of analog and digital control system engineering, time response and frequency response analysis with its practical implementation. This course helps in understanding the design of Compensator and PID controller for the Automatic control of Industry.

Pre-requisite: Mathematics, Network Analysis& Synthesis

1. **Introduction:** Introduction to control systems, digital control system, types of control systems and their examples, mathematical modeling of electrical and mechanical systems (f-v and f-i analogy). [8]

2. **Reduction Techniques:** Block diagram reduction and signal flow graph representation of systems. [6]

3. **Domain Analysis:** Introduction, correlation between Transient response and frequency response, standard input signals, Response of 1st and 2nd order systems, time domain specifications i.e. rise time, peak time, delay time, peak overshoot, settling time steady state error etc., different types of feedback systems, Steady state errors for unit step, unit ramp and unit parabolic inputs, controller components. [10]

4. **Stability:**Introduction, concept of stability, conditions for stable system, asymptotic, relative and marginal stability, Routh-Hurwitz criterion for stability. [4]

5. **Plotting Techniques:** Root locus techniques, Bode plots, polar plots Nyquist criterion and Nichol's chart. [8]

6. **State Variables:** Analysis of systems, state vector, state space, advantages of state space techniques, state space representation, State variable analysis and design. [4]

Outcome: After completion of the course,

- The student will be able to get acquainted of analog and digital control system.
- The student will analyze and to design and development of automatic controller for industrial application.
- The student will gain the knowledge of stability analysis and improvement of stability for control system.
- This course becomes very beneficial for the graduates who wish to work in core sectr industry as most of the core sector is state-of-art control.
- This course becomes very beneficial for the 4th year student who will choose elective paper in Digital control system and other control system elective.

Text Books:

1. K. Ogata, "Modern Control Engineering," Pearson Education/Prentice Hall of India, 4th Edition, 2003.
2. I.J. Nagrath and M. Gopal, "Control System Engineering," New Age International Publishers, 2nd Edition, 2003.

Reference Books:

1. Syed HasanSaeed, "Automatic Control Systems (with MATLAB Programs)," S.K. Kataria& Sons Publishers, 6th edition, 2008.
2. SamarjitGhosh, "Control Systems: Theory and Applications," Pearson Education, 2nd Edition, 2012.
3. M.N. Bandyopadhyay, "Control Engineering Theory and Practice," Prentice Hall of India, 2nd Edition, 2003.

EE-14.304 **Power Electronics** **Total Lectures: 40**
3-0-0-3

Objective:
- To introduce to students the theory and applications of power electronics systems for high efficiency, renewable and energy saving conversion systems
- To prepare students to know the characteristics of different power electronics switches, drivers and selection of components for different applications
- To develop students with an understanding of the switching behavior and design of power electronics circuits such as DC/DC, AC/DC, DC/AC and AC/AC converters

Prerequisite: Network Analysis and Synthesis, Basics of Electronics Engineering, Engineering Mathematics

1. **Introduction:** Review of power semiconductor devices, SCR, Static and dynamic characteristics, Turn-on and Turn-off methods and circuits, Ratings and protection of SCRs, Series and parallel operation of thyristor, Other members of thyristor family. [8]

2. **Phase Controlled Converters:** Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits, Single phase dual converters and their operation with circulating and non-circulating currents. [10]

3. **AC Voltage Controllers:** Types of single-phase voltage controllers, Singlephase voltage controller with R and RL type of loads, gate pulse requirements to trigger the SCRs of ac voltage controllers. [5]

4. **Cycloconverters:** Principles of operation, Single phase to single phase step up and step down cycloconverters. Three phase to single phase cycloconverter. [5]

5. **DC Choppers:** Principle of chopper operation, Control strategies, Types of choppers, Step up and step down choppers, Types of choppers and operations. [5]

6. **Inverters:** Single phase VSI: half bridge and full bridge inverters, three phase bridge inverters with 180 degree and 120 degree modes of operation, Series and parallel inverters, Introduction to current source inverters. [7]

Outcome:
- The student will be able to understand the principle of operation of commonly employed powerelectronic converters
- The student will be capable of analyzing non-linear circuits with several power electronic switches
- The student will be equipped to take up advanced courses in Power Electronics and its application areas

Text Books:

1. Rashid, M., Power Electronics, Prentice Hall of India Private Limited, 4th Edition,2006.
2. P.S. Bimbhra, Power Electronics, Khanna publishers, 5th edition, 2012.

Reference Books:

1. Mohan,N., Undel, T.M. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley and Sons, 3rd Edition, 2007.
2. Jain,A., Power Electronics and its Applications, Penram International Publishing (India) Pvt. Ltd., 4th Edition, 2008.
3. Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.N.K., Thyristoried Power Controllers, New Age International (P) Limited, Publishers, 2nd Edition, 2004.

EE-14.305 **Power Plant Engineering** **Total Lectures: 40**

3-0-0-3

Objective: This course facilitates the students to understand the basic functioning of generation and design/economics consideration of various power plants.

Pre-requisite: Electrical Engineering course of First Year.

1	**Introduction:** Energy sources and their availability, Principle types of power plants, Their special features and applications, Present status and future trends. Economic aspects in power Generation: Terms commonly used in system operation, various factors affecting cost of generation: Load curves, load duration curves, Connected load, maximum load, Peak load, base load and peak load power plants, load factor, Plant capacity factor, Plant use factor, Demand factor, diversity factor, Cost of power plant.	[10]
2	**Thermal Power Plant:** General developing trends, Essentials, Plant layout, Coal storage, Preparation, Handling, Feeding and burning, Ash handling, Dust collection, High pressure boilers and steam turbines, Their main components like super heaters, Economizers, Pre-heaters etc., Fuel efficiency/heat balance.	[8]
3	**Hydro Electric Power Plants:** Classifications, Plant layout, various components, Types of turbines, Pumped storage, hydro-electric plants, advantages and disadvantages. Environmental aspects for selecting the sites and locations of hydro power stations.	[8]
4	**Gas Turbine Power Plants:** Schematic arrangement, advantages and disadvantages of Gas turbine power plant. Open cycle and Closed cycle gas turbine power plant, Combined cycle power plant, Comparison of various power plants.	[6]
5	**Nuclear Power Plant:** Nuclear fuels, Nuclear energy, Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect.	[8]

Outcome: The students shall develop an insightful knowledge to apply the basic laws and operating principles in various power plants.

Text Books:

1. Deshpande, M.V., "Power Plant Engineering", McGraw Hill, 4th Edition 2004.
2. Gupta B. R., "Generation of Electrical Energy", S. Chand Publications, 14th Edition, 2011.

Reference Books:

1. Wood A.J. & Wallenberg B.F, "Power Generation and Control", John Wiley & Sons, 2nd Edition, 2012.
2. P.K Nag "Power Plant Engineering", McGraw Hill publications, 2nd Edition, 2008.
3. Arora S.C & Domkundawar S, "A course in Power Plant Engineering", Dhanpat Rai, 2nd Edition, 2002.

EE-14.310 **Reliability of Electrical Power System** **Total Lectures: 40**
3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to the concept of probability theory, distribution, network modeling and reliability analysis.

Pre-requisite: Power system analysis, Power system transmission and distribution, Matrices, Probability and Calculus.

1. **Review of Probability Theory:** Element of probability theory Probability Distribution, Random variable, Density and distribution functions. Mathematical expectation. Binominal distribution, Poisson distributions, Normal distribution, Exponential distribution, Weibull distribution.. [8]
2. **Reliability of Engineering Systems**:Component reliability, Hazard models, Reliability of systems with non-repairable components, series, Parallel, Series-Parallel, Parallel-series configurations. Non-series-parallel configurations, minimal tie-set, minimal cut-set and decomposition methods. Power System reliability. [8]
3. **Reliability of Engineering Systems**:Reliability model of a generating unit, State space methods, Combing states, sequential addition method, Load modeling, Cumulative load model, merging of generation and load models, Loss of load probability, Percentage energy loss, Probability and frequency of failure, Operating reserve calculations. [8]
4. **Power Network Reliability:** Weather effect on transmission lines, Common mode failures, Switching after faults, three, state components, Normally open paths, Distribution system reliability. [8]
5. **Composite System Reliability:** Bulk Power supply systems, Effect of varying load, Inter connected systems, correlated and uncorrelated load models, Cost and worth of reliability. [8]

Outcome: The students shall have a thorough understanding of the main principles in power system reliability analysis as well as knowledge of different methods and tools for reliability analysis.

Text Books:
1. J. Endreny, “Reliability Modeling in Electric Power Systems”, John Wiley & Sons. 1980
2. Roy Billinton& Ronald, N allan, “Reliability Evaluation of Power Systems”, Plenum Press, New York. 1990

Reference Books:
1. Sullivan, R.L., “Power System Planning”, Heber Hill, 1987.
2. Patrick O'Connor, Andre Kleyner“Practical Reliability Engineering”, Wiley 5th Edition,2012

EE-14.403 **Electric Drives and Control** **Total Lectures: 40**
3-1-0-4

Objective: This course aims to equip the students with a basic understanding of Electric drive system and their controls. The course also equips students with ability to understand selection of motor for industrial drive applications, and develops the ability to understand the characteristics and speed control of motors using power electronics based circuits.

Pre-requisite: Power Electronics, Electrical Machines and Control System.

1 **Introduction :**Introduction to an electric drive system, parts of electric drive system, choice criteria for drive system [5]

2 **Dynamics of Electric Drives:** Dynamic equations of an electric drive, torque equations, multi-quadrant operation, type of loads, energy loss during transients and load equalization. [5]

3 **Electric Drive Control:** Control of electric drives, modes of operation, speed control, open & closed loop drives, current limit control, torque limit control, position, PLL and speed control. [6]

4 **Selection of Motor Drive Rating:** Selection of motor rating – thermal model of motor, classes of duty and determination of motor rating for different classes of drive operation duty. [6]

5 **Control of DC Motor:** DC motor drive – starting, braking, transient analysis, speed control, controlled rectifier converters for DC drives and chopper fed DC drives. [9]

6 **Control of AC Motors:** Induction motor drive – starting, braking, transient analysis, speed control, Control of Induction Motor by AC Voltage controllers-Waveforms, Speed torque characteristics, Variable frequency control of induction motor by Voltage Source, Current Source inverters and cycloconverters. [9]

Outcome: After completion of the course, students would be able to apply the knowledge of various drives, their selection criteria and its control mechanisms for domestic and industrial applications.

Text Books:

1. Dubey G.K. “Fundamentals of Electrical Drives”,Narosa Publications, New Delhi, 2nd Edition 1995.
2. Gopal K. Dubey, “Power semiconductor Controlled Drives”, PHI publications, Newest 1st Edition 1989.

Reference Books:

1. Murphy J. M. D., Turnbull F.O., “Power Electronic Control of AC motors”, Pergamon Press, 1st Edition 1988.
2. Pillai S.K., “A first course on Electrical Drives”, New age International Publisher, 2nd Edition 1989.
3. U. A. Bakshi, M. V. Bakshi, “Electrical Drives and Controls”, Technical Publications Pune, 1st Edition 2009.

EE-14.404 **Renewable Energy Systems** **Total Lectures: 40**

3-0-0-3

Objective: This course provides the principles of renewable technologies for sustainable future. It also provides the details of renewable resources, energy conversion techniques and applications of solar, wind, biomass, geothermal, hydro-electric, wave and tidal energy technologies.

Pre-requisite: Power Plant Engineering

1	**Energy Scenario:** Energy Resources: Conventional and non-conventional, Energy needs of India, Energy consumption patterns, Worldwide Potentials of these sources, Energy efficiency, Energy security, Energy and its environmental impacts, Global environmental concern, Kyoto Protocol, Concepts of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF),Factors favoring and against renewable energy sources.	[8]
2	**Solar Energy:** Solar Energy basics-Extraterrestrial and Terrestrial radiation, Spectral energy distribution, Solar Radiation Geometry, Empirical equation for estimating solar radiation on horizontal surface. Solar Thermal Systems, Types of collectors-Concentrating and Flat plate, Efficiency calculations, Solar water heater- thermosiphon and pumped, Greenhouses heating and cooling, Photo Voltaic (PV) technology, Solar cells, Characteristic of PV systems, Equivalent circuit, Array design, Standalone and grid interactive system.	[8]
3	**Wind Energy:** Wind Energy, Wind speed and power relation, Power extracted from wind, Wind distribution and wind speed predictions, Wind power systems, System components, Types of turbine, Turbine rating, Variable speed operation, Maximum power Operation, Control systems, System design features, Standalone and grid connected operation.	[8]
4	**Other Energy Sources:** Biomass, Various resources, Energy contents, Technological advancements, Conversion of biomass in other form of energy, solid, liquid and gases, Gasoliers, Biomass fired boilers, Co firing, Energy Generation from agro-dairy apart from municipal waste ,used for vehicles , Hydro energy, Feasibility of small, mini and hydel plants: scheme, layout and economics, Tidal and wave energy, Geothermal and Ocean, Thermal Energy Conversion (OTEC) systems, Schemes, feasibility and viability	[8]
5	**Energy Storage and Hybrid System Configurations:** Energy storage, Battery, Types, Equivalent circuit, Performance characteristics, Battery design, Charging and charge regulators, Battery management, Fly wheel energy relations, Components, Benefits over battery,Fuel cell energy, Storage systems and Ultra capacitors, Energy Management.	[8]

Outcome: Upon completion of this course, the students should be able to:

1. Recognize the need of renewable energy technologies and their role in the world energy demand.
2. Distinguish between the sustainable energy sources and fossil energy sources
3. Describe the principles of renewable energy production from various renewable sources.

Text Books:

1. Rai G.D. “Non- Conventional Energy Sources”, Khanna Publishers, 4th Edition,2004.
2. Khan B.H., “Non-Conventional Energy Resources”,McGraw-Hill Education Private Limited, 2nd Edition, 2015.

Reference Books:

1. Kothari D.P. and Singal K.C. “Renewable Energy Sources and Emerging Technologies”, PHI Learning Private Limited, 2nd Edition, 2011.
2. Boyle, G. “Renewable energy: Power for a sustainable future” Oxford University press, 3rd Edition, 2014.

EE-14.405 **Electrical Machine Design** **Total Lectures: 42**

3-1-0-4

Objective: To provide knowledge of design aspects of various dc machines, ac machines and transformers.

Pre-requisite: Electrical Machines

1 **Fundamentals of Electrical Machine Design:** Standard specification of frame size, conductors and insulation, Magnetization and loss curves, Choice of specific loadings Heating and cooling of electrical machines. [6]

2 **D.C Machines:** Construction details, output equation, main dimensions, Choice of specific loadings, choice of number of poles, armature design, design of field poles and field coils ,design of commutator and brushes. [10]

3 **Transformers:** Construction details of core and shell type transformers, output rating of single phase and three phase transformers, optimum design of transformers, design of yoke, core and winding for core and shell type transformers, equivalent circuit parameters from design data and design of tank and cooling tubes of transformers. [10]

4 **A.C. Machines:** Construction details of A.C. machines, output equation, main dimensions, Choice of specific loadings, design of stator, design of squirrel cage and slip ring rotor equivalent circuit parameter from design data, Short circuit ratio, design of rotor of cylindrical pole and salient pole machines. [10]

5 **Computer Aided Design:** Need for computer aided design, Analysis method, Synthesis method, Introduction to analysis of Electric machine parameters using FEM. [6]

Outcome: After completion of the course, students would be able to apply the knowledge of magnetism in the design of transformer and rotating electrical machines.

Text Books:

1. A.K. Sawhney, A course in Electrical Machine Design, DhanpatRai and sons, New Delhi, 2nd Edition, 2002.
2. S K Sen, Principles of Electrical Machine Design with Computer Programme,Oxford and IBH publishing Co. Pvt Ltd., New Delhi, 3rd Edition, 2004.

Reference Books:

1. R.K Agarwal, Principles of Electrical Machine Design, S.K.Katariasons, New Delhi, 4th Edition, 2002.
2. V.N. Mittle and A. Mittle, Design of Electrical Machines, Standard Publications and Distributors, Delhi, 3rd Edition, 2002.

EE-14.411 **Smart Grid** **Total Lectures: 40**

3-0-0-3

Objective:

- This course aims to equip the students to understand the change in electricity power business from conventional sectors to smart grid sectors.
- To understand and analyze the basic architecture of smart grid and functions of its various components like renewables generation, measurement and communication system etc.

Pre-requisite: Power system , Electrical Measurement & Instrumentation

1	**The Traditional Power Generation and Transmission System:** Introduction, Power System reliability and quality, Voltage profile of power system, Power transfer Through radial feeder, Power system stability and control, Protection system, SCADA System.	[8]
2	**Smart Grid:** Introduction, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, The Environmental Impacts of Smart Grid, Technologies Required for Smart Grid.	[8]
3	**Renewable Energy Integration:** Introduction, Solar Energy, Wind Energy, Distributed Energy Resources Integration Challenges, Forecasting and Scheduling, Impacts of Renewable Energy into the Grid.	[8]
4	**Smart Grid Communications and Measurement Technology:** Communication, Measurement and Monitoring Technologies, Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) ,Smart Appliances, Advanced Metering Infrastructure (AMI),Communication Protocols.	[10]
5	**Smart Meter:** Details Description of Smart Meter, Benefits of Smart Meter, Technical Configurations of Smart Meter, Components of Smart Meter Network in Distribution System, and Characteristics of smart meters.	[6]

Outcome: Upon completion of the course the student will be able to:

1. Understand the difference between conventional grid and smart grid.
2. Understand the integration necessity and challenges of renewable in conventional grid system.
3. Understand the operation of communication and measurement technology in modern grid context.

Text Books:

1 Momoh James., "Smart Grid Fundamentals of Design and Analysis" ,John Wiley &Sons, Inc., Hoboken, New Jersey, 4th Edition, 2012

2 Bollen, Math and Hassan F, "Integration of Distributed Generation in The Power System", IEEE press, 2011.

Reference Books:

1 Shawkat Ali A. B. M., "Smart Grids Opportunities, Developments and Trends", Springer Verlag, London, 4th Edition, 2013.

2 Chowdhury S., Crossley P. "Microgrids and Active Distribution Networks" The Institution of Engineering and Technology, UK, 3rd Edition, 2009.

EE-14.412 **EHV AC & DC Transmission** **Total Lectures: 40**
3-0-0-3

Objective: To provide an in-depth understanding of the different aspects of Extra High Voltage A.C. and D.C. Transmission system design and Analysis.

Pre-requisite: Transmission & Distribution & Power System Analysis

1. **EHV AC System:** Flexible AC transmission, control of FACTS devices, reactive power planning, static VAR compensation, optimal location, Sub-synchronous resonance, Ferro-resonance, true saturation characteristic. [6]
2. **Transients in Three Phase EHV AC system:** Switching of three phase transformer banks, transmission lines, capacitive banks, effects of neutral connection. Symmetrical component method of analysis of three phase switching transients, effect of open conductors. EMTP application. [6]
3. **Traveling Waves:** Generation of traveling waves, refraction and attenuation of waves, effects of line terminators, multi-conductor systems. [6]
4. **Protection of EHV AC Lines:** Protection against switching over-voltages, lightning over-voltages. Surge diverters, surge capacitors and reactors, overhead ground wires. [6]
5. **HVDC Systems:** Comparison with AC systems. Various configurations, inversion and conversion, operation and control, harmonics and filters. Parallel operation of HVDC/AC system. Back to back connections. Multi-terminal HVDC system. Transients in HVDC converters. [6]
6. **Overvoltage and Insulation Coordination:** Lightning, switching and temporary overvoltage, BIL and SIL, methods of insulation coordination, conventional and statistical methods. [6]
7. **Gas Insulated Systems:** Gas Insulated lines, substations, advantages and problems. [4]

Outcome:
1. Understand issues of concern with EHVAC& DC transmission
2. identify and calculate the various parameters of EHV line for modeling
3. Estimate the over–voltages in EHV AC systems and protect against it.
4. Understand insulation coordination and gas insulated system.

Text Books:
1. Rakesh Das Begamudre, “Extra High Voltage Ac Transmission Engineering”, New Age International, 4th Edition, 2011.
2. Padiyar. K. R.,"HVDC Power Transmission Systems", New Academic Science, 2nd Edition, 2011

Reference Books:
1. A Chakraborti, D.P. Kothari “Performance, Operation and Control of EHV Power Transmission Systems”, T.M.H publication,2nd Edition, 1983.
2. TuranGonen “Electric Power Transmission System Engineering”,Taylor & Francis, 2nd Edition,2007.

EE-14.413 **Modern Control System** **Total Lectures: 40**
3-0-0-3

Objective: To impart knowledge about advances in control system in the areas of state-space modeling & stability of continuous & discrete system. It will also make students familiar with the non-linear system – their modeling and analysis. At the end of the course a student will be equipped to handle linear and non-linear control problems.

Pre-requisite: Linear Control System

1 **State Space Analysis of Continuous Time Systems**: State variable representation – Conversion of state variable form to transfer function and vice versa – Eigenvalues and Eigenvectors – Solution of state equation – Controllability and observability –Pole placement design – Design of state observer [8]

2 **Z-Transform and Sampled Data Systems:** Sampled data theory – Sampling process – Sampling theorem – Signal reconstruction –Sample and hold circuits – z-Transform – Theorems on z-Transforms – Inverse z-Transforms – Discrete systems and solution of difference equation using z transform – Pulse transfer function – Response of sampled data system to step and ramp Inputs – Stability studies –Jury's test and bilinear transformation. [6]

3 **State Space Analysis of Discrete Time Systems**: State variables – Canonical forms – Digitalization – Solution of state equations –Controllability and Observability – Effect of sampling time on controllability – Pole placement by state feedback – Linear observer design – First order and second order problems [6]

4 **Nonlinear Systems:**Types of nonlinearity – Typical examples – Phase-plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Basic concepts –Dead Zone – Saturation – Relay – Backlash – Liapunov stability analysis – Stability in the sense of Liapunov – Definiteness of scalar functions – Quadratic forms – Second method of Liapunov – Liapunov stability analysis of linear time invariant systems and non-linear system [6]

5 **MIMO Systems:**Models of MIMO system – Matrix representation – Transfer function representation – Poles and Zeros – Decoupling – Introduction to multivariable Nyquist plot and singular values analysis – Model predictive control. [5]

Outcome: Upon completion of the course the student will be able to develop the mathematical models for various types of systems using different techniques.

Text Books:
1. M. Gopal, "Digital Control and State Variable Methods", McGraw Hill Publication,4th Edition, 2012.
2. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 3rd Edition, 1997.

Reference Books:
1. Katsuhiko Ogata, "Discrete-Time Control Systems", Pearson Education, 2nd Edition, 2002.
2. Richard C. Dorf and Robert H., "Modern Control Systems", 8thEdition, PearsonEducation, 2004.

EE-14.414 **Computer Application in Power Systems** **Total Lectures: 40**
3-0-0-3

Objective: This course is designed to give students the required knowledge for the design and analysis of electrical power grids by using computer programs or a software. The computer programs or software make easy calculation of power flow in a power system network using various techniques.

Pre-requisite: Transmission & Distribution & Power System Analysis

1 **Network Modeling**: Development of network matrices using graph theory, Z-Bus and Y-Bus formation, component models, fixed tap, variable tap and phase shifting transformers. [5]

2 **Short Circuit Studies of Large Systems:** Symmetrical and asymmetrical fault analysis using Z-Bus and Y-Bus Method. [6]

3 **Advanced Load Flow Studies:** Load models, non-convergence of load flow solutions, remedial measures, second order methods, continuation power flow, sparse vector method. [8]

4. **Economic Operation and Security Analysis:** Optimal power flow problem and its solution methods, contingency evaluation methods; distribution factors, direct and indirect methods, contingency ranking and screening. [8]

5. **Angular and Voltage Stability Analysis:** Steady state and transient stability, mathematical models and numerical solution, voltage stability. [8]

6. **State Estimation:** Algorithm, tracking state estimator, bad data identification, Observability. [5]

Outcome:
1. Upon completing this course student able to analysis of different type fault in a power system by computer methods.
2. Student able to apply computer methods in different load flow techniques.

Text Books:
1. J.J.Grainger & W.D.Stevenson, "Power system Analysis",McGraw Hill, 3rd Edition, 2007.
2. HadiSaadat, "Power System Analysis",McGraw Hill ,2nd Edition, 2002.

Reference Books:
1. D.P.Kothari and I.J.Nagrath, "Modern power system analysis", McGraw HillEducation, 2nd Edition, 2003.
2. T.K.Nagsarkar M.S.Sukhija ,"Power System Analysis", OXFORD university press,4th Edition, 2007.

EE-14.415 **Power Quality** **Total Lectures: 40**

3-0-0-3

Objective: This course aims to equip the students with an understanding of emanation of various power quality disturbances their cause, effects and remedial action in particular to harmonics distortion.

Pre-requisite: Power system, Power Electronics

1 **Introduction:** Introduction, power quality -voltage quality, power quality evaluations procedures term and definition:general classes of power quality problem, causes & effect of power quality disturbances. [6]

2 **Voltage Sags and Interruption:** Voltage sags and interruption: sources of sags and interruption, estimating voltages sag performance, fundamental principles of protection, monitoring sags. [6]

3 **Transient Over Voltages:** Sources of transient over voltages, principles of overvoltage protection, devices for overvoltage protection, utility capacitor-switching transients, utility system lightning protection, managing ferro-resonance , switching transient problems with loads. [8]

4 **Harmonics:** Harmonic distortion, voltage versus current distortion, harmonics versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from industrial loads, locating harmonic sources, system response characteristics, effects of harmonic distortion, inter-harmonics. [10]

5 **Applied Harmonics:** Harmonics distortion evaluations, principles for controlling harmonics, harmonics studies devices for controlling harmonic distortion, filters, passive input filter standards of harmonics. [10]

Outcome: Upon completion of the course The student will be able understand

1. The reason for occurrence of power quality disturbances.
2. The difference between disturbing signals like sag, swell transients, harmonics.
3. Various types of filters to filter out the harmonic problems.

Text Books:

1. Dugan R. C.,"Electrical Power System Quality", McGraw Hill Publication, 3rd edition, 2008.
2. Arrillga A.J., "Power System harmonics", Wiley publication, 2nd edition, 2003.

Reference Books:

1. Derek A. Paice, "Power electronic converter harmonics",Wiley publication, 3rd Edition,1999.

EE-14.441 **Engineering Economics** **Total Lectures: 26**

2-0-0-2

Objective(s):

1. Provide students with fundamental concepts of engineering economics.
2. Provide students with economical methods to compare and evaluate alternatives based on present, annual, rate of return, and benefit over cost analyses.
3. Emphasize practical engineering-based applications and the use of real data examples.

Prerequisite(s): Nil

1. **Introduction**: Definitions, Scope; Microeconomics vs. Macroeconomics; Engineering and engineering economics; Principles of engineering economics. **[2]**
2. **Theory of Demand & Supply**: Determinants, law of demand, law of supply, equilibrium, elasticity of demand. **[3]**
3. **Economics Applied to Industries**: Theory of production; production function, Law of variable proportions, Returns to scale, Theory of cost; Various concepts of cost: Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost, average cost, marginal cost, total cost etc, Break even analysis. **[6]**
4. **Market Structures& Pricing Techniques:** Meaning of Market, Types of Market- perfect competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets). **[5]**
5. **Replacement analysis and depreciation**: Replacement Analysis Decision Map, Basic aspects of depreciation, Deterioration & Obsolescence, and its methods **[3]**
6. **Optimization technique**: Optimization under constraints and without constraints, optimal resource allocation, optimization under risk and uncertainty. **[4]**
7. **Capital budgeting**: Concept; under certainty and uncertainty, Techniques; Discounting &compounding techniques, IRR, NPV, PBP, Profitability index, Accounting rate of return. **[3]**

Outcome(s):

1. Understand major principles of economic analysis for decision making among alternative courses of action in engineering.
2. Apply cost estimation and alternative analysis techniques for engineering applications.
3. Recognize the economic impact of engineering solutions.
4. Calculate depreciations and understand the impact of inflation.
5. Perform breakeven analysis for a single project and between two alternatives.

Text Books:

1. Salvatore, Dominick. Managerial Economics, Prentice Hall of India, 6th Ed., 2010.
2. D.N. Dwivedi, Managerial Economics, Oxford University Press,Vikas Publication, 7th Ed., 2014.

Reference Books:

1. Suma Damodran, Managerial Economics, Oxford University Press, 2nd Ed, 2005.

EE-14.442 **Principles and Practices of Management** **Total Lectures : 26**

2-0-0-2

Objective(s):

1. To expose the students to fundamental concepts of management and its processes in organizations.
2. To describe the various skills necessary for effective managers.
3. To explain the Individual and Group Behavior along with various leadership Styles

Prerequisite(s): Nil

1. **Planning and Organizing:** Management: Concept, Nature and functions; Planning: Concept, Missions, Objective and Strategies, Steps in Planning; Organizing: Concept, Formal an Informal Organization, Decentralization of Authority, Delegation of Authority, Principles of Organizing, Line and Staff Authority. **[5]**
2. **Staffing and Controlling:** Staffing: Definition, Recruitment, Selection, Placement, Promotion, Separation, Performance Appraisal; Controlling: Concepts and Process, Controlling as a Feedback System, Requirements for Effective Control. **[4]**
3. **Motivation:** Concept; Theories and Process of Motivation: Maslow's Need-Hierarchy Theory, Herzberg's Hygiene Theory, Goal-Setting Theory, Vroom's Expectancy Theory. **[4]**
4. **Personality:** Concept and Determinates, Types and Traits, Personality Attributes Influencing Organizational Behavior, Locus of Control, Machiavellianism, Self-Esteem, Self-Monitoring, Risk-Taking. **[3]**
5. **Group Behavior and Interpersonal Relationship:** Groups: Concept and Classification, Stages of Group Development, Roles and Norms, Group Decision-Making: Group versus Individual, Group Decision Making Techniques and Process, Interpersonal Relationships, Understanding Self and Others, Developing Interpersonal Relationships, Transactional Analysis, Johari Window. **[6]**
6. **Leadership:** Concept and Functions; Theories of Leadership: Traits, Behavioral, Situational/Contingency; Inspirational approaches to Leadership: Charismatic Leadership, Transformational Leadership, Transactional Leadership, and Contemporary Leadership. **[4]**

Outcome(s): By studying this Course, students would be able to understand various Management functions, individual and group behavior. They would also know various styles of Leadership and its applicability. The course would help the students in understanding various organizational contexts and help them understand organizational systems in a better way.

Text Books:

1. Koontz, Harold and Weihrich, Heinz, Essentials of Management: An International, Innovation and Leadership Perspective, McGraw Hill Private Limited, India, 10th Edition, 2015.
2. Robbins, Stephen P., Timothy Judge and Neharika Vohra, Organizational Behavior, Pearson Education, 12th Ed., 2011.

Reference Books:

1. Prasad L. M., Principles and Practice of Management, Sultan Chand & Sons, 9th Edition, 2015
2. Fred Luthans, Organizational Behavior, McGraw Hill, 11th Ed., 2009

EE-17.419 **Power System Protection** **Total Lectures: 40**

3-1-0-4

Objective: To provide a broad coverage on all types of protective relays, circuit breakers and its working for practical power system protection system.

Pre-requisite: Electrical Machines & Power Plant Engineering

1 **Introduction to Protection System:** Introduction to protection system and its elements, functions of protective relaying, protective zones, primary and backup protection, desirable qualities of protective relaying, basic terminology. [4]

2 **Operating Principle and Relay Characteristics:** Electromagnetic relays, thermal relay, gas actuated relay. Amplitude and phase comparators, over current relays, directional relays, distance relays, differential relay. [8]

3 **Static Relays:** Comparison with electromagnetic relay, classification and their description, over current relays, directional relay, distance relays, differential relay. [6]

4 **Protection of Transmission Line:** Over current protection, distance protection, pilot wire protection, carrier current protection, protection of bus. [6]

5 **Apparatus Protection:** Protection of Transformer, Generator and Motor. [3]

6 **Circuit Breaking:** Properties of arc, arc extinction theories, re-striking voltage transient, current chopping, Resistance switching, capacitive current interruption, short line interruption, circuit Breaker ratings, [6]

7 **Circuit Breaker:** Operating modes, selection of circuit breakers, ratings of circuit breaker, constructional features and operation of Bulk Oil, Minimum Oil, Air Blast, SF6, Vacuum circuit breakers, HVDC circuit breaker, Testing of Circuit Breaker. [7]

Outcome: After completion of the course, students would be able to apply the knowledge of CB, various relaying schemes and overvoltage and protection against overvoltage.

Text Books:

1. Badri Ram and Vishwakarma, D.N., "Power System Protection and Switchgear", McGraw HillPublishing, 3rd Edition, 2001.
2. Ravindranath, B. and Chander, N., "Power System Protection and Switch Gear", New AgeInternational (P) Ltd,3rd Edition, Reprint 1996.

Reference Books:

1. Sunil S.Rao, "Protective Switch Gear", Khanna Publishers, 2nd Edition, 2000.
2. Y. G. Paithangar, "Fundamentals of power system protection", PHI Learning Private Limited, 4th Edition, 2010.

EE-17.501 **Energy Resources** **Total Lectures: 40**

3-1-0-4

Objective:

- To provide an exposure on various concepts of Non-renewable and renewable energy and also its domestics and industrial applications
- To understand the environmental and economic aspects of renewable energy sources

Prerequisite: Power Plant Engineering

1. **Commercial Energy:** Coal, Oil, Natural Gas, Nuclear power and Hydro – their utilization pattern, future projections of energy consumption, environmental impactof fossil fuels, Energy scenario in India – Growth of energy sector and its planning in India. [8]

2. **Solar Energy:** Solar radiation at the earth's surface, measurements and estimation of average solarradiation, solar thermal flat plate collectors, concentrating collectors, solar thermal applications, solar electric power plant - principle ofphotovoltaic conversion of solar energy, types of solar cells, Photovoltaic applications: batterycharger, domestic lighting, street lighting, water pumping etc - solar PV power plant, Net meteringconcept. [8]

3. **Wind Energy:** Nature of the wind, power in the wind, factors influencing wind, wind data and energy estimation, wind speed monitoring, wind resource assessment, Betz limit, site selection, wind energyconversion devices, classification, applications, safety and environmental aspects, wind energy potential and installation in India -Repowering concept. [8]

4. **Bio Energy:** Biomass resources and their classification, Biomass conversion processes, Thermo chemicalconversion - direct combustion, biomass gasification, pyrolysis and liquefaction, biochemicalconversion, anaerobic digestion, types of biogasPlants, applications, alcohol production frombiomass, bio diesel production, Urban waste to energy conversion, Biomass energy program inIndia. [8]

5. **Other Types of Energy:** Ocean energy resources, principle of ocean thermal energy conversion (OTEC), ocean thermalpower plants, ocean wave energy conversion, tidal energy conversion, small hydro, geothermal energy, geothermal power plants, hydrogen production and storage, Fuel cell: principle ofworking, various types, construction and applications. [8]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understanding of commercial energy and renewable energy sources
- Knowledge in working principle of various energy systems
- Capability to do basic design of renewable energy systems

Text Books:

1. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill, 4th edition 2006.
2. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, 3rd edition, 2012.

Reference Books:

1. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 6th edition 2011.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd, 2nd edition, 2006.

EE-17.502 **Energy Audit and Management** **Total Lectures: 40**

3-1-0-4

Objective:

- To provide a broad knowledge on current energy scenario and audit for various applications.
- To acquire the in-depth knowledge of the Energy management systems.

Prerequisite: Renewable Energy System

1. **Energy Scenario**: Role of Energy Managers in Industries , Energy monitoring, auditing & targeting , Economics of various Energy Conservation schemes, Total Energy Systems [8]
2. **Energy Audit**: Various Energy Conservation Measures in Steam, Losses in Boiler. Energy Conservation in Steam Systems, Case studies. [8]
3. **Basics of Energy Conservation:** Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor, energy consumption & energy saving potentials, Design consideration. [8]
4. **Refrigeration & Air conditioning:** Heat load estimation, Energy conservation in cooling towers & sprays ponds; Case studies Electrical Energy, Energy Efficiency in Lighting, Case studies. [8]
5. **Energy Management:** Organizational background desired for energy management motivation, detailed process of M&T-Thermostats, Boiler controls, proportional, differential and integral control, optimizers; compensators. [8]

Course Outcome: Upon successful completion of this course, students should be able to

- Perform energy audit on the systems and know in depth the energy management systems.

Text Books:

1. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.
2. Reay D.A, Industrial Energy Conservation, 1st Edition, Pergamon Press, 6th edition, 2008.

Reference Books:

1. L. C Witte, Philip S. Schmidt, D. R. Brown, Industrial Energy Management & Utilization, Hemisphere Publisher Corp., 1st edition, 1988.
2. Power System Engineering 2nd Ed. D P Kothari, I J Nagrath, McGraw-Hill, 4th edition, 2008.

EE-17.503 **Solar Energy Engineering** **Total Lectures: 40**

3-1-0-4

Objective:
- To develop the ability to understand / analyze the various solar energy design principles.
- To study the various applications of solar energy and storage systems.

Prerequisite: Renewable Energy System.

1. **Introduction:** Source of radiation, solar constant, solar charts, Measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder [5]

2. **Solar Non-Concentrating Collectors**: Design considerations, Classification- air, liquid heating collectors, Derivation of efficiency and testing of flat plate collectors, Analysis of concentric tube collector, Solar green house. [6]

3. **Solar System Design**: Classification, Concentrator mounting, Focusing solar concentrators, Heliostats. Solar powered absorption A/C system, water pump, chimney, drier, dehumidifier, still, cooker. [10]

4. **Photo-Voltaic Cell**: Characteristics-cell arrays-power electric circuits for output of solar panels, choppers, inverters, batteries-charge regulators, Construction concepts. [7]

5. **Energy Storage**: Sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change-Glauber's salt-organic compounds. [12]

6. **Solar Energy Applications**: Introduction and principle of operation of solar cooker, solar air heater, solar water heater, solar distillation, solar pond, solar thermal power generation – Greenhouse - Solar PV system.

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze and design the solar energy system with energy storage devices and perform the selection based on techno-economic view point.

Text Books:

1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003.
2. Edward E. Anderson, "Fundamentals for solar energy conversion", Addison Wesley Publ. Co., 2nd edition 2000.

Reference : Books

1. G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable energy Sources", Narosa Publishing House, New Delhi, 4th edition, 2007.
2. Energy Studies, Second Edition, by W. Shepherd and D. W. Shepherd, Imperial College Press, London, 3rd edition, 2004.

EE-17.504 **Wind Energy Conversion System** **Total Lectures: 40**

3-1-0-4

Objective: To provide the current status, importance, future trends and potential for Wind energy technologies as a complement to, or replacement for, conventional technologies.

Prerequisite: Renewable Energy System

1. **Wind Resource:** Wind characteristics: Meteorology of wind – wind speed distribution across the world – spatial and temporal factors – Eolian features - Biological indicators. Wind measurement: Anemometers – balloon trackers. Wind energy conversion systems (WECS) - classifications. [8]

2. **Wind Energy Conversion:** Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and Strip theory; Maximum power coefficient; Prandlt's tip loss correction; Rotor design and characteristics; Power, torque and speed characteristics – Wind turbine performance measurement – Loading analysis. [8]

3. **Wind Turbines Types:** Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator. [8]

4. **Wind Energy Application:** Wind pumps: Performance analysis, design concept and testing; Principle of Wind Energy Generators; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies. [8]

5. **Cost Economics**: Wind resource assessment and R & D costs, Fixed and variable costs, Value of wind energy, Life cycle costing and cash flow of wind power projects, Wind project owners / developers, Wind energy market. [8]

Course Outcome: Upon successful completion of this course, students should be able to

- Understand the atmospheric processes that produce wind energy.
- Explain the fundamental principle of wind turbine operation.
- Analyze the economics of wind energy.
- Explain recent commercial developments in wind energy and its future potential.

Text Books:

1. S. Rao & B.B. Parulekar, Energy Technology, Khanna publishers, 4th edition, 2005.
2. T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, Wind energy Handbook, John Wiley & Sons, 6th edition, 2011.

Reference Books:

1. Mukund. R. Patel, Wind and Solar Power Systems, Taylor & Francis, 2nd Edition 2001.
2. L .L. Freris, Wind Energy Conversion Systems, Prentice Hall, 4th Edition, 2010.

EE-17.505 **Advanced Energy Storage** **Total Lectures: 52**
4-0-0-4

Objective:
- To develop the ability to understand / analyze the various types of energy storage.
- To study the various applications of energy storage systems.

Prerequisite: Power Plant Engineering

1. **Introduction:** Necessity of energy storage, types of energy storage, comparison of energy storage technologies, Applications. [7]

2. **Thermal Storage System:** Thermal storage, Types, Modelling of thermal storage units, Simple water and rock bed storage system, pressurized water storage system, Modelling of phase change storage system, Simple units, packed bed storage units, Modelling using porous medium approach, Use of Transys. [9]

3. **Electrical Energy Storage:** Fundamental concept of batteries, measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries, Lead Acid, Nickel-Cadmium, Zinc Manganese dioxide and modern batteries: zinc-Air, Nickel Hydride, Lithium Battery. [12]

4. **Fuel Cell:** Fuel Cell, History of Fuel cell, Principles of Electrochemical storage, Types, Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis, advantage and drawback of each type. [10]

5. **Alternate Energy Storage Technologies:** Flywheel, Super capacitors, Principles & Methods, Applications, Compressed air Energy storage, Concept of Hybrid Storage, Applications. [14]

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze various types of energy storage devices and perform the selection based on techno-economic view point.

Text Books:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons, 2nd edition, 2011.
2. Ru-Shiliu, Leizhang, Xueliang Sun, Electrochemical technologies for energy storage and conversion, Volume 1 & 2, Wiley publications, 2nd Edition, 2012.

Reference Books

1. James Larminie and Andrew Dicks, Fuel cell systems Explained, Wiley publications, 1st edition, 2003.

EE-17.506 **Solar Photovoltaic Technology** **Total Lectures: 40**

3-1-0-4

Objective:

- To attain a broad comprehension of solar photovoltaic systems used for various applications.
- To know in depth the types and design of various PV-interconnected systems.

Prerequisite: Renewable Energy System

1. **Photovoltaic Basics:** Structure and working of Solar Cells - Types, Electrical properties and Behavior of Solar Cells – Cellproperties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays -Basics of Load Estimation. [8]

2. **Stand Alone PV Systems:** Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications - Typical applications for lighting, water pumping etc. [8]

3. **Grid Connected PV Systems:** Site selection and land requirements - Techno-economic analysis of solar PV power plants - Environmental considerations.Schematics, Components, Charge Conditioners, Interface Components - Balance of systemComponents - PV System in Buildings. [8]

4. **Design of PV Systems:** Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability - Simple Case Studies. [8]

5. **Solar Economics:** Application of economic methods to analyze the feasibility of solar systems to decide project / policy alternatives - Net energy analysis - and cost requirements for active and passive heating and cooling - for electric power generation - and for industrial process-heating. [8]

Course Outcome: Upon successful completion of this course students will be able to

- Explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems.

Text Books:

1. CS Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2nd Edition 2011.
2. Martin A. Green, Solar Cells: Operating Principles, Technology and System Applications, Prentice- Hall, 4th Edition, 2011.

Reference Books:

1. Nelson J., The Physics of Solar Cells, Imperial College Press, 2nd Edition, 2003.
2. Thomas Markvart, Solar Electricity, John Wiley and Sons, 2nd Edition, 2012.

EE-17.507 **Biomass and Small Hydel Plants** **Total Lectures: 52**
4-0-0-4

Objective:

- To provide understanding of the processes for converting biomass feedstocks to fuels by various approaches.
- To learn to evaluate technological, economic and business dimensions of energy production from biomass.
- To provide understanding of energy generation from small hydro power plant and hydel power plants management.

Prerequisite: Renewable Energy Sources

1. **Biomass Resources and Biomass Properties:** Biomass: definition, classification, availability, estimation of availability, consumption and surplus biomass, energy plantations. Potential of biomass and assessment. [8]
2. **Energy Conversions Techniques:** Thermo chemical conversion: Direct combustion, incineration, pyrolysis and gasification; Biomass stoves, improved chullahs and some exotic designs, Biological conversion: Biodegradation and biodegradability of substrate; Biochemistry and process parameters of biomethanation; Biogas digester types; Digester design and biogas utilisation; Bioconversion of substrates into alcohol: Methanol & ethanol Production, Chemical conversion: Hydrolysis and hydrogenation; Solvent extraction of hydrocarbons; Bioethanol; Chemicals from biomass. [11]
3. **Bio Diesel:** History, Production methods of Bio-diesel: Transesterification, Fuel quality, standards and properties, Availability of Raw materials for bio-diesel, Applications, Bio-diesel potential in India. [8]
4. **Waste To Energy** Introduction to Energy from waste, classification of waste as fuel, agro based, forest residue, industrial waste, Environmental monitoring system for land fill gases, Environmental impacts; Measures of mitigate environmental effects due to incineration. [7]
5. **Hydro Power:** Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works. [9]
6. **Hydel Plant Management:** Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in North East India. [9]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understand the challenges and problems associated with the use of various bioenergy sources with regard to future resource and the environment.
- Evaluate the cost-benefit of various biomass energy conversion processes.
- Identify remedies/potential solutions to the supply and environmental issues associated with biomass based energy resources.
- Conceptualize energy generation techniques and understand different small hydro power plant and hydel power plants management.

Text Books:

1. Capareda S, Introduction to biomass energy conversion, CRC Press, 4th Edition, 2014.
2. Harvey A. & Brown A, Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes. Practical Action publication, 2nd Edition, 2003.

Reference : Books

1. Brown RC and Stevens C, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons, 4th Edition, 2011.

EE-17.508 **Environmental Impact of Energy System** **Total Lectures: 52**

4-0-0-4

Objective: To achieve environmental improvements and know the environmental values and behavior.

Prerequisite: Power Plant Engineering.

1. **Impact of Energy Systems on Environment:** Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants. Methods of Environmental Impact Assessment. [12]
2. **Pollution Due To Thermal, Hydel and Nuclear Power Plants:** Potential sources of Pollution in thermal power plant, Air, water, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control. Various pollution control equipments such as dust collector, bag filter, electrostatic separator, working principle and selection criteria, designing the pollution control system, methods and limitation. Water pollution in thermal power plant, physical and chemical methods of pollution control, Land pollution effect of land pollution, measurement of land pollution. Limitations and advantages of pollution control systems. Hydrothermal plant environmental assessment, hydrothermal plant and rehabilitation measures for hydrothermal plant. Nuclear power plants and environmental pollution, pollution control measures. Effect of Hydroelectric power stations on ecology and environment. [14]
3. **Industrial and Urban Waste & Waste Energy Recovery:** Industrial waste, Waste and effluent treatment, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy. Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control. [10]
4. **Environmental and Pollution Control Laws:** United Nations Framework Convention on Climate Change (UNFCC), Protocol, Conference of Parties (COP) 19 Clean Development Mechanism (CDM), Prototype Carbon Funds(PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project. [10]
5. **Global Environmental Concern:** Global Environmental Issues, ozone layer depletion, Global Warming, Green House Gases Emission. [6]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understand environmental effects and act accordingly to improve the environmental conditions globally.

Text Books:

1. W.K. Foell, Management of Energy Environment Systems, John Wiley and Sons, 6th Edition, 2013.
2. M.C. Macedo Jr, Energy Management and Control Systems, John Wiley and Sons, 4th Edition, 2004.

Reference Books:

1. J.G. Rau, D.C. Wood, Environmental Impact Analysis Handbook, McGraw Hill, 7th Edition, 2005.
2. J.M. Fowler, Energy & Environment, McGraw Hill,, ERIC, 2nd edition, 2009.

EE-17.509 **Power System and Smart Grid** **Total Lectures: 52**

4-0-0-4

Objective:

- To provide the students a systems perspective of modern electricity markets and a systems approach to address various issues faced by the electricity sector.
- To present the student a vision of how Smart Grid will transform the current electricity grid to a reliable and sustainable modern energy system.

Prerequisite: Transmission and Distribution, Power System Analysis.

1. **Supply Side and Demand Side of Electricity:** Basics of electricity, Fossil fuels and hydro power plants, Renewable and alternative energy, Supply curve, Load characteristics, Load curve and load duration curve, Demand side management. [11]

2. **Transmission and Distribution Network:** Physical law of electricity, AC vs. DC power flow, Optimal Power flow and unit commitment models, Distribution network basics. [10]

3. **Basic Elements of Smart Grid:** The origin of power grid, dependency on power grid, desirable features of power grid, reliability, security, economic, efficiency, environmental friendly, safety. [11]

4. **Key Characteristics of Smart Grid:** Demand-side participation, Impact of Smart Grid on reliability, Impact of Smart Grid on air pollutant emissions reduction. [10]

5. **Issues Related to Smart Grid:**Communication and sensing in a smart grid, smart grid threats, vulnerabilities, cyber security strategies. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Gain Knowledge about the economic fundamentals of power systems and electricity markets.
- Understand the concepts of various components of Smart Grid, and their impacts on the energy industry, including renewable integration, demand side management, and greenhouse gas emission reduction.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 4th Edition, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 4th Edition, 2009.

Reference Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2017.

EE-17.510 **Power System for Renewable Energy Sources** **Total Lectures: 52**

4-0-0-4

Objective: To know the grid integration of renewable energy sources, different machines, power electronics devices uses in renewable energy power plants.

Prerequisite: Power System Analysis, Renewable Energy System.

1. **Introduction To Renewable Energy Grid Integration:** concept of mini/micro grids, and smart grids. Review of synchronous generators, Introduction to power system stability problems: rotor angle stability, voltage stability and voltage collapse, classification of stability. Modelling of synchronous machines: transformations, synchronous machine representation in stability studies. [12]
2. **Introduction To Induction Machines:** electrical characteristics, slip, speed torque characteristicsetc. Self-excited induction generator, Constant speed Induction generators, Variable speedInduction generators, Doubly fed Induction generators. [10]
3. **Introduction To Power Electronic Devices:** AC/DC converters, PWM, THD. Permanent magnetsynchronous generator, solar PV systems, fuel cell, aquaelectrolizer. [10]
4. **Issues in Integration of Different Generators:** Issues in integration of synchronous generator based, induction generator based and converterbased sources together.Network voltage management (discusses the issue of voltage levels). [10]
5. **Power Quality Management:** Voltage dips, harmonics and flickers.Frequency management. Influence of WECS on system transient response – IEEE standard and Polices. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Analyze the power quality management in renewable power plants.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 2nd Edition, 2009.

Reference : Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2006.

EE-17.512 **Power Electronics for Renewable Energy Source** **Total Lectures: 52**

4-0-0-4

Objective:
- To impart knowledge on Standalone, Grid connected and Hybrid renewable energy systems.
- To understand the different types of Electrical Machines and Power Converters employed for renewable energy conversion systems

Prerequisite: Power Electronics,Renewable Energy System.

1. **Introduction:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission), Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. [12]

2. **Electrical Machines For Renewable Energy Conversion:** Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG. [8]

3. **Power Converters:** Solar: Block diagram of solar photo voltaic system, Principle of operation: line commutated converters (inversion-mode), Boost and buck-boost converters, selection of inverter, battery sizing, array sizing, Wind: three phase AC voltage controllers, AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. [12]

4. **Analysis of Wind and PV Systems:** Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system, Grid connection Issues, Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system. [10]

5. **Hybrid Renewable Energy Systems:** Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Wind-PV, Maximum Power Point Tracking (MPPT). [10]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understand the concepts of Standalone, Grid connected and Hybrid Energy System
- Understand different types of Electrical Machines and Power Converters employed for Renewable Energy Conversion Systems.

Text Books:

1. Leon Freris, David Infield, Renewable Energy in Power Systems, John Wiley & Sons, 2008.
2. Rashid .M. H, Power Electronics Hand book, Academic press, 1st edition, 2007.

Reference Books:

1. Rai. G.D, Non-Conventional Energy Sources, Khanna publishes, 2nd edition, 2010.
2. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, John Wiley & Sons, 4th edition, 2011.
3. S.N. Bhadra, D.Kastha, Wind Electric Systems, Oxford University Press, 5th edition, 2005.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of ME

Course structure for

B.Tech ME

ME 14.401 **Thermal Engineering System** **Total Lectures: 40**
Credit 3-1-0-4

Prerequisite(s): Engineering Thermodynamics

Objective(s):

Thermodynamics is an essential part of engineering curricula, and has a broad application area such as transportation vehicles, power generation and cooling systems. The course will cover the basic principles of thermodynamics and will give students knowledge about how thermodynamics is applied in engineering practice.

1. **Steam Generator and Draft:** Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox etc, boiler mountings and accessories; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation. Introduction to high pressure boiler [8]
2. **Steam & Gas Nozzles:** Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, Off design operation of nozzle, Effect of friction on nozzle, critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. [8]
3. **Steam Turbines:** Introduction; classification of steam turbine; impulse turbine; working principal; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; efficiency of blade height; condition of maximum efficiency; internal losses in steam turbine; governing of steam turbine. [10]
4. **Compressors:** [6]
Classification, single and multistage reciprocating compressors, isothermal and volumetric efficiencies, centrifugal and axial flow compressors, surging, choking and stalling.
5. **Steam Condensers:** Component of steam condensing plant; types of condensers; air leakage in condensers; Dalton's law of partial pressure; Condenser vacuum, sources of air leakage & its disadvantages, vacuum efficiency; calculation of cooling water requirement; air expansion pump. [8]

Outcome(s):

Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques, including the use of empirical data and property tables, to the analysis of representative fluid and thermal energy components and systems.

Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques, including the use of empirical data and property tables, to the design analysis of auxiliary fluid and thermal energy components and systems representative of the systems encountered in the practice of electrical, industrial, and related disciplines of engineering.

Text Books:

1. P.K. Nag , “Basic and Applied Thermodynamics”, Tata Mc Graw Hill Pub
2. Kearton W. J, “Steam Turbine Theory and Practice”, CBS Publisher & Distribution Pvt Ltd, Latest Edition
3. R.K. Rajput, “Thermal Engg.”, Laxmi Publication

Reference Books:

1. Ballaney P. L, “Thermal Engineering”, Khanna Publishers, Latest Edition.
2. Yadav R, “Thermodynamics and Heat Engines”, Central Publishing House, Latest Edition
3. Chattopadhyay P, “ Boiler Operation Engineering”, TMH, 11th Edition, 2008.

ME 14.403 **Refrigeration and Air Conditioning** **Total Lectures: 40**

Credit-3-1-0-4

Prerequisite(s): Engineering Thermodynamics
Heat Transfer

Objective(s): *This course deals with the heating and cooling effects produced in domestic and industrial applications. The objectives of the course is to enable the student;*

- *To understand the principles of refrigeration and air conditioning.*
- *To calculate the cooling load for human comfort & different applications.*
- *To select the right equipment for a particular application.*
- *To understand the effect of temperature and pressure on moist air.*

6. **Introduction:** Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP), Fundamentals of air-conditioning system. [2]
7. **Air Refrigeration System:** Carnot refrigeration cycle; Temperature Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems. [4]
8. **Vapor Compression Refrigeration Systems:** Simple Vapour Compression Refrigeration systems-Limitations of Reversed Carnot cycle with vapour as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP. [5]
9. **Multistage Vapor Compression Refrigeration Systems:** Necessity of multistage compression, Compound VC cycle, Inter cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers. [7]
10. **Vapor Absorption Refrigeration Systems:** Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; Steam Jet Refrigerating System. [3]
11. **Refrigerants:** Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics. [3]
12. **Psychrometry:** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer. [7]

13. **Air Conditioning:** Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air-conditioning system; year round air conditioning; unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor; Inside design conditions; comfort conditions; components of cooling loads; internal heat gains; system heat gain: external heat gain; Transport air conditioning. [9]

Outcome(s):

Able to understand basic principles of refrigeration.
Able to understand simple and multiple vapour-compression cycle, gas refrigeration cycles and absorption cycles.
Ability to understand the principles of thermal comfort & ventilation
An ability to use refrigerant property tables and psychrometric chart.

Text Books:

1. Stocker W. F. and Jones J.W., "Refrigeration & Air conditioning", TMH, New Delhi, Latest Edition.
2. Arora C. P., "Refrigeration & Air conditioning", TMH, New Delhi, Latest Edition.

Reference Books:

1. Prasad M, "Refrigeration & Air conditioning", Wiley Eastern limited, New Delhi, Latest Edition.

ME 14.404 **CAD/CAM** **Total Lecture 40**
3-0-0

Prerequisite(s) **Mathematics (Matrix), Machine Design, C programming, Machine tool and Machining**

Objective(s)

- Understand the applications and benefits of CAD
- Understand geometric transformation.
- Understand various representations of curves and surfaces.
- Understand the various concepts and characteristics in geometric modeling.
- Understand the basic concepts of CAM. Analyze the components and systems of NC and CNC machine tools. Understand and apply various programming methods for specific jobs.
- Classify various CAPP systems.
- Understand FMS and CIMS with reference to components, advantages and applications.

1. **Fundamentals of CAD**: Introduction: Design Process: Application of computers in design: Creating manufacturing database: benefits of CAD. Computer Hardware; Graphic input devices; display devices; Graphics output devices; Central processing unit (CPU). CAD software and Database: Software configuration of a graphics system: functions of a graphics package: geometric modeling: Database structure and control; Graphics standard: GKS and IGES. **[4]**

2. **Geometric Transformations**: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrices. Application of geometric transformations. **[8]**

3. **Representation of curves and surfaces**: Polygon, meshed and ruled surfaces: Bezier curves; B-spline curves. **[6]**

4. **Geometric Modeling**: Wireframe model: solid modeling: representation, volumetric properties, surface modeling, concepts of hidden-line removal and shading: Kinematics analysis and simulation. Application of CAD techniques to finite Element Mesh Generation. Computer Aided Manufacturing (CAM) **[9]**

5. **Introduction of CAM**: Basic concepts of manufacturing system and CAD/CAM. NC/CMNC Machine Tools; NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system. **[9]**

6. **Computer Aided Process Planning**: Introduction and benefits of CAPP. Types of CAPP systems, machinability data selection systems in CAPP. **[2]**

7. **FMS and CIMS**: Flexible Manufacturing System (FMS) and Computer integrated manufacturing system: FMS and its advantages, components of a FMS system. Introduction to CIMS. **[2]**

Outcome(s)

- Understand the capabilities of general Computer Aided Designing Systems and CAD Systems for designing mechanical parts and elements in 2D and 3D dimensions.
- Use effectively CAD / CAM systems in order to produce the final NC code for the manufacturing of various mechanical parts and carry out exchange of data between CAD and CAM systems.
- Describe the principles of various manufacturing processes, manufacturing technology.

TEXT BOOKS:

1. Groover M.P., "Automation, Production Systems and Computer-Integrated Manufacturing", PHI, Latest Edition.
2. Zeid Ibrahim, "CAD/CAM : Theory & Practice", Tata Mc Graw Hill Publication, Latest Edition.

REFERENCE BOOKS:

1. Rao P.N., "CAD/CAM : Principle and Applications", Tata McGraw Hill Publication, Latest Edition

ME 14.405 **Total Lectures: 40**

Production Technology III

Pre – requisites: Material Science, Production Technology I **Credit-3-0-0-3**

Objective: *The course should enable the students :*

1. To exposed to fundamental concept of machining processes like grinding, super-finishing, thread and gear manufacturing.
2. To familiar with rapid prototyping.
3. To understand various non conventional manufacturing processes.

1 **Abrasive Machining:** Grinding machines, various grinding operations; Grinding wheels, preparation for wheel operation. Lapping, honing, super finishing. **[7]**

2 **Threads and Gear manufacturing:** Introduction, thread making, thread grinding, thread rolling, Gears types and gear making, machining of gears, gear finishing. **[6]**

3 **Powder Metallurgy:** Introduction, basic process, powder manufacturing, powder mixing and blending, composting, sintering. **[5]**

4 **Rapid prototyping and Micro Manufacturing:** Introduction, role of rapid prototyping & rapid tooling, features and classifications. Micro & Nano manufacturing processes, fabrication of electronics products and IC. **[6]**

5 **Jigs & Fixtures:** introduction, necessity for jigs & fixtures, elements of fixtures, locators, types of locators, clamping, locating principles. **[4]**

6 **Non Traditional Machining:** AJM, WJM, EDM, ECM, USM: working principle, components of set up, field of application, Parameters affecting machining characteristics, Material removal mechanism. **[12]**

Outcome *The students should be able to:*

1. Apply the knowledge of various advance manufacturing processes.
2. Identify various process parameters and their effect on processes.
3. Figure out application of modernization in machining.
4. Get the knowledge of Jigs and Fixtures so as to utilize machine capability for variety of operations

Text Book

1. Lindberg, "Processes and Materials of Manufacture", Prentice hall India (P) Ltd, Latest Edition.
2. Rao P. N, "Manufacturing Technology", TMH, Latest Edition.
3. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Pearson Publications.

Reference Book

1. Degarmo, Black and Kosher, "Material and Processes in Manufacturing", Latest Edition.
2. Kempster M. H. A, "Introduction to Jigs and Fixtures Design", Latest Edition.
3. Ghosh A, "Rapid Prototyping", EWP, Latest Edition.

ME 14.406 Operations Management

Total Lectures: 40

Pre – requisites: Elementary knowledge of calculus

Credit 3-1-0-4

Objective: *The course should enable the students :*

1. To understand the strategic significance of Operation management

2. To impart knowledge on Forecasting, Project management, Inventory, Scheduling & capacity planning with appropriate tools and techniques needed for understanding the operational situation.

1	**Manufacturing System:** Introduction to operation management, Types and characteristics of manufacturing systems.	[3]
2	**Forecasting Technique:** Use and types of forecasting, Methods of forecasting. Regression analysis	[6]
3	**Project Management:** Project management techniques; Introduction to CPM and PERT techniques, network analysis, activities and events, conventions adopted in drawing networks, graphical representation of events and activities.	[5]
4	**Materials Planning and Control:** Field and scope, materials planning; Inventories-types and classification; ABC analysis, economic lot size, EOQ model, leads time and reorder point, inventory control systems. Aggregate planning: definition, aggregate planning methods, Introduction to MRP and MRP-II, Master Production Schedule, Bill of materials.	[12]
5	**Operations Scheduling:** Concepts, loading, scheduling and sequencing, single processor scheduling, flow shop scheduling, job shop scheduling, scheduling criteria; Gantt chart.	[6]
6	**Capacity Planning:** Definition of capacity, capacity planning, capacity requirement planning, Capacity available and required.	[4]
7	**JIT & ERP:** Introduction to the new manufacturing concepts; JIT, lean manufacturing, pull and push systems of production; Kanban system. Introduction to ERP.	[4]

Outcome *The students should be able to:*

1. Understand and recognize key issues and problems in Operations Management.

2. Develop an understanding of how Operations Management functions relate to overall organization strategy, effectiveness and performance.

Text Book

1. Monks, J. G, "Operations Management", TMH, Latest Edition.
2. Russel Taylor, "Operations Management"**,** Wiley India.
3. Adam & Ebert, "Productions & Operations Management", PHI, Latest Edition.

Reference Book

1. Buffa W, "Modern Production/Operations Management", Eastern Ltd, Latest Edition.
2. Chary S.N, "Production and Operations Management", TMH, Latest Edition.

ME 14.407 **Industrial Engineering & Operation Research** **Total Lectures: 40**

Pre – requisites: Knowledge of linear algebra and basic mathematical concepts **Credit-3-0-0-3**

Objective: *The course should enable the students :*

1. To understand Concept of Industrial Engineering
2. To learn various Industrial Engineering techniques
3. To understand and apply operations research techniques to industrial applications
4. To understand Linear Programming concepts
5. To understand sequencing game theory

1 **Introduction to Industrial Engineering:** Relevance & importance of industrial engineering in industry. Productivity Management*:* Productivity measurement and improvement. [3]

2 **Plant Layout & Material Handling***:* Factors affecting plant location, Selection of plant site, Quantitative techniques of plant location decision, Plant layout, Types of layout Principles of layout design, Methods for evaluation of a layout, Quantitative techniques of developing layouts, Manual assembly lines, line balancing problems way to improve line balancing. Group Technology, parts family, parts classification and coding, production flow analysis. Introduction to material handling. [12]

3 **Work study & Ergonomics:** Method study, micro - motion study and principles of motion economy. Work measurement: time study, work sampling, standard data, PMTS. Introduction to ergonomics and its scope in relation to work. [7]

4 **Linear Programming**: Introduction to Operation Research, Problem formulation, Simplex methods, primal & dual problem, dual Simplex, sensitivity analysis. Transportation, & Assignment problems, Dynamic Programming. [12]

5 **Decision & Queuing Theory:** Decision under various conditions. Game Theory, Minimax & Maximin strategies. Introduction to Queuing Models. [6]

Outcome: *The students should be able to:*

1. Understand Concept of Industrial engineering and its role in industry.
2. Be good team member and project leaders to carry out projects in companies.
3. Build and solve Linear programming, Transportation models and assignment models.
4. Develop critical thinking and objective analysis decision making.

Text Books:

1. Khanna O P, "Industrial Engineering and Management", Dhanpat Rai Publications, Latest Edition.
2. Monks J. G, "Production/Operations Management", McGraw Hill, Latest Edition.

3. Taha H. A, “Operations Research – An Introduction”, Prentice Hall India, Latest Edition

Reference Books:

1. Chitale A. K & Gupta R. C, “Product Design and Manufacturing”, McGraw Hill Latest Edition.
2. Sanders M. and Mc Cormic, E., “Human Factors in Engineering”, McGraw Hill, Latest Edition.
3. Work Study, ILO, Geneva, Latest Edition.
4. Curie R, “Introduction to Work Study”, McGraw Hill, Latest Edition.
5. Philips R & Solberg, “Operations Research”, John Wiley, Latest Edition.
6. J K Sharma, Operations Research, Macmillan, 1997

ME 14.415 **Mechatronics** **Total Lecture 40**

Credit 3-1-0-4

Prerequisite(s) EC 14.101

Objective(s)

- *To study the definition and elements of mechatronics system.*
- *To learn how to apply the principles of mechatronics for the development of productive and efficient manufacturing systems.*
- *To study the hydraulic and pneumatic systems employed in manufacturing industry.*

1. **Introduction**: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. **[5]**

2. Review of fundamentals of electronics. Data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs. **[9]**

3. **Drives:** stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer **[6]**

4. **Hydraulic systems**: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. **[8]**

5. **Pneumatics:** production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description **[6]**

6. Description of PID controllers. CNC machines and part programming. Industrial Robotics. **[6]**

Outcome(s)

- *Be able to analyze and design mechatronics system used for automstion.*
- *Demonstrate knowledge on basic electronics used in manufacturing systems.*
- *Be able to design hydraulic systems for automating manufacturing systems.*
- *Be able to design pneumatic systems for automating manufacturing systems.*

Text Books:

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. J. Musa, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012.

Reference Books:

1. G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile and industrial applications, SAE, 1994.
2. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.
3. R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005

ME 14.419 **Non Convectional Energy Resources** **Total Lectures: 40**

Credit: 3-1-0

Prerequisite(s): Nil

Objective(s):

- *To familiarize students with the various renewable energy sources.*
- *Awareness of the potential of renewable energy technologies, for sustainability in particular.*
- *Suitable applications of solar, wind, biomass, hydro, geothermal and ocean energy.*
- *Awareness and development of suitable social and economic models with implications.*

1. **Energy Scenario**
   Energy resources in India and worldwide, energy needs and consumption patterns, social and economic implications, global environmental impact, Kyoto protocol, salient features of renewable energy technologies, pollution control and sustainability, Indian govt. policies and Supreme Court directive on renewable energy, subsidies, incentives and other financial implications, ROI., energy audit, energy optimization, green buildings. **10**

2. **Solar Energy Applications**
   Solar thermal systems: Domestic and industrial water heating, green houses, concentrated solar power (CSP), solar refrigeration and air conditioning, solar appliances- cookers, dryers, desalination of water, turbines.
   Solar photovoltaic systems (PV): Solar cell fundamentals, classification, comparison of silicon, thin film, Building Integrated photovoltaic (BIPV) panel technologies, stand alone and grid – integrated systems including storage and other components, economics. **10**

3. **Wind Energy**
   Fundamentals of wind energy, wind power systems- turbines, site selection and economics. grid connected operation, comparison with other renewable systems. **10**

4. **Other Energy Sources**
   Biomass-Conversions and energy content, mini hydro power plant, advantages and economics, geothermal, ocean tidal, wave and thermal energy, fuel cells, hybrid Systems, energy storage, emerging technologies. **10**

Outcome(s):

- *Identify appropriate renewable technology for application.*
- *Assess the economics and ROI.*
- *Implement concepts of clean development mechanism (CDM) and carbon credits.*
- *Utilize energy management and renewable energy systems in everyday life.*
- *Select ecofriendly, cost effective, energy efficient alternatives to unsustainable practices.*

Text Books:

1. B.H. Khan, "Non-Conventional Energy Resources", Tata McGraw-Hill, Latest Edition.
2. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publication, First Edition

Reference Books:

1. M. M. El-Wakil, "Power Plant Technology", McGraw-Hill, Latest Edition.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

B.Tech CSE

CS-14.101 **Programming Language** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To learn principles of programming by the structured native language 'C'.
- To comprehend the rudiments, constructs, syntax, and statements with essentials of efficient compiling, running and debugging processes.

1. **Introduction:** The role of programming languages, programming paradigms, language description and syntax structure, basics of structured programming, object-oriented programming, functional programming, logic programming, concurrent programming. [10]

2. **Fundamentals of 'C' language** : Character set, variables data types constants, arithmetic,relational and logical operators, type conversion,increment,decrement, bitwise and assignment operators, conditional expressions, statements and blocks, *if-else*,*switch*, loops-*do-while*, *while*, *for*; *break*, *continue* and *goto* statements, labels. [10]

3. **Functions, pointers and Arrays**: Basics of functions, automatic, external, static and register variables, scope rules, and header files, recursion and C preprocessor, arrays, pointers and addresses, pointers and arrays address arithmetic, character pointers and functions, pointer arrays, pointers to functions, pointers and multidimensional arrays, command line arguments. [10]

4. **Structures, unions and file processing:** Basics of structures, structures, and functions, arrays of structures, pointers to structures, self-referential structures, unions, bit fields, theconcept of files, standard input and output, formatted output, file access in different modes, reading from and writing to a file. [10]

Outcome(s):

- Students would be able to apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner.

Text Books:

1.Brain W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second edition, Pearson Education, 2013,

2.Ravi Sethi&K.V.Viswanatha, Programming Languages-Concepts, and Constructs, Second edition, Pearson Education,2013,

Reference Books:

1.Herbert Schildt, C: The Complete Reference, Fourth Edition, McGraw-Hill Education, 2017

2.E Balagurusamy, Programming in ANSI C, Tata McGraw - Hill Education,6th edition,2012

CS-14.201 **Discrete Structures** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): None

Objective(s):
- To Introduce fundamental concepts and applications of discrete structure in the field of computer science

1.	**Sets, Relations and Functions**: Set theory, combination of sets, multi-sets, ordered pairs, set identities, relations, operations on relations, properties of relations, composite relations, equality of relations, order of relations, functions, classification of functions, operations on functions, recursively defined functions.	[8]
2.	**Partially Ordered Sets:** Definition, combination of partial order sets, Hasse diagram, lattices: definition, properties of lattices: bounded, complemented, modular and complete lattice, morphisms of lattices.	[6]
3.	**Algebraic Structures:** Groups, subgroups and order, cyclic groups, cosets, Lagrange's theorem, normal subgroups, permutation and symmetric groups, group homomorphisms, rings, fields, integers modulo n.	[6]
4.	**Propositional Logic:** Proposition, well formed formula, truth tables, tautology, satisfiability, contradiction, algebra of proposition, theory of inference, natural deduction, predicate logic: first order predicate, well formed formula of predicate, quantifiers, and inference theory of predicate logic.	[7]
5.	**Counting:** Basic principles, permutations, combinations, summations, principle of inclusion and exclusion, pigeon-hole principle, generating functions and recurrence relations.	[6]
6.	**Graph Theory:** Graphs, isomorphic and homomorphic graphs, subgraphs, Eulerian chains and cycles, Hamiltonian chains and cycles, graph traversal algorithms, chromatic number, plannar graph.	[7]

Outcome(s): On the successful completion of the course, the student will be able to:
- Understand the theory and techniques of logic, graphs and trees, and algebraic systems.
- Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.

Text Books:
1. Bernard Kolman, Robert C., Busb Sharon, Cutler Ross, Discrete Mathematical Structures, PHI, 6th Edition, 2009.
2. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw- Hill, 7th Edition, 2011.

Reference Books:
1. Swapan Kumar Chakraborty, BikashKanti Sarkar, Discrete Mathematics, Oxford Higher Education, 2011
2. C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, Tata Mcgraw-Hill, 3rd Edition, 2008.

CS-14.202 **Java Programming** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 14.101 (Programming Language)

Objective(s): The objective of this course is to:

- cover issues related to the definition, creation and usage of classes, objects and methods.
- discuss the principles of inheritance and polymorphism.
- provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- cover the basics of API and to explore the java abstract programming interface.

1.	**Overview:** Introduction to Java, importance of Java, interactive Development Environments: Eclipse/Net Beans, basics of OOP.	[4]
2.	**Data Types, Variable, and Arrays:** Primitive data types, type casting, arrays, operators and control structures, identifiers, constants and literals.	[6]
3.	**Classes and Objects:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, this keyword, garbage collection, the finalize() method, overloading methods, using objects as parameters and return type, introducing access control, understanding static, introducing final, introducing nested and inner classes, exploring the string class, using command-line arguments.	[9]
4.	**Inheritance:** Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final in inheritance, the object class.	[4]
5.	**Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, JAVA's built-in exceptions, user defined exception.	[6]
6.	**Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managing threads, thread class built-in functions.	[4]
7.	**I/O and String Handling:** I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer.	[7]

Outcome(s): Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifies, automatic documentation through comments, error exception handling).
- Use of development environment like Eclipse for collaborative programming

Text Books:

1. Herbert Schildt, Java The Complete Reference, Herbert Schildt, 8th Edition, 2011.
2. John Jukowski, Mastering Java, 2002.

Reference Books:

1.Allen B. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
2. Paul Deitel, Harvey Deitel , Java How To Program (Early Objects), 10th Edition, 2014.

CS -14.203 **Data Structures** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1.	**Introduction:** Basic terminology, elementary data organization, algorithm, efficiency of an algorithm, time and space complexity, asymptotic notations, time-space trade- off, abstract data types.	[4]
2.	**Array:** Definition, single and multidimensional arrays, representation of arrays: row major order, and column major order, application of arrays, sparse matrices and their representations.	[4]
3.	**Searching & Sorting:** Sequential search, binary search, comparison and analysis, hash function, collision resolution strategies, insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort.	[6]
4.	**Linked list:** Singly linked lists, doubly linked list, circular linked list, insertion, deletion, traversal, polynomial representation and addition, generalized linked list.	[6]
5.	**Stack:** Primitive stack operations: push and pop array and linked list implementation of stack, application of stack: prefix and postfix expressions, evaluation of postfix expression, recursion, and tower of Hanoi problem.	[4]
6.	**Queue:** Queue operations, circular queues, array and linked list implementation of queues, dequeue and priority queue	[4]
7.	**Tree:** Binary trees, binary tree representation, tree traversal algorithms: inorder, preorder and postorder, threaded binary trees, Huffman algorithm, binary search trees AVL trees.	[6]
8.	**Graph:** Terminology, sequential and linked representations of graphs: adjacency matrices, adjacency list, adjacency multi list, graph traversal: depth first search and breadth first search, spanning trees.	[6]

Outcome(s): On the successful completion of the course, the student will be able to:

- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:

1. Lipschutz, "Data Structures" Schaum's Outline Series, TMH, Revised Edition Feb. 2014

Reference Books:

1.Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI, 2nd Edition, 2012.

2. Horowitz and Sahani, Fundamentals of Data Structures, University Press, 2nd Edition2008.

3. Jean Paul Trembley and Paul G. Sorenson, An Introduction to Data Structures with applications, McGraw Hill, 2nd Edition, 2003.

4. G. A. V. Pai, Data Structures and Algorithms, TMH, 2008

CS-14.204 **Database Management Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS 14.207(Computer Information System), CS14.203 (Data Structures).

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS & RDBMS in the organization.

1.	**Introduction:** Databases and database users, database system concepts and architecture, data modeling using the entity-relationship (ER) model, enhanced entity relationship model.	[7]
2.	**Relational Data Model:** Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model.	[7]
3.	**Structured Query Language (SQL)**: SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views.	[4]
4.	**Database Design:** Functional dependencies and normalization of relational databases, first normal form (1NF), 2nf, 3nf, boyce-codd normal form (BCNF), multi valued dependency, 4NF, join dependency, 5NF.	[8]
5.	**Transaction Processing:** Introduction, properties, recoverability, serializability, concurrency control techniques: two phase locking protocol, concurrency control based on time-stamp ordering, database recovery techniques: recovery concepts, recovery techniques based on deferred and immediate update, the ARIES recovery algorithm.	[7]
6.	**Object and Object-Relational Databases:** Concepts for object databases, object database standards and design, object relational and extended relational systems.	[7]

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.

Text Books:

1. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Management Systems, Edition, Pearson Education, 2013.

2. Raghu Ramakrishnan, Database Management Systems, 3rd Edition, Tata McGraw Hill, 2008.

Reference Books:

1. G.W. Hansen, and J.V. Hansen, Database Management and Design, 2nd Edition, Prentice Hall India, 2000.

2. Korth and Schilberschatz, Database System Concepts, 5th Edition, Tata McGraw Hill, 2006.

3. C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CS -14.205 **C++ Programming** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To get a basic knowledge of object-oriented concepts.
- To master in programming related to classes inheritance using C++.

1.	**Object Oriented Programming:** Basic concepts of object-oriented programming, Structured versus object oriented programming, merits and demerits of object oriented methodology.	[5]
2.	**Beginning With C++:** Preprocessor directives, Variables, data types, constants, operators, scope resolution operator, memory management operators, decision and loop controls, arrays, strings, functions	[5]
3.	**Classes And Objects:** Class definition, Structure versus class, accessing member functions within a class, data hiding, arrays within a class, static data and member functions, objects, friend functions and friend classes, constant member functions, pointers to members, constructors and destructor	[7]
4.	**Overloading and Exception Handling:** Definition, unary operator overloading, binary operators overloading, overloading of new and delete operators, manipulation of string using operators, type conversion, overloading with friend functions, function overloading, error and exception handling	[8]
5.	**Inheritance and Overriding:** Derived and base classes, type of inheritance, Derived class constructors and destructor, overriding member functions, public and private inheritance, virtual base classes, abstract classes, this pointer, virtual functions and pure virtual functions, static and dynamic bindings	[8]
6.	**I/O Streams and The Standard Library:** Header files, I/O stream library, stream I/O for objects, File I/O.	[4]
7.	**Templates:** Class templates, function templates, overloaded function templates, member function templates.	[3]

Outcome(s): On the successful completion of the course, the student will be able to:

- To gain the basic knowledge on object oriented concepts.
- To understand the role of inheritance, polymorphism, dynamic binding and generic structures in building reusable code.
- To implement features of object oriented programming to solve real world problems.

Text Books:

1. Herbert Schildt, "C++: The Complete Reference "4th edition, TMH July 2017.
2. Robert Lafore, "Object-Oriented Programming in C++", 4th edition, SAMS.

Reference Books:

1. Bjarne Stroustrup,"Programming-Principles and Practice Using C++", Addison-Wesley,4th Edition 2013
2. E. Balagurusamy,"Object Oriented Programming With C++",5th edition 2011, TMH

CS -14.206 **Theory of Computation** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): CS 14.201(Discrete Structures)

Objective(s): The goal of this course is to

- Provide students with an understanding of basic concepts in the theory of computation.
- To understand variety of issues in the mathematical development of computer science theory, particularly finite representations for languages and machines, as well as gain a more formal understanding of algorithms and procedures.

1. **Finite Automata and Regular Expression:** Finite state systems, basic definitions, regular languages and regular expression, finite automata ,Equivalence of DFA and NDFA , Kleen's theorem, pumping lemma for regular sets, regular expression with algebraic method Using Arden's Theorem, closure properties of regular sets, minimization of finite automata, Mealy and Moore machine - conversion of Mealy machine into Moore machine and vice versa. [11]
2. **Context-Free Grammars:** Context-free grammars, union, concatenation of CFG, derivation trees, simplification of context-free grammars, Chomsky normal form, Greibach Normal form, ambiguous context-free grammar. [9]
3. **Context-Free Languages and Pushdown Automata:** Pushdown automata and context-free languages, pumping lemma for CFL, closure properties of CFL, decision, algorithms for CFL. [8]
4. **Turing Machine:** Turing machine model, techniques for Turing machine construction, Turing machines as language acceptor, combining Turing machines, properties of recursive and recursively enumerable languages, universal Turing machine. [8]
5. **Chomsky Hierarchy of Languages:** Regular grammars, unrestricted grammars and Turing machines, context-sensitive grammars and linear bounded automata. [4]

Outcome(s):

- Be able to prove the equivalence of languages described by finite state machines and regular expressions.
- Be able to construct pushdown automata and the equivalent context free grammars.
- Be able to prove the equivalence of languages described by pushdown automata and context free grammars.
- Be able to construct Turing machines and Post machines.
- Be able to prove the equivalence of languages described by Turing machines and Post Machines.

Text Books:

1. Peter Linz, An Introduction to Formal Languages and Automata, Third Edition, Jones and Bartlett, 2001.
2. Hopcroft, Motwani, Ullmann, Introduction to Automata Theory, Languages and Computation, Pearson Education, Second Edition, 2005.

Reference Books:

1. Daniel I. A. Cohen, Introduction to Computer Theory, Prentice-Hall, Second Edition,1997.
2. Martin, Introduction to Languages and the theory of Computation, Tata McgrawHill, Third Edition, 2006

CS-14.207 **Computer Information Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): None

Objective(s):

- To give essential knowledge about computer information system and its components

1.	**Introduction:** Evolution of computers, generation of computers, classification of computers, block diagram of digital computers, memory unit, ALU,CPU, I/O devices, basic bus architecture, software classification, machine language, assembly languages and high level languages, assembler, compilers and interpreters, process of compilation, programming language generations, introduction to operating systems and role of the operating system.	[8]
2.	**Digital Logic:** Introduction to Boolean algebra and logic gates, K-map representation and Boolean function simplification, number systems: conversion from one number system to another, binary operations, complement representation of numbers, alphanumeric codes, floating point representation of numbers, floating point arithmetic operations.	[6]
3.	**Digital Circuit Building Blocks:** Adders, subtractors, comparators, encoders, decoders, multiplexers, de-multiplexers, latches, flip-flops, master slave flip flops, shift registers and counters.	[10]
4.	**Internet Technologies**: Introduction to computer networks, Internet, WWW and E-mail, web browsers, introduction to LAN,MAN, WAN, introduction to the design of web pages, HTML tags and CSS, web servers, server scripting, XML.	[8]
5.	**Software Development:** a systematic approach to program design, coding, testing, and debugging, application of these skills to the construction of robust programs, use of programming environments and tools to aid in the software development process.	[6]
6.	**Computers and Society**: Impact of computers in social life, education, business, issues of security and privacy, computer ethics.	[2]

Outcome(s):

- On successful completion of this course, students will be able to take specialized courses with strong fundamentals of Computer Information Systems.

Text Books:

1. P.K. Sinha, Computer Fundamentals, BPB Publications, 6th Edition, 2017
2. M. Morris Mano, Digital Logic & Computer Design, Pearson, 2nd Edition, 2010
3. Roger S. Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill Higher Education, 8th Edition, 2014
4. Thomas Powell, HTML and CSS: The Complete Reference, Tata McGraw-Hill, 5th Edition, 2010

Reference Books:

1. Andrew S.Tanenbaum, Computer Networks, Pearson Education, 5th Edition, 2013
2. Rajaraman, Fundamentals of Computers, PHI, 6th Edition, 2014

CS-14.232 **Computer Organization and Architecture** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.207 (Computer Information System)

Objective(s):

- To have a thorough understanding of the basic structure and operation of a digital computer.
- To discuss in detail the operation of the arithmetic unit including the algorithms &
- implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
- To study the different ways of communicating with I/O devices and standard I/O interfaces. To study the hierarchical memory system including cache memories and virtual memory.

1.	**Introduction:** Von-Neuman architecture, register transfer and micro operations: register transfer language, arithmetic micro-operations, logic micro-operations, shift micro- operations, bus and memory transfers, computer organization and design: instruction cycle, computer registers, common bus system, computer instructions, addressing modes, design of a basic computer.	[8]
2.	**Central Processing Unit:** General register organization, stack organization, instruction formats, data transfer and manipulation, program control, RISC, CISC characteristics, pipeline and vector processing: pipeline structure, speedup, efficiency, throughput and bottlenecks, arithmetic pipeline and instruction pipeline	[8]
3.	**Computer Arithmetic:** Hardware implementation of addition and subtraction, multiplication algorithms, Booths multiplier, array multiplier, division algorithms, floating point arithmetic: floating point representation, add, subtract, multiplication, division.	[8]
4.	**Memory & I/O Organization:** Memory hierarchy, RAM, ROM chips, memory address map, memory connection, associative memory, cache memory and virtual memory: paging and segmentation, auxiliary memory: magnetic disks, magnetic tapes, Input-output interface, Asynchronous data transfer, modes of transfer, priority interrupt, DMA, IOP.	[8]
5.	**Hardwired and Microprogrammed Control:** Hardwired control, microprogrammed control: microinstruction, microprogram sequencing, wide-branch addressing, microinstruction with next-address field, prefetching microinstruction.	[6]
6.	**Advance Topics:** Case study on Pentium series processors.	[2]

Outcome(s): On the successful completion of the course, the student will be able to:

- Understand basic structure of a digital computer.
- Perform arithmetic operations of binary number system.
- Know the organization of the control unit, arithmetic and logical unit, memory unit and the
- I/Ounit.

Text Books:

1. M. Morris Mano, Computer System Architecture, Pearson Education, 3rd edition, 2008.
2. Carl Hamacher, ZvonkoVranesic and SafwatZaky, Computer Organization, Tata McGraw Hill, 5th edition, 2002.

Reference Books:

1. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/ Software interface, Elsevier, 3rd edition, 2005.
2. William Stallings, Computer Organization and Architecture – Designing for Performance, Pearson Education, 6th edition, 2000.
3. John P. Hayes, Computer Architecture and Organization, Tata McGraw Hill,3rd edition,1998.

CS-14.301 **Design and Analysis of Algorithms** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): CS-14.201(Discrete Structures), CS-14.203(Data Structures)

Objective(s):
- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms power.

1.	**Introduction:** Fundamentals of algorithms and problem solving, asymptotic notations, time complexity and analysis of algorithms, solutions of recurrence relations, master theorem and summations techniques.	[8]
2.	**Analysis of Sorting and Searching Algorithms:** Linear, binary and interpolation search, insertion, selection, merge, quick and heap sort, stability and other issues, hashing.	[8]
3.	**Algorithm Design Approaches:** Greedy method (knapsack problem, job sequencing problem), dynamic programming (assembly line scheduling, matrix chain multiplication), backtracking (8 queens problem, sum of subsets), branch and bound (0/1 knapsack problem), divide and conquer algorithms (Strassen matrix multiplication), problems based on these design paradigms.	[8]
4.	**Tree and Graph algorithms:** Spanning trees, Prim and Kruskal's algorithm, Huffman coding, BFS and DFS, disjoint set operations, connected components, shortest path algorithms in a graph such as Dijkstra, Bellman Ford, Warshall's etc.	[8]
5.	**Complexity Classes:** P,NP,NP hard and NP complete problems, reducibility, decision and optimization problems, examples of NP complete problems such as 3 CNF, clique, vertex cover and traveling salesman problem, basic introduction of approximation algorithms.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:
- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.
- Modify existing algorithms to improve efficiency.

Text Books:
3. Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, PHI Learning Private Limited, 3rd edition, 2016.
4. Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, Computer Algorithms, Silicon Press, 2nd edition, 2008.

Reference Books:
3. Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 3rd edition, 2012.
4. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, 1st edition, 2006.
5. Donald E. Knuth, The Art of Computer Programming, Volumes 1& 3, Pearson Education, 2009.
6. Steven S. Skiena, The Algorithm Design Manual, Springer, 2nd edition, 2008.

CS-14.303 **Operating System** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.207 (Computer Information System)

Objective(s):

- Understand the fundamental operating system abstractions like processes, threads, files, semaphores, IPC and deadlocks.
- Understand operating system from user's perspective as well as from system's perspective.
- Understand the principles of concurrency and synchronization.
- Understand basic resource management techniques.
- Understand different theoretical principles in depth through hands on high level programming.

1.	**Overview:** Definition, types of operating systems: mainframe, server, multiprocessor, personal computer, real-time, embedded and smart card, system calls and utilities, batch, multiprogramming and multitasking operating system.	[3]
2.	**File Systems:** File concept, user and system programmer view of file systems, different modules of a file system, disk structure, disk-space allocation methods: contiguous, linked, indexed directory structures, file protection, disk scheduling algorithms.	[6]
3.	**Process Management:** Process concepts, threads, scheduling concepts, types of schedulers, scheduling algorithms, process state diagram, comparison of various CPU scheduling algorithms, multi-level queue scheduling.	[6]
4.	**Memory Management:** Logical and physical address spaces, base, limit and relocation registers, address binding, dynamic loading and linking, partitioning, swapping, contiguous memory allocation, non-contiguous memory allocation: segmentation, paging and segmentation.	[8]
5.	**Process Synchronization and deadlock:** Independent and concurrent processes, shared memory approach and message passing approach, mutual exclusion, synchronization, inter process communication, critical section problem and its solution to semaphores: binary and counting semaphores, wait/signal operations and their implementation, classical problems of synchronization, deadlock.	[11]
6.	**Case Studies:** Windows, UNIX and Linux: scheduling and memory management.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Analyze the primary functionalities of operating system.
- Manage system resources efficiently as an operating system designer.
- Develop new operating systems as well as work on existing ones to develop them further.

Text Books:

1. Galvin, Silberschatz, Gagne, Operating System Concepts, Wiley India, 9th edition, 2015.

Reference Books:

1. Andrew S. Tanenbaum, Modern Operating Systems - Prentice-Hall, Inc., 4th edition, 2015.
2. Deitel, Operating Systems, Pearson Education , 3rd edition, (2012 reprint).
3. **Stallings, Operating Systems: Internals and Design Principles, Pearson education, 7th edition 2013.**

CS-14.305 **Logic in Computer Science** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.201(Discrete Structures), CS-14.207(Computer Information Systems)

Objective(s):

- To introduce the main notions of mathematical logic: logical notations (syntax) and how to assign meaning to them (semantics).
- To study formal frameworks (in the sense of being rigorous as well as in the sense of manipulating "form") for constructing logical arguments (proof theory).
- To study some deductive systems for propositional and first-order logic.
- To introduce the concept of fuzzy logic.

1.	**Introduction:** Role of logic in computer science, problem representation, review of the principle of mathematical induction, the principle of structural induction, review of Boolean algebra, language, models, interpretations, validity, proof, decision problems in logic, decidability.	[6]
2.	**Propositional Logic:** Syntax, semantics, logical and algebraic concepts, identities and normal forms, tautology checking, propositional satisfiability, propositional resolution and tableaux method.	[10]
3.	**First Order Predicate Logic:** Quantifiers, first order models, validity and satisfiability, forward and backward chaining, Skolmization, normal forms, unification, Horn formulas and programs, resolution and tableaux.	[12]
4.	**Binary Decision Diagrams:** Representing Boolean functions, algorithms for ordered reduced binary decision diagram (OBDD), geometric templates from spatial relations, image based rendering, symbolic model checking, relational Mu-calculus, coding CTL models and specification.	[8]
5.	**Fuzzy Logic:** Classic sets, fuzzy sets and membership, fuzzy set operations, Cartesian product, operations and properties of crisp relationship, operations and properties of fuzzy relationship.	[4]

Outcome(s): On successful completion of this course, the students will be able to

- Use propositional and first-order logic.
- Apply of logic in specifying properties.
- Develop proof by induction.
- Design binary decision diagrams.
- Identify the scope for fuzzy logic.

Text Books:

3. Huth M and Ryan M, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press, 2nd edition, 2004.
4. Enderton H B, A Mathematical Introduction to Logic, Academic Press, 2nd edition, 2001.

Reference Books:

5. Arindama Singh, Logics for Computer Science, Prentice Hall of India, 1st edition, 2004.
6. M. Ben-Ari, Mathematical Logic for Computer Science, Springer, 2nd edition, 2003.
7. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 3rd edition, 2009.
8. C. L. Chang and R. C. T. Lee, Symbolic Logic and Mechanical Theorem Proving, Academic Press, 1st edition, 1973.

CS 14.309 **Microprocessor and Assembly Language Programming** **Total Lectures: 40**
Credit: 3-0-0 -3

Prerequisite(s): CS 14.207 (Computer Information System)

Objective(s):
- To study architecture and memory management of 8-bit and 16-bit microprocessor (8085 & 8086)
- To study assembly language programming and use it to solve various problems.

1.	**Introduction:** Evolution of Microprocessor and its types, 8085 microprocessor architecture, buses, registers, flags, 8085 pin configuration & function.	[6]
2.	**8085 Instruction Set:** Addressing modes of 8085, 8085 instruction set, data transfer arithmetic, logical and branch instructions, 8085 interrupt structure, limitations of 8085 microprocessor.	[8]
3.	**Interfacing:** Memory mapped I/O, I/O mapped I/O, address decoding, interfacing of memory with 8085, interfacing of I/O with 8085.	[8]
4.	**Advance Microprocessors:** 8086 microprocessor architecture, 8086 pin configuration & function, addressing modes of 8086, instruction set of 8086, 8086 interrupts, study of advance processors of the family (8088, 80286, 80386, 80486 and Pentium).	[10]
5.	**Assembly Language Programming:** Introduction, assembler directives, looping, condition and jump, subroutines, procedures, macros, parameter passing.	[8]

Outcome(s): On successful completion of this course, students will be able to:
- Draw block diagram of 8085/86 processor and know the pin function
- Know the instruction set and addressing modes
- Write the assembly language program for different problems and know the use of procedures and macros.
- Design interface of memory chips.

Text Books:

3. **Gaonkar R. S., "Microprocessor Architecture, Programming and Applications", 6th Ed., Penram International, 2013.**
4. **Hall D. V.,SSSP Rao, "Microprocessors and its Interfacing (SIE)", 3rd Ed., Tata McGraw-Hill Publishing Company Limited, 2012.**

Reference Books:

5. Stewart J, "**Microprocessor Systems- Hardware, Software and Programming", Prentice Hall International Edition, 1990.**
6. Short K. L., "Microprocessors and Programmed Logic", 2nd Ed., Pearson Education, 2008
7. Ray, A.K. and Bhurchandi, K.M., "Advanced Microprocessor and Peripherals Architecture, Programming and Interfacing", Tata Mc-Graw Hill, 2006
8. Chhabra, "The Intel 8086/8088 microprocessor architecture programming design & interfacing", Dhanpat Rai Publication

CS 14.315 **Python Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language (CS 14.101)

Objective(s): Python is a general-purpose, versatile and popular programming language. It's great as a first language because it is concise and easy to read, and it is also a good language to have in any programmer's stack as it can be used for everything from web development to software development and scientific applications.

1.	**Introduction**: The basic elements of python, python syntax, compiled vs interpreted languages, formal and natural languages, built in python types, python as a calculator, basic input, branching programs, control structures, strings, tuples, lists and input iteration.	[6]
2.	**Functions and Abstraction**: Functions and scoping flow of execution, specifications, recursion, global variables, modules, stack diagrams, files, system functions and parameters, input and output, making your own module.	[7]
3.	**Structured Types and Higher-Order Functions**: Mutability strings, tuples, lists and dictionaries, lists and mutability, functions as Objects.	[5]
4.	**Classes and Object-Oriented Programming and Data Structure**: Abstract data types and classes, inheritance, encapsulation and information hiding, simple algorithms and data structures, list, tuple, sequence, set, search algorithms, sorting algorithms, hash tables.	[8]
5.	**Testing and Debugging**: Exceptions and assertions, types of testing – black-box and glass-box, debugging, handling exceptions, assertions.	[6]
6.	**Advance Python:** Regular expressions – REs and Python, plotting using PyLab, networking and Multithreaded Programming – sockets, threads and processes, chat Application, security – encryption and decryption, classical cyphers, graphics and GUI programming – drawing using Turtle, Tkinter and Python, Other GUIs.	[8]

Outcome(s): Upon completion of this course students will be

- Familiar with Python syntax.
- Able to use python to implement a given logic.

Text Books:

3. John V Guttag, Introduction to Computation and Programming using Python, Prentice Hall of India, 2nd Edition, 2013.
4. Swaroop C H. , A Byte of Python, URL: https://python.swaroopch.com

Reference Books:

4. Zed A. Shaw ,Learn Python the hard way: a very simple introduction to the terrifyingly beautiful world of computers and code, Third edition, 2014.
5. Richard L. Halterman,Learning to Program with python, 2011.
6. Allen Downey ,Think Python How to Think Like a Computer Scientist, Version 2.0.17, Green Tea Press Needham, Massachusetts,2012.

CS-14.316 **Computer Graphics** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.101 (Programming Languages), MA-14.101 Mathematics I

Objective(s):

- To introduce the students with the graphics mode, with the help of basic algorithms and methodologies.
- The objective of the course is to equip students with fundamental knowledge and basic technical competence in the field of computer graphics.
- Provide an understanding of how a computer draws the fundamental graphics primitives.
- To learn Computer Graphics methodologies/Algorithms and techniques and their implementations.

1. **Introduction to Computer Graphics and graphics primitives**: Overview of interactive graphics model, applications of computer graphics, graphics devices, random and raster scan systems, color models: RGB, YIQ, scan conversion: point, line, circle and ellipse. [7]
2. **2D Transformation and Viewing**: Basic transformations (translation, rotation, scaling), homogeneous coordinates, composite transformations, reflection and shearing, filling: scan line filling, flood filling, boundary filling, clipping: point clipping, line clipping, polygon clipping, and character generation. [7]
3. **Curves and Surfaces**: Introduction to curves, conic curves, polygon surfaces, tables, quadric surfaces, spline representation, cubic spline interpolation methods, Bezier curves and surfaces, B-spline curves and surfaces, fractals and its applications. [7]
4. **3D Transformation and Viewing**: 3D transformation, composite transformation, viewing pipeline, parallel and perspective projection, visible surface detection: classification of visible surface detection algorithms, back face detection, depth buffer method, A-buffer method, scan-line method, depth sorting method. [7]
5. **Illumination Model and Surface Rendering Techniques**: Basic illumination models, Halftone patterns and dithering techniques, polygon rendering methods, ray tracing methods. [6]
6. **Introduction to Animation and Multimedia:** Introduction to animation, key-frame animation, construction of an animation sequence, animation techniques, multimedia: introduction, features of multimedia system, components of multimedia systems and application of multimedia systems. [6]

Outcome(s): On successful completion of this course, students will be able to

- Understand basic concepts of computer graphics.
- Acquire knowledge about drawing basic shapes such as lines, circle ellipse, polygon.
- Perform processing of basic shapes by various processing algorithms /techniques.
- Implement two and three dimensional transformations.
- Apply various algorithms of clipping.
- Acquire knowledge about illumination models, color models and surface rendering.

Text Books:

3. Donald D. Hearn & M. Pauline Baker, Computer Graphics-C Version, Pearson Education, 2nd edition, 2002.
4. James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, Computer Graphics Principles and Practice, 2nd Edition in C, Addison Wesley, 1995.

Reference Books:

3. Donald Hearn and M Pauline Baker, Computer Graphics with OpenGL, Pearson Education, 4th edition, 2010.
4. David F. Rogers, Procedural Elements for Computer Graphics, Tata McGraw Hill Publications, 2nd edition, 2001.

CS-14.317 **Advance Web Technology** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.207 (Computer Information System)

Objective(s):

- To learn the platform neutral fundamentals of secure, dynamic web application development.
- To learn how to implement a web application using one specific set of open source server side tools: PHP and MySQL.

1. **Introduction:** HTTP protocol : request and response, web browser and web servers, concepts of effective web design, web design issues including browser, bandwidth and cache, display resolution, look and feel of the website, page layout and linking, user centric design, sitemap, planning and publishing website, designing effective navigation. [4]

2. **JavaScript and XML:** Client side scripting with JavaScript, variables, functions, conditions, loops and repetition, pop up boxes, advance JavaScript: JavaScript and objects, JavaScript own objects, the DOM and web, browser environments, manipulation using DOM, forms and validations, Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas, using XML with application, transforming XML using XSL and XSLT. [12]

3. **PHP:** Introduction and basic syntax of PHP, decision and looping with examples, PHP and HTML, arrays, functions, browser control and detection, string, form processing, files, advance features: Cookies and sessions, Object Oriented Programming with PHP. [12]

4. **PHP and MySQL:** Basic commands with PHP examples, connection to server, creating database, selecting a database, listing database, listing table names, creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PhpMyadmin and database bugs. [12]

Outcome(s): Upon completion of the course students will be able to:

- Use the JavaScript to develop the dynamic web pages.
- Use server side scripting with PHP to generate the web pages dynamically using the database connectivity.
- Develop the modern Web applications using the client and server side technologies and the web design fundamentals.

Text Books:

3. Luke Welling, Laura Thomson: PHP and MySQL Web Development, Pearson, 2016.
4. Robin Nixon: Learning PHP, MySQL, and JavaScript, O'Reilly Media, 2012.

Reference Books:

4. Elizabeth Naramore, Jason Gerner, Yann Le Scouarnec, Jeremy Stolz, MichaelK. Glass, Beginning PHP5, Apache, and MySQL Web Development, Wrox, 2005.
5. Developing Web Applications in PHP and AJAX, Harwani, McGrawHill, 2010.
6. W. Jason Gilmore: Beginning PHP and MySQL 5 From Novice to Professional, Apress, 2010.

CS-14.318 **Artificial Intelligence** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.101 (Programming Language), CS-14.207(Computer Information Systems)

Objective(s):

- To understand the basic problem solving in Artificial Intelligence.
- To learn different blind as well as heuristic search strategies.
- To understand the various ways of knowledge representation in Artificial Intelligence.
- To know the concepts of game theory and natural language processing.

1. **Overview of Artificial Intelligence:** Introduction to artificial intelligence and intelligent agents, brief history of artificial intelligence, related research fields, AI techniques, AI problems, applications of AI, future of AI, basic concepts of LISP and PROLOG. [6]
2. **Problem Solving and Search Techniques:** Basics of problem solving, Problem representation paradigms, defining problem as a state space representation, uninformed search, depth first search, breadth first search, heuristic search, heuristic functions, generate and test, hill climbing, best first search, A* algorithm, problem reduction, AND/OR graph, AO* algorithm. [10]
3. **Knowledge Representation and Logic:** Representation and mappings, procedural versus declarative knowledge, approaches and issues in knowledge representation, introduction to logic-based problem solving, Boolean logic, first order logic, higher order logic, unification and resolution for performing logical inference, fuzzy logic, probabilistic logic. [8]
4. **Game Theory:** Minimax search, alpha-beta cutoffs, iterative deepening, references on specific games. [5]
5. **Natural Language Processing:** Introduction to NLP, syntactic processing, semantic analysis, discourse and pragmatic processing. [5]
6. **Learning:** Learning from observation, rote learning, inductive learning, explanation basedlearning, statistical learning methods, supervised and unsupervised learning, basics of neural network, reinforcement learning discovery, analogy. [6]

Outcome(s): On successful completion of this course, students will be able to

- Solve the basic problems and apply searching techniques used in Artificial Intelligence.
- To select knowledge representations to solve AI problems.
- Apply various game playing algorithms.
- Work with natural language processing and apply learning techniques.

Text Books:

3. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 3rd edition, 2009.
4. Russell S., and Norvig P., Artificial Intelligence – A Modern Approach, Prentice-Hall of India, 3rd edition, 2014.

Reference Books:

8. Patterson D. W., Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall of India, 1st edition, 2015.
9. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 5th edition, 2009.

CS- 14.319 **Advanced Java** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.202 (Java)

Objective(s): This course extends the study of Web Programming Fundamentals. Advanced concepts of program design, implementation and testing will be introduced with J2EE framework. Student will learn various concept of advance Java for implementation of small to medium sized application programs that illustrate professionally acceptable coding and performance standards.

1.	**Introduction:** OOPS principle, class and objects, basics of HTML, web development introduction, web framework, J2EE building blocks, web application structure	[3]
2.	**Servlets:** Servlet needs, servlet request-response model, servlet life cycle (init, service, doGet, doPost), servlet configuration, scopes (session, request, page), servlet parameters, servlet context, forms processing (get, post), HTTP header processing, HTTP responses.	[5]
3.	**Java Server Pages**: JSP life cycle, JSP a servlets, creating dynamic content with use of JSP elements: expressions, scriptlets & declarations, JSP composition, redirecting, forwarding, accessing default objects (request, response, session, application, config, pageContext), error processing with use of JSP, Servlets vs. JSP pages	[8]
4.	**Session management**: Http session, the Http session interface session tracking: cookies, hidden fields, cookies and JSP, sending and receiving cookies.	[4]
5.	**Using Beans and tag libraries**: Separating presentation and business logic, JSP actions, JavaBeans, working with properties, <jsp:useBean>, <jsp:getProperty> and <jsp:setProperty>,using form parameters with Beans, custom tags, types of tags.	[10]
6.	**Web application:** Case study of a web application, the web.xml deployment descriptor, web.xml – document definition, web.xml – adding servlets, web.xml – mapping servlets, web.xml – sending parameters, web.xml – pre-loading servlets, web application archive, deployment of web application	[10]

Outcome(s): Upon successful completion of this course you should be able to:

- Demonstrate knowledge of the advance Java along with object oriented development process and apply this understanding to the analysis and design of solutions for small to medium scale problems.
- Implement web application using all the feature of J2EE covered in the course.

Text Books:

3. By Martin Bond, Debbie Law, Andy Longshaw, Dan Haywood, Peter Roxburgh, Sams Teach Yourself J2EE in 21 Days, 2nd Edition,SAMS , 2004.
4. Phillip Hanna , Osborne, JSP 2.0: The Complete Reference, 2nd edition, McGraw-Hill, 2003.

Reference Book:

3. Bryan Basham, Kathy Sierra & Bert Bets, Head First Servlets and JSP, 2nd Edition, , Oreilly publication, 2008.

CS-14.320 **Cryptography** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.201 (Discrete Structures), CS-14.207 (Computer Information Systems)

Objective(s):

- To understand the classical encryption and decryption algorithms, their techniques as well cryptanalysis.
- To acquire basic knowledge of finite fields and number theory.
- To understand the various block ciphers, stream cipher models, principles of public key cryptosystems, hash functions and digital signatures.
- To understand the different authentication techniques.

1. **General Overview and Classical Cryptography:** General overview of threats, risks and consequences, sources of threats, attacks, classification and preventive measures, introduction to some simple ciphers such as shift cipher, substitution cipher, affine cipher, Vigener cipher, hill cipher, permutation cipher and stream ciphers, rigorous cryptanalysis of all the above ciphers. [8]
2. **Symmetric/Secret Key Cryptography:** Block ciphers and their principles- boxes, P-boxes, DES, 3 DES, AES. [6]
3. **Elementary Number Theory:** Euclid's algorithm, extended Euclid's algorithm, groups, solving modular linear equations, Chinese remainder theorem, modular exponentiation, discrete logarithm problem, prime numbers and primality testing, factorization problem, Fermat's and Euler's theorem, computation of generators of primes. [8]
4. **Key Exchange/Distribution Schemes:** Diffie - Hellman key exchange, man- in- the-middle attack, Fiat-Naor key distribution, Needham – Schroeder scheme and attack possible on it, Kerberos. [6]
5. **Asymmetric Key/Public Key Cryptosystems:** RSA description, different attacks on RSA and remedies, other public key crypto systems such as ElGamal and Rabin cryptosystems and possible attacks on them. [6]
6. **Digital Signature Schemes:** Security requirements for digital signatures, ElGamal digital signature scheme and its security analysis, the digital signature algorithm (DSA), Schnorr digital signature scheme, provably secure signature schemes and undeniable signatures. [6]

Outcome(s): On successful completion of this course, students will be able to :

- Analyze the security threats.
- Design robust cryptographic algorithms.

Text Books:

2. Douglas R. Stinson, Cryptography: Theory and Practice, (Discrete Mathematics and Its Applications) Chapman and Hall/CRC, 3rd edition, 2005.

Reference Books:

4. Jonathan Katz , Yehuda Lindell, Introduction to Modern Cryptography, (Cryptography and Network Security Series), Chapman and Hall/CRC; 2nd edition, 2014.
5. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, 6th edition 2013.
6. Wenbo Mao, Modern Cryptography Theory & Practice, 1st edition, 2004.

CS-14.321 **Windows Programming** **Total Lectures:40**
Credit : 3-1-0-4

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To provide knowledge of windows programming using Visual Basic .NET.
- To focus on Visual Basic program structure, language syntax and implementation details.

1.	**Overview of Windows Programming:** The Windows environment, history of Windows, aspects of Windows, Windows programming options, APIs and memory models, programming environment	[4]
2.	**Visual Basic 2010:** The Visual Studio development environment, writing the code, building and deploying the application, working with Toolbox control, working with specific data types, working with operators, if…then structure, select case structure, the for…next loop, using counter variable, complex for…next loop, do loops, using timer object, processing errors by using try…catch statement, using finally clause, the exception object, using nested try…catch, the exit try statement.	[12]
3.	**Modules and Procedures:** Working with modules, creating public variables, creating procedures, writing sub procedure, passing arguments by value, working with array, using ReDim, the array class, working with object collections, for each…next loop, creating your own collection.	[8]
4.	**Designing User Interface:** Managing windows forms and controls at run time, adding graphics, the system drawing namespace, adding animation to your program, inheriting forms and creating base classes, working with printers.	[6]
5.	**Database:** Exploring text files, reading and writing text files, getting started with ADO.NET, SQL statements and LINQ, data presentation using Data Grid View control.	[6]
6.	**Web Programming:** Creating websites and webpages using Visual Web Developer and ASP.NET, difference between webpages and web forms, server controls, HTML controls, using webpage designer, adding server controls to a webpage.	[4]

Outcome(s): Upon completion of the course the student should be

- Able to analyze program requirements.
- Design/develop programs with GUI.
- Code program and develop interface using Visual Basic .NET.
- Perform tests, resolve defects and revise existing code.

Text Books:

1. Michael Halvorson, Microsoft Visual Basic 2010, Microsoft Press, 2010
2. Bradley and Millspaugh, Programming in Visual Basic 2010, Mcgraw-Hill, 2010

Reference Books:

1. Shelly Hoisington, Microsoft Visual Basic 2010 for Windows, Web, Office and Database Applications: Comprehensive, Cengage Learning, 2010.
2. Sheldon Bill et. al., Professional Visual Basic 2010 and .NET 4, John Wiley & Sons, 2010
3. Andrew Moore, Visual Studio 2010 All-in-one for Dummies, John Wiley & Sons, 2010

CS-14.322 **Data Mining** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS-14.204 (Database Management System), CS-14.301(Design and Analysis of Algorithms), MA-14.202 (Statistics and Probability Theory).

Objective(s):

- Understand the functionality of the various data mining and data warehousing components.
- Appreciate the strengths and limitations of various data mining and data warehousing models.
- Compare the various approaches to data warehousing and data mining implementations
- Describe and utilize a range of techniques for designing data warehousing and data mining systems for real-world applications.

1.	**Overview:** Evolution of the database system technology, concept of data mining and warehousing, data warehouse roles and structures, cost of warehousing data, approaches to data exploration and data mining, foundations of data mining, web warehousing, introduction to knowledge management and knowledge bases.	[5]
2.	**Data Warehouse:** Overview of data warehousing, data marts, data warehouse architecture, multidimensional data model, online analytical processing (OLAP), OLAP operations, data about data - metadata.	[4]
3.	**Data Mining and Data Visualization:** Data mining general approach, classification and clustering, introduction to DM tool (Weka, Rapidminer), techniques used to mine the data, current limitations and challenges to DM, data visualization, visualization tools.	[6]
4.	**Data Preprocessing:** Overview, data cleaning, data integration, data reduction strategies, principal component analysis, sampling, histograms, clustering, data cube aggregation, data transformation and discretization.	[6]
5.	**Machine Learning:** Supervised and unsupervised machine learning, market basket analysis (Apriori algorithm), fuzzy logic and linguistic ambiguity, artificial neural networks, genetic algorithms, genetically evolved networks, applications for machine learning.	[7]
6.	**Text Mining:** Information retrieval and search, text classification, text clustering, unsupervised learning, mining frequent patterns and correlations, classification concepts, back propagation, decision tree induction, rule based classification, clustering basic concepts and methods, K-means centroid based technique.	[6]
7.	**Web Based Statistical Analysis:** Delivering information over the web, query and reporting tools and business value, business value from analytical tools, statistical analysis applications, data discovery tools overview, data discovery applications, search engines and the web, search engine architecture, future of data mining.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Identify, formulate, and solve data science related problems by applying principles of the course.
- Understand both analysis and synthesis in the design process with the help of data mining and data warehousing tools.
- Develop and conduct appropriate experiments, analyze and interpret data, and use data visualization to draw conclusions.
- Function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

Text Books:

4. George M Marakas, Modern Data Warehousing, Mining and Visualization, Pearson Education, 1st edition, 2002.
5. **Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 3rd edition, 2011.**
6. Mattison R., Web Warehousing and Knowledge Management, Tata McGraw-Hill, 1st edition, 1999.

Reference Books:

4. W.H. Inmon, BuildingtheData Warehouse, Wiley Publishing Inc., 3rdedition, 2005.
5. Anahory and Murray, Data Warehousing in the Real World, Pearson Education/Addison Wesley, 1st edition, 1997.
6. Prabhu C.S.R., Data Warehousing, Prentice-Hall of India, 2ndedition, 2002.

CS -14.323 **Shell Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language (CS 14.101)

Objective(s):
- To familiarize students with the Unix/Linux environment
- To learn the fundamentals of shell scripting/programming
- To familiarize students with basic Unix/Linux administration

1. **UNIX-Basic Concepts:** Introduction, file systems, visual editors, Unix philosophy and features, understanding the Unix commands and general purpose utilities and navigating the file system, the shell and kernel. [8]

2. **UNIX-Advanced Features:** File and directory structures, file systems and peripheral devices, handling ordinary files, file attributes. UNIX system administration, data blocks and i-nodes. [8]

3. **Unix Editors and Filters:** Vi Editor, simple filters, regular expression and grep family, advanced filters: sed and awk, awk pattern scanning and processing, awk arithmetic, operators and variables. [8]

4. **Shell Fundamentals:** Command syntax, Shell variables, pattern matching, escaping, command substitution, input /output redirection, pipes, tees, [6]

5. **Shell Scripting:** Bourne shell, C shell; scripts, meta characters and environment, shell programming and scripts, logical operators, control and looping statements and programs. Shell reliability, maintainability, efficiency, portability and usability. [10]

Outcome(s): After completion of the course students will be able to
- Work confidently in Unix/Linux environment
- Write shell scripts to automate various tasks
- Master the basics of Unix/Linux administration
- Understand the basic difference between high level programming and shell programming

Text Books:
3. Sumitabha Das, UNIX, Tata McGraw-Hill Companies, 4th edition, 2011.
4. **Cameron Newham, Learning the bash Shell:Unix Shell Programming, 3rdedition,O'Reilly Media,2009.**

Reference Books:
1. Bill Rosenblatt , Learning the Korn Shell, O'Reilly Media, 2002.
2. Mark G. Sobell ,A practical guide to Linux commands, editors, and shell programming, 2nded. Prentice Hall, 2013.

CS-14.324 **Data Compression** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): MA-14.202 (Statistics and Probability Theory)

Objective(s):

- To develop theoretical foundations of data compression.
- To know the concepts and algorithms for lossy and lossless data compression.
- To understand signal modeling and its extension to compression with applications to speech, image and video processing.

1. **Introduction:** Compression techniques, measures of performance, modeling and coding, information theory, Shannon coding theory, physical models, probability models, Markov models, composite source model, fixed and variable length codes, uniquely decodable codes, prefix codes, Kraft's theorem. [10]

2. **Lossless Compression:** The Huffman coding algorithm: minimum variance Huffman codes, adaptive Huffman coding, Golomb codes, rice codes, Tunstall codes, coding a sequence, generating a binary code, comparison of binary and Huffman coding, diagram coding, dictionary based compression techniques, adaptive dictionary, LZ77, LZ78 and LZW approach, predictive coding, prediction with partial match, the Burrows-Wheeler transform, facsimile encoding, dynamic Markov compression. [10]

3. **Lossy Compression:** Distortion criteria, distortion measurement models, scalar quantization, uniform quantizer, adaptive quantization, non-uniform quantization, advantages of vector quantization over scalar quantization, the Linde-Buzo-Gray algorithm, tree structured vector quantizers, structured vector quantizers. [10]

4. **Multimedia Compression:** M-law and A-law commanding, DPCM and ADPCM audio compression, MPEG audio standard, frequency domain coding, lossless techniques of image compression, gray codes, transform coding, GIF**,** JPEG, predictive techniques, PCM and DPCM, video compression and MPEG industry standard, wavelet based compression. [10]

Outcome(s): On successful completion of this course, students will be able to

- Understand the concepts, applications and models of data compression.
- Apply the methods of lossy and lossless data compression.
- Apply the methods and standards of image, audio and video data compression.

Text Books:

2. **Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers, 4th edition, 2012.**

Reference Books:

3. Mark Nelson and Jean-Loup Gailly: The Data Compression Book, M&T Books, 2nd edition, 1996.
4. David Salomon, Data Compression: The Complete Reference, Springer, 4th edition, 2006.

CS-14.332 **Software Engineering** **Total Lectures:40**

Credit:3-0-0-3

Prerequisite(s): CS-14.101 (Programming Language), CS-14.203 (Data Structures)

Objective(s):

- To understand the basic software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To know about software requirements specification, requirement elicitation, structured system analysis and introduction of object-oriented analysis and design, design techniques.
- To acquire knowledge on implementation issues such as modularity and coding standards.
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study web based-system and application, software re-use, software re-engineering, agile software engineering, software engineering and testing tools.
- To develop teamwork and have project based experience.

1. **Introduction:** Programs versus software products, software crisis, need for software engineering, attributes of effective software, software myths, software characteristics, and role of management in software development, overview of quality standards like ISO 9001, SEI-CMM. [6]

2. **Software Processes and Requirement Analysis:** Software engineering: a layered technology, the software process, software process models, component based development, problem analysis, requirement engineering, requirement elicitation, requirement analysis, software requirement and specifications, data flow diagrams, data dictionaries, entity-relationship diagrams. [8]

3. **Software Project Planning:** Responsibilities & skills of a project manager, project planning, and project size estimation: LOC, function point & feature point metric, project estimation techniques, COCOMO model, staffing level estimation, scheduling, risk management, software configuration management. [9]

4. **Software Design:** The design process, design principles, design concepts, effective modular design: cohesion & coupling, classification of cohesiveness & coupling, design notations, design techniques, structure charts, introduction to object-oriented design. [8]

5. **Coding and Testing:** Software testing fundamentals, test case design, white box testing:-basis path testing, control structure testing, black box testing: boundary value analysis, equivalence class testing, decision table testing, cause effect graphing, level of testing, debugging, testing tools &standards, testing for client/server architecture, real time systems and GUIs testing. Brief of software re-use, reverse engineering, software re-engineering, agile software engineering. [9]

Outcome(s):

On successful completion of this course, students will be able to

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Author a software requirements document and understanding of the proper contents of a software requirements document.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.
- Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

3. R. S. Pressman, Software Engineering – A practitioner's approach,Tata-McGraw- Hill Int. Ed., 8th edition, 2014.
4. K. K. Aggarwal, Yogesh Singh, Software Engineering, New Age International, 1st edition, 2008.

Reference Books:

4. Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publisher, 3rdedition, 2005.
5. Rajib Mall, Fundamentals of Software Engineering, Prentice-Hall, 2ndedition, 2004.
6. Robert C. Martin, Agile Software Development, Principles, Patterns and Practices, 1st edition, 2002.

CS-14.336 **Computer Networks** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.203 (Data Structures), CS-14.207 (Computer Information Systems)

Objective(s):

- To become familiar with layered communication architectures (OSI and TCP/IP).
- To understand the client/server model and key application layer protocols.
- To construct large-scale computer networks
- To understand fundamentals of computer networks and major protocols.
- To analysis and evaluate major Internet protocols.
- To program simple network applications using socket API
- To learn and adopt newly introduced computer network technologies by themselves.

1.	**Introduction to Network Model:** History and development of computer networks, networks topologies, MANET, categories of networks, layering and protocols.	[5]
2.	**Physical Layer:** Different types of transmission media, transmission impairments, encoding schemes (NRZ, NRZI, Manchester, 4B/5B, Manchester etc.), packet and circuit switching.	[5]
3.	**MAC Layer:** Aloha, CSMA/CA, CSMA/CD protocols, performance evaluation and characteristics.	[3]
4.	**Data Link Layer:** Framing concept, error detection (parity, CRC), sliding window, stop and wait protocols, stop performance and efficiency.	[5]
5.	**Local Area Network:** IEEE 802.3, 802.4, 802.5, 802.11, performance evaluation.	[5]
6.	**Network Layer:** IPv4, IP address classes, classless addressing, IPv6, ARP, RARP, DHCP, ICMP, routing algorithms: distance vector, metrics, RIP, OSPF, BGP, congestion control algorithms, leaky bucket, token bucket.	[8]
7.	**Transport Layer:** Duties of the transport layer, connection, TCP, TCP services, TCP header, UDP, evaluating protocol such as TCP/UDP using simulator like NS2.	[5]
8.	**Application Layer:** DNS, FTP, HTTP, SMTP, POP, basics of network security (cryptography, digital signature and firewall).	[4]

Outcome(s): On successful completion of this course, students will be able to

- Analyze computer network component and devices.
- Synthesize how communication works in a network and internet.
- Formulate the concept of topologies and their applications.
- Analyze protocol at different layers and how they play important role in network implementation.
- Identify and analyze the latest technology with existing one.
- Enumerate the layers of OSI and TCP/IP models.
- Configure network and wireless technology including client/server programming.

Text Books:

1. Tanenbaum A. S., Computer Networks, Prentice-Hall of India, 5th edition, 2010.
2. Stallings W., Data and Computer Communications, Prentice-Hall of India, 10th edition, 2013.

Reference Books:

3. Forouzan B. A., Data Communications and Networking, Tata McGraw-Hill, 5th edition, 2013.
4. Hayes J. F., Modeling and Analysis of Computer Communication Networks, Plenum Press, 1st edition, 1987.

CS-14.371 **Colloquium** **Credit: 0-0-0-1**

Prerequisite(s): NIL

Objective(s):

- To observe and analyze some popular technology and gain insights
- To comprehend the acquired knowledge.
- To present the acquired knowledge to larger audience.

Content: Students have to comprehend and present on some popular technology in the field of computing.

Outcome(s): On successful completion of this course, the students will be able to

- Communicate effectively to arrange of audience.
- Recognize the need for continuous learning.
- Recognize the social impact of engineering solutions.

CS-14.374 **Comprehensive-II** **Credit: 0-0-0-4**

Prerequisite(s): CS-14.220 (Comprehensive-I), CS-14.301 (Design and Analysis of Algorithms), CS-14.303 (Operating System), CS-14.305 (Logic in Computer Science), CS-14.309 (Microprocessor and Assembly Language Programming), CS-14.332 (Software Engineering), CS-14.334 (Compiler Design), CS-14.336 (Computer Networks)

Objective(s):

- To examine the understanding of the student in different fields of computer science in concise manner.

1. **Design and Analysis of Algorithms:** Sorting, divide and conquer, graph theory, greedy algorithms, dynamic programming, backtracking, NP complete.
2. **Operating System:** Batch processing, multiprogramming, multiprocessing, and multitasking, process management, CPU scheduling, I/O scheduling, resource scheduling, deadlock and scheduling algorithms. Banker's algorithm for deadlock handling, memory management: virtual memory, paging, segmentation, concurrent processing: mutual exclusion, critical regions lock and unlock, scheduling.
3. **Logic in Computer Science:** Propositional (Boolean) logic, predicate logic, well–formed–formulae (WFF), satisfiability and tautology.
4. **Microprocessor:** Introduction to microprocessor, microprocessor instruction set, architecture of microprocessor, register set, mapping of memory and I/O devices, addressing modes, counters and time delays.
5. **Software Engineering**: Information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.
6. **Compiler Design:** Context free languages and push-down automata, recursively enumerable sets and Turing machines, undecidability, lexical analysis, syntax and semantic analysis, intermediate code generation, code generation and optimization.
7. **Computer Networks:**ISO/OSI stack, LAN technologies (Ethernet, token ring), flow and error control techniques, routing algorithms, congestion control, TCP/UDP and sockets, IPv4, application layer protocols (ICMP, DNS, SMTP, POP, FTP, HTTP), basic concepts of hubs, switches, gateways, and routers, network security, basic concepts of public key and private key cryptography, digital signature, firewalls.

Outcome(s):

- At the end of this course students will be able to comprehend her knowledge gained in the entire year.

CS 14.401 **Soft Computing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 14.305(Logic in Computer Science)

Objective(s):

- To familiarize with soft computing concepts
- To introduce the idea of neural networks, fuzzy logic and use of heuristics based on human experience
- To introduce the concept of genetic algorithm and its applications to soft computing using some applications

1.	**Introduction**: Introduction of soft computing, types of soft computing, applications of soft computing, introduction of artificial intelligence, production system, various search techniques, hill climbing, best first search, knowledge representation, monotonic and non-monotonic reasoning.	[8]
2.	**Neural Networks:** Structure and function of a single neuron, definition of ANN, characteristics of ANN, applications of ANN, single layer networks, perceptron training algorithm, linear separability, various learning rules, delta rule, ADALINE, MEDALINE, multi-layer networks, activation functions, error back propagation algorithms, characteristics of EBPA.	[8]
3.	**Neural Network Architectures**: Counter propagation networks, architecture, functioning, characteristics, Hopfield network, configuration, associative memory, limitations and applications, Hopfield vs Boltzman machine, adaptive resonance theory, architecture, classification, implementation and training	[8]
4.	**Fuzzy Logic :**Fuzzy logic, fuzzy set theory, fuzzy set vs crisp set, crisp relation and fuzzy relation, introduction and features of membership functions, fuzzy rule based system, fuzzy propositions, formation, decomposition and aggregation of fuzzy rules, fuzzy reasoning, fuzzy interference system, fuzzy decision making, applications of fuzzy logic.	[8]
5.	**Genetic Algorithms :**Genetic algorithm, fundamentals, basic concepts, working principle, encoding, fitness function, reproduction, genetic modelling, inheritance operator, cross over, inversion and deletion, mutation operator, bitwise operator, generational cycle, convergence of GA, applications and advances in GA, difference and similarities between GA and other traditional methods.	[8]

Outcome(s): On successful completion the students will be able to:

- Identify and describe soft computing techniques and their roles in building intelligent machines
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
- Apply genetic algorithms to combinatorial optimization problems
- Apply neural networks to pattern classification and regression problems
- Evaluate and compare solutions by various soft computing approaches for a given problem

Text Books:

4. S. N. Sivanandan and S.N. Deepa, “Principles of Soft Computing”, Wiley India, 2007
5. J.S.R.Jang, C.T.Sun and E. Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, 2004
6. Pravir K. Chawdhry, Rajkumar Roy, Raj K. Pant “Soft Computing in Engineering Design and Manufacturing”Springer, 2012.

Reference Books:

4. S. Rajasekaran and G.A.V. Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003
5. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, McGraw-Hill, 3rdEdition, 2009.
6. Davis E. Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Pearson Education , 2006

CS 14.402 **Distributed Systems** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): CS 14.202 (Java Programming), CS 14.303 (Operating Systems), CS 14.306 (Computer Networks)

Objective(s): To make students aware of:

- What a distributed system is, its example, use and utilities.
- Hardware and software requirements/constraints for implementation of distributed systems.
- Abstractions like, RMI, distributed objects, RPC, distributed shared memory etc.
- Notion of time in a distributed system.
- Databases in a distributed system.

1.	**Characterization of Distributed Systems:** Definition, distributed systems-Internet, intranet, mobile, ubiquitous computing, resource sharing and World Wide Web challenges-heterogeneity, openness, security scalability failure handling concurrency and transparency.	[3]
2.	**System Models:** Architecture models- software layers, system architecture, variations on client-server model, interfaces, design requirement for distributed architectures, fundamental and interaction models, and failure and security models.	[4]
3.	**Distributed Object and Remote Invocation:** Introduction to remote method invocation (RMI) and interface in distributed systems, communication between distributed objects-objects model, distributed objects, distributed objects model and design issues for RMI, implementation of RMI and distributed garbage collection, remote procedures call and sun RPC case study, events and notifications participants, JINI distributed event specification, Java RMI case study, building client and server programs, design and implementation of Java RMI.	[8]
4.	**Time and Global State:** Clocks, events and process states, synchronizing physical clocks-synchronization in a synchronous system, Cristian method for synchronizing clocks, Berkley algorithm, network time protocol, global state and consistent cuts.	[5]
5.	**Distributed Shared Memory:** Introduction, message passing versus DSM, implementation approaches to DSM, design and implementation issues-structure and synchronization model.	[5]
6.	**Distributed Database Systems:** Distributed DBMS architecture, distributed database design, alternate design strategies, distribution design issues, fragmentation, and allocation.	[5]
7.	**Processes and Processors in Distributed Systems:** Threads, system models, processor allocation, scheduling, fault tolerance.	[5]
8.	**Distributed File System:** Design, implementation, trends in distributed file system.	[5]

Outcome(s): On successful completion of the course the student will be able to:

- Understand the concept of distributed systems.
- Explain the principles underlying the functioning of distributed systems as well as how these principles are applied in distributed systems.
- Comprehend the problems and challenges of distributed systems.
- Understand and estimate the impact of different design choices, system features on distributed systems.

Text Books:

3. Colouris, “Distributed Systems Concepts and Design”, Addison Wesley, 5th edition, 2011.
4. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair,"Distributed Systems" , Pearson Education Limited, 2013

Reference Books:

3. Pradeep K. Sinha,"Distributed Operating Systems",PHI Learning Pvt. Limited, 2011.
4. MukeshSinghal, NiranjanShivrathri, “Advanced Concepts in Operating Systems”, TMH, 2011.

CS 14.403 **Parallel Computing** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.208 (Computer Organization and Architecture)

Objective(s):

- To provide students with contemporary knowledge in parallel computing.
- To equip students with skills to design and analyze parallel applications.
- Describe the various design issues in a parallel computing System e.g. system performance and reliability, distributed file system etc.
- Describe and program the communication among processes at different hosts to facilitate parallel computing.

1. **Introduction**: scope and issues of parallel and distributed computing, taxonomy of parallel structures, control mechanism, address-space organization, interconnection connection networks: static and dynamic interconnection networks, evaluating static interconnection networks, embedding other networks (linear array, mesh, binary tree) into a hypercube, routing mechanisms for static interconnection networks: store and forward (SF) routing, cut - theory (CT) routing, cost-performance trade-off, architectural models for parallel algorithm design. [8]
2. **Basic Communication Operation**: Simple message transfer between two processors, one-to-all broadcast, all-to-all broadcast, reduction and prefix sums, one-to-all personalized communication, all-to-all personalized communication, circular shift. [7]
3. **Performance and Scalability of Parallel Systems**: Performance matrices for parallel systems: run time, speed up, efficiency and cost, the effect of granularity and data mapping on performance, scalability of parallel systems, ISO-efficiency metric of scalability. [7]
4. **Models of Distributed Computing**: Mini computer model, workstation pool model, client-server model, pool of processors model, hybrid model. [6]
5. **Inter Process Communication and Remote Procedure Calling**: Building blocks, client-server communication, group communication, case study: inter processor communication in Unix, design issues in remote procedure calling, implementation. [6]
6. **Parallel Computing Algorithms**: Various sorting and searching algorithms, performance metrics for parallel algorithm implementations. [6]

Outcome(s): At the end of this course, student will be able to accomplish following.

- Define terminology commonly used in parallel computing, such as efficiency and speedup.
- Describe different parallel architectures, inter-connect networks, programming models, and algorithms for common operations such as matrix-vector multiplication.
- Given a problem, develop an efficient parallel algorithm to solve it.
- Given a parallel algorithm, analyze its time complexity as a function of the problem size and number of processors.
- Given a parallel algorithm, an input to it, and the number of processors, show the steps performed by that algorithm on that input.

Text Books:

3. Vipin Kumar, Ananth Grama, Anshul Gupta and George Karypis, "Introduction to Parallel Computing", 2nd Ed, Pearson Education,2008.
4. George Coulouris, Jean Dollimore and Tim Kindberg," Distributed Systems Concepts and Design", 4th Ed., Pearson Education, 2009.

Reference Books:

5. S G Akl, "The Decision and Analysis of Parallel Algorithms", Prentice Hall, 1989.
6. Hwang, Kai, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", 2nd Ed., McGraw Hill, 2011.
7. J Jaja, "An Introduction to Parallel Algorithms", Addison Wesley, 1992.
8. T G Lewis and H El Rewini, "Introduction to Parallel Computing", Prentice-Hall 1992.

CS-14.405 **Digital Image Processing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.101 (Programming Language), MA-14.201(Applied Mathematics)

Objective(s):

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the image segmentation and representation techniques
- To study the image representation in form of features and descriptors

1.	**Digital Image Fundamentals:** Elements of digital image processing systems, elements of visual perception, brightness, contrast, hue, saturation, mach band effect, color image fundamentals - RGB, HSI models, image sampling, quantization, dither, two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD.	[7]
2.	**Image Enhancement and Restoration:** Histogram equalization and specification techniques, noise distributions, spatial averaging, directional smoothing, median, geometric mean, harmonic mean, contra harmonic mean filters, image restoration - degradation model, unconstrained restoration, inverse filtering, removal of blur caused by uniform linear motion.	[7]
3.	**Morphological Image Processing:** Basics, structuring element, erosion, dilation, opening, closing, hit-or-miss transform, boundary detection, hole filling, connected components, convex hull, thinning, thickening, skeletons, pruning, and reconstruction by dilation and erosion.	[7]
4.	**Image Segmentation:** Edge detection, edge linking via Hough transform, thresholding, region based segmentation, region growing, region splitting and merging, and segmentation by morphological watersheds, basic concepts, dam construction, and watershed segmentation algorithm.	[7]
5.	**Image Representation:** Boundary representation, chain code, polygonal approximation, signature, boundary segments, boundary description, shape number, Fourier descriptor, regional descriptors, and topological features.	[6]
6.	**Image Compression:**Need for data compression, Huffman, run length encoding, shift codes, arithmetic coding, vector quantization, transform coding, JPEG standard, MPEG.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Discuss digital image fundamentals.
- Apply image enhancement and restoration techniques.
- Use image compression and segmentation Techniques.
- Represent features of images.

Text Books:

10. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.
11. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011.
12. Bernd Jähne, Digital Image Processing, Springer Science & Business Media, 29-Jun-2013.

Reference Books:

13. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
14. William K Pratt, “Introduction to Digital Image Processing”, CRC Press, 13-Sep-2013.

CS 14.411 **Advanced Computer Architecture** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming languages), CS 14.208 (Computer Organization and Architecture)

Objective(s):

- To discuss the organization of computer-based systems and how a range of choices are influenced by application.
- To understand the organization and operation of current generation computer systems including multiprocessor and multicore systems.
- To understand the principles of I/O in computer systems including viable mechanism for I/O and secondary storage organization.

1.	**Introduction**: Overview of parallel processing and pipelining, study and comparison of uni-processors and parallel processors, architectural classification, applications of parallel processors, instruction level parallelism, performance matrices and measures, speedup.	[6]
2.	**Pipelining:** Principles and implementation of pipelining, classification of pipelining processors, pipeline architecture, general pipelining reservation table, design aspect of arithmetic and instructional pipeline, pipelining hazards and resolving techniques, advanced pipelining techniques, software pipelining, implementation issues.	[8]
3.	**Vector and Array Processors** : Vector and array processors, basic vector architecture, issues in vector processing, SIMD computer architecture, masking and data network mechanism, interconnection networks of SIMD, static vs dynamic networks, parallel algorithm for array processors, matrix multiplication, sorting, implementation issues.	[10]
4.	**Multiprocessor Architecture** : Multiprocessor architecture, loosely and tightly coupled multiprocessors, characteristics of multiprocessor, inter-processor communication network, memory contention and arbitration techniques, cache coherence, bus snooping, massively parallel processors, inter process communication and synchronization.	[10]
5.	**Parallel Algorithms:** Multithreading, synchronous and asynchronous message passing, shared memory, study of parallel programming concepts, parallel algorithm for multiprocessors, operating system for multiprocessors, message passing interfaces, parallel programming languages, Fortran 90, Occam, C-Linda, CCC.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Describe the operation of performance enhancements such as pipelines, dynamic scheduling, branch prediction, cache, and vector processors.
- Describe modern architectures such as RISC, super scalar, multiprocessor and multicore systems.
- Develop applications for high performance computing systems.

Text Books:

3. Kai Hwang, Naresh Jotwani, “Advanced Computer Architecture”, McGraw-Hill Education, 2011.
4. John L Hennessey, David A Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann, Elsevier Publishers, 5th edition, 2012.

Reference Books:

3. Kai Hwang, Zhi Wei Xu, “Scalable Parallel Computing”, McGraw Hill,1998.
4. Kai Hwang, Faye A Briggs, “Computer Architecture and Parallel Processing”, McGraw Hill, 1984.

CS 14.412 **Software Project Management** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS 14.302 (Software Engineering)

Objective(s):

- To introduce the concepts of Software Project Management to the students.
- To make the students understand the requirement for project evaluation.
- To make the students understand the requirement for Software quality assurance and project management along with its tools.

1.	**Introduction to Software Project Management (SPM) : S**oftware Engineering problem and software product, software product attributes, definition of a Software Project (SP), SP vs. other types of projects activities covered by SPM, categorizing SPs, Project Management cycle, SPM framework, types of project plan	**[6]**
2.	**Project Evaluation:** Strategic assessment, technical assessment, cost benefit analysis, cash flow forecasting, cost benefit evaluation techniques, risk evaluation	**[5]**
3.	**Activity Planning:** Objectives, project schedule, sequencing and scheduling activities, network planning models, forward pass, backward pass, activity float, shortening project duration, activity on arrow networks, risk management, nature of risk, types of risk, managing risk, hazard identification, hazard analysis, risk planning and control	**[8]**
4.	**Monitoring and Control:** Introduction, creating the frame work, collecting the data, visualizing progress, cost monitoring, earned value, prioritizing monitoring, getting the project back to target, change control	**[6]**
5.	**Managing people and Organizing teams:** Introduction, understanding behaviour, organizational behaviour: a background, selecting the right person for the job, instruction in the best methods, motivation, the Oldman, Hackman job characteristics model, working in groups, becoming a team, decision making leadership, organizational structures, stress, health and safety, case studies	**[8]**
6.	**Software Quality Assurance and Testing:** Testing principles and objectives, test plan, types and levels of testing, test strategies, program verification and validation, software quality, SEI-CMM,SQA activities, QA organization structure, SQA plan	**[7]**

Outcome(s):

Upon completion of the course the student should be able to:

- Examine the fundamentals of the software project and the factors involved in using a methodology in the context of project management.
- Explain the risks, issues, and critical success factors associated with technology projects and software projects in particular.
- Create a project plan, including scope definition, risk assessment, task breakdown, team selection, estimates, communication mechanisms and progress evaluation and reporting using an appropriate project lifecycle.
- Present and justify a fully documented project plan.
- Employ appropriate software for project planning, estimation, monitoring and control, communication and reporting.

Text Books:

3. Bob Hughes, Mikecotterell, “Software Project Management”, Fourth Edition, Tata McGraw Hill, 2009.
4. Ashfaque Ahmed,"Software Project Management: A Process-Driven Approach",CRC Press, 2016.

Reference Books:

4. **Ramesh, Gopalaswamy, "Managing Global Projects", Tata McGraw Hill**, 2nd ed. 2005.
5. Royce, “Software Project Management”, Pearson Education, 1999.
6. Walker Royce, Software Project Management, 1998, Addison Wesley.

CS 14.413 **Foundations and Applications of IoT** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming Language), CS 14.303 (Operating System), CS 14.306 (Computer Networks)

Objective(s):
- To introduce the vision and impact of IoT.
- To understand IoT Market perspective.
- To understand the challenges that must be overcome by IoT technology.

1.	**M2M to IoT:** The vision-introduction, from M2M to IoT, M2M towards IoT-the global context, a use case example, differing characteristics.	[5]
2.	**M2M to IoT – A Market Perspective:** Introduction, some definitions, M2M value chains, IoT value chains, an emerging industrial structure for IoT, the international driven global value chain and global information monopolies, M2M toIoT-an architectural overview, building an architecture, main design principles and needed capabilities, an IoT architecture outline, standards considerations.	[9]
3.	**M2M and IoT Technology Fundamentals:** Devices and gateways, local and wide area networking, data management, business processes in IoT, everything as a service (XaaS), M2M and IoT analytics, knowledge management.	[7]
4.	**IoT Architecture- Introduction, State of the art:** Architecture reference model-introduction, reference model and architecture, IoT reference model.	[6]
5.	**IoT Reference Architecture:**IoT reference architecture- introduction, functional view, information view, deployment and operational view, other relevant architectural views, real-world design constraints- introduction, technical design constraints-hardware is popular again, data representation and visualization, interaction and remote control.	[8]
6.	**Implementation Examples:** Industrial automation, the smart grid, smart cities.	[5]

Outcome(s): On successful completion of this course, students will be able to
- Understand the vision of IoT from a global context.
- Determine the Market perspective of IoT.
- Understand the use of Devices, Gateways and Data Management in IoT.
- Build architecture in IoT
- Analyze, design and develop parts of IoT solution

Text Books:
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
4. Malcolm Frank, Paul Roehrig, Ben Pring,"What To Do When Machines Do Everything" ,John Wiley & Sons, 13-Feb-2017

Reference Books:
4. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
5. Peter Waher, "Learning Internet of Things", Packt Publishing Ltd, 27-Jan-2015.
6. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013

CS 14.414 **Technologies of Big Data** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.415 (Data Science and Big Data and Analytics)

Objective(s): To understand and learn various technologies of Big Data Analytics and apply them to solve real world problems.

1.	**Hadoop and MapReduce**: Functional programming, MapReduce programming, running a MapReduce programs on Hadoop, word count, distributed sort, distributed grep.	[7]
2.	**Hive**: Hive, HiveQL vs SQL, Hive in Hadoop ecosystem, installation of Hive, query execution in Hive, data types and file formats, create table, alter table, drop table, loading data into tables, select-from clause, where clause ,group by clause, join statements, views and indexes.	[10]
3.	**Pig**: Pig , PigLatin, Pig on Hadoop, installing and running Pig, Grunt, Pig data models, load, store and dump, relational operations-foreach, filter, groupby, orderby, distinct, Join, user defined functions(UDFs),developing and testing PigLatin scripts.	[10]
4.	**Spark**: Spark, Hadoop versus Spark, Installation of spark, spark architecture, solving business problem with Spark, Spark streaming framework and processing models.	[7]
5.	**NoSQL Databases**: NoSQL, database scaling, CAP theorem, ACID versus BASE, key – value stores, column oriented databases, document databases, graph databases, NoSQL challenges.	[6]

Outcome(s): On successful completion of this course, students would be able to

- Apply learning and knowledge of Big Data technologies tosolve real world problems and acquire required skills set for industry.

Text Books:

3. Chuck Lam, “Hadoop in Action”, Manning Publications,2nd ed. 2015, ISBN: 9781935182191
4. Edward Capriolo, Dean Wampler, Jason Rutherglen,“Programming Hive”, O’Reilly Media,2016,ISBN: 978-1-449-31933-5

Reference Books:

3. Alan Gates, “Programming Pig”, O’Reilly Media,2011,ISBN: 978-1-449-30264-1
4. James A. Scott, “Getting Started with Apache Spark”, MapR Technologies,2015

CS 14.415 **Data Science and Big Data Analytics** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.204 (Database Management System)

Objective(s): To understand the fundamental concept of Data Science and Big Data Analytics and its application in various fields.

1.	**Data and its Classifications**: Data, information, knowledge and wisdom, digital and analog data, unstructured data, semi-structured data ,structured data, sources of data, dealing with unstructured data, data science and responsibilities of data scientist, database, data warehouse, data mining and big data.	[10]
2.	**Introduction to Big Data**: Big data, characteristics of big data-volume, velocity, variety, challenges with big data, applications of big data in healthcare, agriculture, education, scientific experiments, advertising, stock market etc., integrity and privacy of big data, big data and cloud computing, big data and IoT.	[10]
3.	**Classification of Analytics:** Descriptive, diagnostic, discovery, prescriptive and predictive analytics, big data analytics, semantic analytics, in-memory analytics, analytics and decision making, shared nothing architecture, CAP theorem, parallel and distributed system, massively parallel processing.	[10]
4.	**Hadoop and its Architecture**: RDBMS and Hadoop, master slave architecture, HDFS, name node, secondary name node, data node, HDFS client, replica placement strategy, MapReduce, job tracker, task tracker, map phase, reduce phase, shuffle phase, Hadoop 1.0 and Hadoop 2.0, YARN, Installation of Hadoop in pseudo distributed mode and full distributed mode.	[10]

Outcome(s): On successful completion of this course, students will be able to

- Apply learning and knowledge ofData Science and Big Data Analytics to solve real life problems in various areas of social importance.

Text Books:

4. Seema Acharya, SubhashiniChellapan, “Big Data and Analytics”, Wiley,,ISBN:978-81-265-5478-2, 2015
5. Tom White, “Hadoop: The Definitive Guide”, O’Reilly Media,2012,ISBN: 978-1-449-38973-4
6. Vincenzo Morabito, "Big Data and Analytics: Strategic and Organizational Impacts",Springer,2015

Reference Books:

3. Rick Smolan, Jennifer Erwitt,“The Human Face of Big Data”, Sterling, 2012, ISBN:9781454908272
4. EMC Education Services , “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, John Wiley & Sons, 05-Jan-2015, ,ISBN: 978-1-118-87613-8

CS 14.416 **Designing of IoT** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming Languages), CS 14.303 (Operating System), CS 14.306 (Computer Networks)

Objective(s):
- To understand IoT architecture and IoT design constraints
- To understand the vision and impact of IoT
- Understand IoT Market perspective.

1.	**Internet/Web and Networking Basics** : OSI Model, data transfer referred with OSI model, IP addressing, point to point data transfer, point to multi point data transfer & network topologies, sub-netting, network topologies referred with web, introduction to web servers, introduction to cloud computing	[5]
2.	**IoT Platform Overview:** Overview of IoT supported hardware platforms such as: raspberry pi, ARM cortex processors, arduino and intel galileo boards, network fundamentals: overview and working principle of wired networking equipment's – router, switches, overview and working principle of wireless networking equipment's – access points, hubs etc. linux network configuration concepts: networking configurations in linux accessing hardware & device files interactions.	[7]
3.	**IoT Architecture:** History of IoT, M2M – machine to machine, web of things, IoT protocols, remote monitoring & sensing, remote controlling, performance analysis, the layering concepts , IoT communication pattern, IoT protocol architecture, the 6LoWPAN, security aspects in IoT.	[8]
4.	**IoT Application Development**: MQTT, REST/HTTP, CoAP, MySQL, apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB object type database, HTML, CSS & jQuery for UI designing, JSON lib for data processing, security & privacy during development, application development for mobile platforms: overview of android / IOS app development tools.	[13]
5.	**Case Study & advanced IoT Applications:**IoT applications in home, infrastructures, buildings, security, Industries, home appliances, other IoT electronic equipments, use of big data and visualization in IoT, industry 4.0 concepts, sensors and sensor node and interfacing using any embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino)	[7]

Outcome(s): On successful completion of this course, students will be able to:
- Explain the current status and expected future directions of the internet of things.
- Identify and propose applications which advance the IoT.
- Develop applications which advance the IoT.

Text Books:

4. Dr.OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers,2013
5. Jean-Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet", Morgan Kuffmann, 2010.
6. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", Wiley, 2011.

Reference Books:

3. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing", 4th ed. Tata McGraw Hill, 2010.
4. F. Adelstein and S.K.S. Gupta, "Fundamentals of Mobile and Pervasive Computing", McGraw Hill, 2009.

CS 14.418 **Software Defined Networking** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.302 (Software Engineering), CS 14.306 (Computer Networks)

Objective(s):

- To explore the basics of SDN
- To discuss various types plane
- To list out various controllers
- To program a simple SDN

1.	**Control and Data Planes**: Introduction, evolution vs revolution, the control plane, data plane, moving information between planes, distributed control planes, convergence time, load balancing, creating the MPLS overlay, centralized control planes, logical vs literal, ATM.LANE, route servers.	[8]
2.	**SDN Controllers:** Wire protocol, replication, FAWG, hybrid approaches, SDN controllers, VMware, Nicira, OpenFlow, Mininet, NOX/POX, Trema, Ryu, L3VPN, RSPV-TE problem statement, bin-packing, deadlock, Plexxi, Cisco OnePK.	[8]
3.	**Network Programmability:** The management interface, the application-network divide, NETCONF and NETMOD, SNMP, modern programmatic interface, XMPP, JSON, I2RS, OpenStack, CloudStack, Puppet, virtual multitenant data center, SDN solution for data center networks.	[8]
4.	**Network Function Virtualization**: Virtualization and data plane I/O, services engineered path, service locations and chaining, NFV at ETSI, non-ETSI NFV work, network topology, LLDP, BGP-TE/LS, ALTO, I2RS topology.	[8]
5.	**Building an SDN framework:** Build code first, ask questions later, the Juniper SDN framework, IETF SDN framework, open daylight controller/framework, use cases for bandwidth scheduling, manipulation, data center overlays, big data, NFV, and traffic monitoring.	[8]

Outcome(s): On successful completion the students will be able to:

- Describe the key benefits of SDN
- Describe the data plane
- Configure an SDN friendly network emulator
- Program a simple SDN for a given task using a low level approach and high level approach
- Evaluate a sample SDNs performance and reliability

Text Books:

2. Ken Gray, Thomas D Nadeau, “SDN: Software Defined Networks”, O’Reilly, 2013.

Reference Books:

4. Paul Goransson, Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, First edition, 2014 .
5. Vishal Shukla, “Introduction to Software Defined Networking – OpenFlow&VxLAN”, Createspace, 2013.
6. Patricia A Morreale, James M. Anderson, “Software Defined Networking: Design and Deployment”, CRC Press, 2014.

CS 14.422 **Software Testing and Quality Assurance** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.302 (Software Engineering)

Objective(s):

- To explore the basics and goals of software testing
- To discuss various types of software testing and its techniques
- To list out various tools that can be used for automating the testing process
- To introduce various software quality standards for establishing quality environment
- To discuss various methods and evaluation procedures for improving the quality Models

1.	**Basics of Software Testing**: Definition, test cases, insights from a Venn diagram, identifying test cases, error and fault taxonomies, levels of testing, examples: generalized pseudo-code, the triangle problem, the NextDate problem, the commission problem	[6]
2.	**Decision Table Based Testing:** Decision tables, test cases for triangle problem, test cases for Next Date problem, test cases for commission problem, data flow testing, use testing, slice based testing, guidelines and observation, traditional view of testing levels, alternative life-cycle models, separating integration and system testing, decomposition based, call graph based, path based integration, case study	[10]
3.	**System and Interaction Testing:** Threads, basic concepts of requirements specification, finding threads, structural strategies and functional strategies for thread testing, SATM test threads, system testing guidelines, interaction testing, a taxonomy of interactions, composition, and determinism, client-server testing, issues in object-oriented testing, inheritance and polymorphism, levels of object-oriented testing, GUI testing, dataflow testing for object-oriented software, examples and case study	[10]
4.	**Object-Oriented Integration Testing**: UML support for integration testing, MM paths for object-oriented software, GUI testing, unit testing, object-oriented system testing, UML based system testing, statechart based system testing	[6]
5.	**Quality Assurance:** Software quality, level of measurement, reliability and validity, Ishikawa's seven basic tools, cause and effect diagram, reliability models, quality and quality management metrics, software process maturity assessment	[8]

Outcome(s): On successful completion the students will be able to:

- Compare and pick out the right type of software testing process for any given real world problem
- Carry out the software testing process in efficient way
- Automate the testing process by using several testing tools
- Establish a quality environment as specified in standards for developing quality software
- Analyze and improve the quality procedures based on the past experience

Text Books:

3. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications, 4th Edition, 2016.
4. Stephen H Khan, "Metrics and Models in Software Quality Engineering", Pearson, 2nd edition 2013.

Reference Books:

4. CemKaner, Rebecca L. Fiedler,"Foundations of Software Testing" , Context-Driven Press, 2013
5. Aditya P Mathur, " Foundations of Software Testing", Pearson, 2008.
6. Mauro Pezze, Michal Young,"Software Testing and Analysis – Process, Principles and Techniques", John Wiley & Sons, 2008.

CS 14.424 **Machine Learning with Big Data** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.322 (Data Mining)

Objective(s): To learn the fundamental concept of machine learning and apply the concept of recommendations, clustering and classifications on large scale data sets using mahout.

1. **Introduction**: learning problems, designing learning system, perspectives and issues, concept learning, version spaces and candidate elimination algorithm, inductive bias, decision tree learning, representation, heuristic space search [8]
2. **Data Mining, Machine Learning** : Data mining ,machine learning, statistical modeling, feature extraction, computational approaches to modeling, statistical limits on data mining, statistical limits on data mining, Bonferroni's principle, recommendation engines, clustering and classifications, mahout : Mahout, installation and setting up of Mahout, tackling large scale data with mahout and Hadoop [8]
3. **Recommendations:** Defining recommendation, Running a recommender engine, Evaluating a recommender, Evaluating precision and recall, evaluating the GroupLens data set, representing preference data, in-memory data models, coping without preference values, user-based recommendation, item-based recommendation, similarity metrics, slope-one recommender, distributing recommendation computations [8]
4. **Clustering**: Clustering basics, measuring the similarity of items, running a simple clustering example, distance measures, representing data, visualizing vectors, representing text documents as vectors, generating vectors from documents, clustering algorithms in Mahout, k-means clustering, different kinds of clustering problems, fuzzy k-means clustering, model-based clustering, evaluating and improving clustering quality, real-world applications of clustering [8]
5. **Classifications**: Introduction to classification, Mahout for classification, differences between classification, recommendation, and clustering, applications of classification, working of classification, training a classifier, extracting features to build a Mahout classifier, preprocessing raw data into classifiable data, converting classifiable data into vectors, evaluating and tuning a classifier, deploying a classifier [8]

Outcome(s): Students would be able to apply learning and knowledge of machine learning techniques in the area of Big Data Analytics using Mahout to solve real life problems.

Text Books:

4. Sean Owen, Robin Anil, Ted dunning, Ellen friedman, "Mahout in Action",Manning Publications,2012,ISBN 9781935182689
5. Jared Dean,"Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners", Wiley,2014, ISBN: 978-1-118-61804-2
6. Tom M. Mitchell, "Machine Learning", McGraw Hill , 2013

Reference Books:

3. Suthaharan, Shan, "Machine Learning Models and Algorithms for Big Data Classification ", Springer,2016,ISBN 978-1-4899-7641-3
4. AnandRajaraman, Jure Leskovec, Jeffrey D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2015,ISBN:978-1-107-07723-2

CS 14.426 **Wireless and Sensor Networks** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.306 (Computer Networks)

Objective(s):

- To provide an overview about wireless and sensor networks and emerging technologies
- To study about the network architecture of sensor nodes and its execution environment
- To understand the concepts of communication, MAC and routing protocols in WSN
- To learn about topology control and clustering for localization services with sensor tasking and control
- To study about sensor node hardware and software platforms and understand the simulation and programming techniques

1.	**Overview of Wireless Sensor Networks**: Introduction, characteristics, challenges for WSN, emerging technologies for WSN, advantages of sensor networks, applications.	[8]
2.	**Architecture:** Single-node architecture, hardware components, energy consumption of sensor nodes, operating system and execution environment, network architecture, single hop vs multi hop, multiple sources and sinks, optimization goals and figures of merit, WSN gateway and tunneling.	[8]
3.	**Networking Sensors:** Physical layer, MAC protocols for WSN, low duty cycle and wakeup concept S-MAC, address and name management, assignment of MAC addresses, routing protocols, multipath unicast routing, energy efficient routing, geographic routing.	[8]
4.	**Infrastructure**: Topology control, clustering, multilayer clustering, time synchronization, localization and positioning, positioning in multihop environment, ranging techniques, range based localization, sensor tasking and control, information based sensor tasking, joint routing and information aggregation	[8]
5.	**Platforms and Tools:** Sensor node hardware, Berkeley motes, programming challenges, node level software platforms, TinyOS, nesC, TinyGALS, simulators, ns2, TOSSIM, state centric programming	[8]

Outcome(s): On successful completion the students will be able to:

- Compare and pick out the right type of software testing process for any given real world problem
- Carry out the software testing process in efficient way
- Automate the testing process by using several testing tools
- Establish a quality environment as specified in standards for developing quality software
- Analyze and improve the quality procedures based on the past experience

Text Books:

3. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2007.
4. Feng Zhao, Leonidas Guibas, Jie Liu, , “Wireless Sensor Networks- An Information Processing Approach", 2nd ed. Elsevier, 2016.

Reference Books:

3. KazemSohraby, Daniel Minoli, &TaiebZnati, “Wireless Sensor Networks- Technology, Protocols, And Applications”, John Wiley, 2007.
4. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

CY-14.101 **Engineering Chemistry** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- To purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers their preparation, properties and uses.
- To develop the basics of protecting engineering materials from the natural forces.
- To understand the present-day up-to-date knowledge of the contemporary energy sources.
- To build up the basis of the future Engineering materials like superconductors, conducting organic polymers, Nanomaterials etc.

1. **Water treatment**: Hardness, types of hardness, determination of hardness by complex metric (EDTA) method, degree of hardness, boiler troubles: corrosion, sludge and scale formation, prevention of sludge and scale formation in boilers, methods of boiler water treatment: lime-soda process, permutit (zeolite) process, ion exchange methods, numerical problems based on water treatment (lime-soda process). [10]

2. **Organic and Inorganic Polymers:** Classification, functionality, types of polymerization, mechanism of addition polymerization, plastics: thermoplastic and thermosetting resins, preparation, properties and uses of Polyamides, Bakelite, Polyesters, Rubber, vulcanization of rubber, synthetic rubber viz. Buna-S, Buna-N, Butyl and Neoprene rubbers, Silicones-polysiloxanes and Sulphur based polymers. [8]

3. **Electrochemistry and Corrosion**: Classifications (Galvanic cell, electrolytic cell), types of electrodes (reference electrodes-standard hydrogen electrode, indicator electrodes- glass electrode), theorigin of electrode potential, Nernst equation of electrode potential. electromotive force, electrochemical series. corrosion: definition and its significance, theories of corrosion, mechanism of corrosion, types of corrosion, Galvanic cell, and concentration cell, water line corrosion, pitting & stress corrosion (caustic embrittlement), protection against corrosion, corrosion control (corrosion inhibitors, cathodic protection - sacrificial anodic and impressed current cathodic protection),protective metallic coatings. [10]

4. **Fuels:** Classifications of fuels, Comparison of solid, liquid & solid fuels, Calorific value of a fuel, Bomb calorimeter, determination of LCV & HCV, petroleum: origin, composition, processing, cracking, synthetic petrol, refining, reforming, knocking, unleaded petrol, LPG as a gaseous fuel, numerical problems based on combustion. [6]

5. **New Engineering Materials**: Introduction: superconductors, high and low-temperature superconductors, organic electronic materials, fullerenes and nanomaterials, industrial applications of fullerenes and nanomaterials. [6]

Outcomes: The student will be able to understand the basis of the future Engineering materials like of superconductors, conducting polymers, Nano materials etc and purification of the most valuable natural resource of the future-water

Text Books:

1. O.G. Pananna, “Engineering Chemistry” 2nd Edition, McGraw Hill Education, 2017
2. Jain and Jain, “Engineering Chemistry,” 16th Edition, DhanpatRai Publishing Company, 2013.

Reference Books:

1. C. Housecroft, A.G. Sharpe, Inorganic Chemistry, 4th Edition, , Pearson Education Limited, England, 2012.
2. Atkins, “Physical Chemistry,” 8th edition,W. H. Freeman and Company New York, 2006.
3. William D. Callister, “Materials Science and Engineering: An Introduction, Eighth Edition,.John Wiley & Sons, Inc, 2010.
4. Bokris and Reddy, “Modern Electrochemistry,” 2nd Edition, Kluwer Academic Publishers New York, 2004.

CY-14.111 **Chemistry Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

1. To determine the Total, Temporary and permanent hardness of water by EDTA method.
2. To determine the % of available chlorine in a sample bleaching powder.
3. To determine the alkalinity of given water sample.
4. To prepare urea formaldehyde resin.
5. To determine the Calorific value of a fuel by bomb calorimeter.
6. Determination of the strength of HCl by titrating it against NaOH pH metrically.

7.Determination of the strength of HCl by titrating it against NaOHconductometrically.

Outcome(s): On completion of this course, students will have the knowledge in

- Handling different types of instruments for analysis of materials using small quantities of materials involved for quick and accurate results.
- Carrying out different types of titrations for estimation of concerned in materials using comparatively more quantities of materials involved for good results.

EC-14.101 **Basics of Electronics Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course would facilitate the learner to acquire good exposure to electronics and communication engineering.

1. **Introduction:** Brief history of major inventions, scope, significance and job opportunities in electronics and communication engineering, Overview of various specializations in ECE, Electronic testand measurement equipment's, Specifications for electronic components. [3]

2. **Semiconductors:** Material and its properties, Formation of energy band diagram, Currents in semiconductors, Fermi-Dirac energy distribution, Types of semiconductors – Intrinsic and Extrinsic, Mass action law, Hall effect. [5]

3. **Diodes:** Introduction, Characteristic of ideal and real diode, Current components in thediode, load characteristics, Breakdown in thediode, Zener diode, Varactor diode, Tunnel diode, Clippers and Clampers, Rectifiers – Half and Full-wave rectifiers. [8]

4. **Transistors:** Introduction to PNP and NPN transistors, current components, active, cutoff and saturation regions, CC, CB and CE configuration, Operating point, Biasing circuits, Bias Stability, Thermal runway and thermal stability. [8]

5. **Signals:** Definition, Classification of signals – Analog and Digital, Deterministic and Random signals, Power and Energy of signals, Bandwidth, Bit and Baud rate. [4]

6. **Basics of Communication**: Definition, Block representation of communication system, Modulation – Definition, Need for modulation, Frequency translation, Types of modulation - Analog and Digital, Multiplexing – TDM and FDM. [6]

7. **Applications of Communication**: Introduction to - Optical Fiber, Transmission line, Waveguides, Satellite communication, and RADAR. [6]

Outcome(s):

- The learners are expected to have an overview of electronics and communicationengineering and learn the introductory concepts in each of the specializations in ECE.

Text Books:

1. George Kennedy, Bernard Davis, Electronics Communication Systems, 4th Edition, Tata McGraw-Hill, 2009.
2. Behrouz Forouzan, Data Communication, and Networking, 5th Edition, McGraw-Hill, 2012.
3. Robert L. Boylestad, Louis Nashelsky, Electronics Devices and Circuits Theory, 11th Edition, Prentice Hall,2013.

Reference Books:

1. David A. Bell, Electronics Devices, and Circuits, PHI, 4th edition, 2008.
2. Wayne, Tomasi, Advanced Electronic Communication Systems, 6th edition, PHI, 2013.

EE-14.101 **Elements of Electrical Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

1. **Introduction:** Background, major inventions, scope, significance and job opportunities in electrical engineering,brief overview of various energy resources. Apparatus used in generation, transmission, and distribution of electrical power and various industries. [3]

2. **D.C. circuits:** Review of circuit elements, voltage sources, current sources, ohms law,KVL, KCL, source transformation, mesh current and node voltage analysis of circuits. [5]

3. **Network Theorems**: Superposition theorem, Thevenin's theorem, Norton's theorem. Maximum Power Transfer theorem, star-delta transformation. [6]

4. **Single phase A.C. circuits:** Basic terminologies, average &RMS values of a.c. quantities, phasor representation, theresponse of R, L, C and their combination to a.c. excitation, theconcept of power and power factor in a.c. circuits. [6]

5. **Three phase A.C. circuits:** Three phase supply, phase sequence, star connection, delta connection, therelationship betweenphase andline quantities in 3-phase circuits, measurements of three-phase power underbalanced condition. [6]

6. **Magnetic Circuits & Transformer**: Magnetic circuit, mutually coupled circuit, Transformer: working principle, emf equation, ideal & practical transformer, equivalent circuits, transformer testing: open circuit and short circuit test, losses, voltage regulation and efficiency. [8]

7. **Rotating Machines:** Electro-mechanical energy conversion, introduction to rotating machines and applications [6]

Outcome(s):

- The students shall develop an insightful knowledge on various fundamental elements and devices of electrical engineering.

Text Books:

1.Nagrath& Kothari, Theory and Problems of Basic Electrical Engineering, 2nd edition PHI Publication,2017.
2. Fitzgerald & Kingsley, Basic Electrical Engineering, 6th edition TMH publication,2002.

Reference Books:

1. H.Cotton, Advanced Electrical Technology, CBS Publication,2005.

EE-14.111 **EEE Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- The objective of this course is to introduce the students to the basic concepts of Electronics Engineering.
- The aim of this course is to study the fundamental aspects of Electronics Engineering.
- To acquire the knowledge of hardware and verify the results on Multisim software.
- This lab facilitates the students to get a comprehensive exposure to operations of AC and DC machines, measurements of various parameters and applications of electrical machines.

Practical to be performed on Hardware:

1. Introduction to basic electronics components and study of breadboard, CRO, function generator, multimeter, and D.C. power supply.
2. To plot VI characteristics of p-n junction diode and Zener diode.
3. To design a half wave rectifier with and without filter circuit and find the ripple factor.
4. To design a full wave rectifier with and without filter circuitand find the ripple factor.
5. Study of clipper and clamper circuits and implement on abreadboard.
6. To perform soldering and de-soldering to make abanana probe, BNC probe, and connection on PCB.
7. To conduct open circuit test and short circuit test on single phase transformer and to determine equivalent circuit parameters.
8. Measurement of three-phase power by using two wattmeter methods.
9. Speed control of DC machine by field current control method.
10. To construct a fluorescent tube wiring and to measure thevoltage across tube rod, thevoltage across choke and current.

Practical to be performed using Multi-Sim Software:

1. An Introduction to Electronic Circuit Simulation using **Multi-Sim Software**.
2. To verify Ohm's law and Kirchhoff's law.
3. Simulate half wave and full wave bridge rectifier.
4. To plot VI characteristics of p-junction diode

Outcome(s): After completion of the course, students would be able to:

- To use the technique, skills, and modern engineering tools necessary for engineering practice.
- Able to explain the basic concepts of basic electronics components.
- Able to describe& explain Clipper and Clamper circuits, V-I Characterization of p- n junction & Zener diode.
- The students shall develop an insightful knowledge on various ac and dc machines with their industrial applications.

ET-362 **Mobile Apps Development** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS 14.202(Java Programming)

Objective(s):

- To learn how mobile apps are different from others traditional apps by learning those aspects of mobile programming that make it unique from other platforms
- Program mobile applications for the Android operating system that use basic and advanced phone features
- Deploy applications to the Android marketplace for distribution.

1.	**Getting started with Mobility:** Mobility landscape, mobile platform, mobile apps development, overview of android platform, setting up the mobile app development environment along with an emulator, a case study on mobile app development.	[8]
2.	**Building blocks of mobile apps: Apps user:** Interface designing-mobile UI resources (Layout,UI elements, Draw-able,Menu), activity-states and life-cycle, interaction amongst activities. app-functionality beyond user interface- threads, async task, service –state and life cycle, notification, broad cast receivers, telephony and smsapis native data handling-on device file I/O, shared preferences, mobile database such as SQLite, and enterprise data access(via Internet/Intranet)	[15]
3.	**Sprucing up mobile apps:** Graphics and animation- custom views, canvas, animation APIs, multimedia-audio/video playback and record, location awareness, and native hardware access (sensor such as accelerometer and gyroscope).	[8]
4.	**Testing mobile apps:** Debugging mobile apps, white box testing, black box testing, and test automation of mobile app, JUnit for Android, Robotium, Monkey Talk.	[6]
5.	**Taking apps to market:** Versioning signing and packaging mobile apps, distributing apps on mobile market place.	[3]

Outcome(s): On successful completion of this course, students will be able to

- Understand the android operating system in details
- Create mobile application for various screens
- Deploy on play store market
- Use various sensors available in mobile

Text Books:

1. Barry Burd, Android Application Development All in One for Dummies, Johen Wiley & Sons Inc., Edition I , 2011.

2. Anubhav Pradhan ,Anil V Deshpandy, Mobile App Development, Edition I

Reference Books:

1. Lauren Darcey, Shane Conder, "Teach Yourself Android Application Development in 24 Hours",Sams Publishing, 2012, 2nd Edition , 2012.

ET 463 **Enterprise Computing – I** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS14.101 (Programming Language), CS 14.204 (Database Management System)

Objective(s):

- To define enterprise computing
- To provide an in-depth and comprehensive knowledge of the hardware and software architecture of enterprise system
- To introduce about the enterprise standards

1.	**Characteristics of Enterprise Computing:** Reliability, availability, scalability, capacity, access to large amount of data, integrity and security, system management, autonomic capabilities.	[5]
2.	**Introduction to TSO & ISPF:** Logging in a mainframe, understanding ISPF menus, understanding datasets & record length, sequential, partitioned VSAM, creation of a PDS for programs, JCL etc. vs Loadlib, creation of a sequential DS for application data, understanding catalog, using ISPF editor.	[10]
3.	**JCL & SDSF Basics:** Basic JCL programming, modifying an existing compile, link and execute JCL for specific use, JOBCARD, DD statements, understanding JOB-STEP, understanding JOBLIB and STEPLIB, understanding PARM to move data from JCL to program, understanding SDSF outputs.	[10]
4.	**Basic Application Programming:** Understanding logical file name (used in program) and physical file name (used in JCL) and how they are mapped, writing a simple COBOL program with data stored in a VSAM file or a flat file (intent is not to teach COBOL language, the student should be able to apply the language in the environment, student will be provided with sample JCLs & VSAM file that will be used in program).	[10]
5.	**Introduction to SPUFI:** Understanding how to use SPUFI environment to write and execute SQL statements.	[5]

Outcome(s): On successful completion of this course, students will be able to

- Describe the hardware and software architecture of an actual enterprise platform and explain the main functionality of the physical and virtual components.
- Perform basic administrative tasks in an enterprise computer system such as: the creation of new users, job monitoring and management, and back-ups and re- store operations.
- Possess basic practical knowledge regarding the process of installing, configuring and operating applications in an enterprise computer system as well as applying updates to the operating system

Text Book:

5. Alex Leon , IBM Mainframe Handbook, 1/e PB 1st Edition.
6. Alan Simon, "Network Re-engineering: Foundations of Enterprise Computing", Academic Press, 2012.
7. Mike Ebbers, John Kettner, Wayne O'Brien, Bill Ogden, IBM Redbooks, "Introduction to the New Mainframe: z/OS Basics", IBM Redbooks, 2012.

ET 465 **Agile Software Development** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS14.332 (Software Engineering)

Objective(s):

- To learn the fundamental principles and practices associated with each of the agile development methods.
- To learn how agile methods scale to large and distributed projects.
- To learn the essentials of collaboration as they apply to agile methods.
- To perform in-depth explorations into aspects of agile development that are particularly relevant to each student through detailed discussion sessions.

1. **Fundamentals of Agile:** The genesis of Agile, introduction and background, Agile manifesto and principles, overview of Scrum, extreme programming, feature driven development, lean software development, Agile project management, design and development practices in Agile projects, test driven development, continuous integration, refactoring, pair programming, simple design, user stories, Agile testing, Agile tools. [7]
2. **Agile Scrum Framework:** Introduction to Scrum, project phases, Agile estimation, planning game, product backlog, sprint backlog, iteration planning, user story definition, characteristics and content of user stories, acceptance tests and verifying stories, project velocity, burn down chart, sprint planning and retrospective, daily scrum, Scrum roles – product owner, Scrum master, Scrum team, Scrum case study, tools for Agile project management. [9]
3. **Agile Testing:** The Agile lifecycle and its impact on testing, test driven development (TDD), unit framework and tools for TDD, testing user stories – acceptance tests and scenarios, planning and managing testing cycle, exploratory testing, risk based testing, regression tests, test automation, tools to support the Agile tester, securing Agile software. [10]
4. **Agile Software Design and Development:** Agile design practices, role of design principles including single responsibility principle, open closed principle, Liskov substitution principle, interface segregation principles, dependency inversion principle, Agile design, need and significance of refactoring, refactoring techniques, continuous integration, automated build tools, version control. [10]
5. **Industry Trends:** Market scenario and adoption of Agile, Agile ALM, roles in an Agile project, Agile applicability, Agile in distributed teams, business benefits, challenges in Agile, risks and mitigation, Agile project on cloud, balancing Agility with discipline, Agile rapid development technologies. [4]

Outcome(s):

On successful completion of this course, students will be able to

- Understand concept of agile software engineering and its advantages in software development. Recognize various agile methods.
- Design and manage a project using Scrum.
- Write user stories for project requirements.
- Write test cases for developing features.

Text Books:

4. Ken Schawber, Mike Beedle, Agile Software Development with Scrum, Pearson, 2008.
5. Robert C. Martin, Agile Software Development Principles, Patterns and Practices, Prentice Hall
6. Lisa Crispin, Janet Gregory, Agile Testing: A Practical Guide for Testers and Agile Teams, Addison Wesley.

Reference Books:

3. Alistair Cockburn, Agile Software Development: The Cooperative Game, Addition Wesley, 2006
4. Mike Cohn, User Stories Applied for Agile Software, Addison Wesley, 2004

ET 471 **Cloud Computing (Infosys)** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s):
Objective(s):

1.	**Overview of Cloud Computing:** Brief history and evolution - History of Cloud Computing, Evolution of Cloud Computing, Traditional vs. Cloud Computing. Why Cloud Computing, Cloud service models (IaaS, PaaS & SaaS). Cloud deployment models (Public, Private, Hybrid and Community Cloud), Benefits and Challenges of Cloud Computing. Introduction to AWS Public Cloud Vendor. Cost optimization in AWS.	[10]
2.	**Virtualization**: Basics of virtualization, Virtualization technologies, Server virtualization, VM migration techniques, Role of virtualization in Cloud Computing. Introduction to EC2 service of AWS.	[8]
3.	**Working with Private Cloud:** Private Cloud Definition, Characteristics of Private Cloud, Private Cloud deployment models, Private Cloud Vendors - CloudStack, OpenStack, Eucalyptus Microsoft, Private Cloud – Benefits and Challenges. Private Cloud implementation in Amazon EC2 service.	[8]
4.	**Working with Public Clouds:** What is Public Cloud, Why Public Cloud, When to opt for Public Cloud, Public Cloud Service Models, and Public Cloud Players. Infrastructure as a Service Offerings, IaaS Vendors, PaaS offerings, PaaS vendors, Software as a Service. Demonstrating public cloud with AWS – Storage and Database services. Private vs. Public Cloud – When to choose.	[12]
5.	**Overview of Cloud Security:** Explain the security concerns in Traditional IT, Introduce challenges in Cloud Computing in terms of Application Security, Server Security, and Network Security. Security reference model, Abuse and Nefarious Use of Cloud Computing, Insecure Interfaces and APIs, Malicious Insiders, Shared Technology Issues, Data Loss or Leakage, Account or Service Hijacking, Unknown Risk Profile, Shared security model between vendor and customer in IAAS/PAAS/SAAS, Implementing security in AWS.	[8]
6.	**Future directions in Cloud Computing:** When and not to migrate to Cloud, Migration paths for cloud, Selection criteria for cloud deployment, Issues/risks in cloud computing, Future technology trends in Cloud Computing.	[4]

Text Books:

1. Cloud Computing: Principles and paradigms By Raj Kumar Buyya, James Broberg, AndrezeiM.Goscinski, 2011
2. Cloud Computing, By Michael Miller, 2008.
3. Cloud Computing for dummies, By Judith Hurwitz, Robin Bllor, Marcia Kaufman, Fern Halper, 2009.
4. Cloud Computing: A Practical Approach, By Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, McGraw Hill, 2010.
5.Handbook of Cloud Computing, By BorkoFurht, Armando Escalante (Editors), Springer, 2010.

Reference Books:

1.Cloud computing: Implementation, management and security By Rittinghouse, John, W.
2.Cloud Computing Bible, By Barrie Sosinsky, Wiley, 2011.
3.Cloud Computing Architected: Solution Design Handbook by Rhoton, John.
4.Cloud Security, A comprehensive Guide to Secure Cloud Computing by Krutz, Ronald L.; Vines, Russell Dean

ET 474 **Enterprise Computing – II** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 463 (Enterprise Computing – I)

Objective(s):

- To define advance JCL.
- To provide an in-depth and comprehensive knowledge of the hardware and software architecture of enterprise system.
- To introduce about the enterprise standards.

1. **Advanced JCL:** Coding a JCL, using PROCS (Catalog and In-Stream), using DFSORT, ICETOOL. [8]
2. **Advanced Datasets:** Understanding record length, allocation of SPACE, fixed and variable record length, VSAM, defining VSAM, understanding CI and CA, GDG, understanding usage of GDG, defining GDG. [12]
3. **Understanding CICS:** CICS fundamentals, understanding transactions, pseudo conversational programming, understanding CICS tables, coding BMS maps, compiling of a CICS program & NEWCOPY + CEMT entry for programs, writing simple CICS program to read key data (say StudentID) from user & display details obtained from a VSAM, CICS tables for VSAM/DB2 will be provided. [20]

Outcome(s): On successful completion of this course, students will be able to

- Describe the hardware and software architecture of an actual enterprise platform and explain the main functionality of the physical and virtual components.
- Perform basic administrative tasks in an enterprise computer system such as: the creation of new users, job monitoring and management, and back-ups and re- store operations.
- Possess basic practical knowledge regarding the process of installing, configuring and operating applications in an enterprise computer system as well as applying updates to the operating system

Text Book:

3. IBM Mainframe Handbook by Alex Leon.
8. Alan Simon, "Network Re-engineering: Foundations of Enterprise Computing", Academic Press, 2012.
4. Mike Ebbers, John Kettner, Wayne O'Brien, Bill Ogden, IBM Redbooks, "Introduction to the New Mainframe: z/OS Basics", IBM Redbooks, 2012.

CS-18.307	Big Data Programming	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	Basic knowledge of Linux • Basic SQL knowledge • Working knowledge with big data and Hadoop technologies • Have a basic understanding of notebook technologies for data science • Students can attend free courses at www.bigdatauniversity.com to acquire the necessary requirements • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	• To Understand what Big Data is • To understand how the growth of interconnected devices helps big data. • To Learning the tools that will enable to continue big data education after the course	
1.	**BIG DATA OVERVIEW**: Introduction to Big Data, Introduction to the Big Data Ecosystem, Introduction to Hortonworks Data Platform (HDP), Apache Ambari, Hadoop and HDFS, MapReduce and YARN, Apache Spark, Storing and quering data, ZooKeeper, Slider, and Knox, Loading data with Sqoop, Security and Governance, Stream Computing, Exercise: Exploration of the lab environment, Managing Hadoop clusters with Apache Ambar, File access and basic commands with HDFS, Running MapReduce and YARN jobs, Creating and coding a simple MapReduce job, Working with a Spark RDD with Scala, Using Hive to access Hadoop/HBase data, Explore Zookeeper, Moving data into HDFS with Sqoop,	[20]
2.	**Introduction to Data Science**: Data Science and Data Science Notebooks, Data Science with Open Source Tools, Exercise: Moving data into HDFS with Sqoop	[5]
3.	**Big SQL**: Using Big SQL to access data residing in the HDFS, Creating Big SQL schemas and tables, File formats and querying Big SQL tables, Managing the Big SQL Server, Configuring Big SQL security, Data federation with Big SQL, Exercise: Connecting to the IBM Big SQL Server, Creating and managing Big SQL schemas and tables, Querying Big SQL tables, Managing the Big SQL Server, Configuring Big SQL security, Configuring impersonation in Big SQL, Using Fluid Query with Big SQL.	[9]
4.	**IBM Watson Studio:** Introduction to IBM Watson Studio, Analyzing data with Watson Studio,Exersice: Getting started with Watson Studio, Analyzing data with Watson Studio.	[6]
Outcome(s):	On the successful completion of the course, the student will be able to: • Hadoop and the Hadoop Distributed File System•Analyze the time and space complexity of algorithms. • Apache Spark. • ZooKeeper, Slider, and Knox	
Text Books:	1. IBM Study Material	
Reference Books:		

CS-18.205	Application Development for Cloud	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	Basic knowledge of JavaScript. • Basic knowledge of Eclipse-based development tools • Basic understanding of HTML • Basic understanding of the IBM Skills Academy learning environment • Basic understanding of the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	To Define cloud computing • To Describe the choices that are available to developers when creating cloud applications • To Describe infrastructure as a service, platform as a service, and software as a service • To Describe IBM Cloud • To Describe the architecture of IBM Cloud	
1.	**CLOUD APPLICATION FOUNDATIONS**: Introduction to HTML5 and JavaScript Programming, JavaScript programming for web applications, HTML5 features,Exersices: Working with JavaScript in HTML documents, Working with HTML5 features	[8]
2.	**CLOUD APPLICATION DEVELOPER**: Essentials of Cloud Application Development, Introduction to cloud computing and IBM Cloud, Getting started with IBM Cloud, Developing IBM Cloud applications on a local workstation, Adopt a DevOps approach by using IBM Cloud Continuous Delivery, REST architecture and Watson APIs, Introduction to data services in IBM Cloud, IBM Cloud mobile backend as a service, Exercise: IBM Cloud command line interface (CLI), Develop IBM Cloud applications with Eclipse, Developing IBM Cloud applications with IBM Cloud Continuous Delivery, IBM Cloud with Cloudant,Build a mobile application by using Kinetise,	[20]
3.	**Developing Cloud Applications with SDK for Node.js**: Introduction to server-side JavaScript, Asynchronous I/O with callback programming, Express web application framework, Exercise :Developing a Hello World Node.js app on IBM Cloud, Understanding asynchronous callback, Creating your first express application, Understanding asynchronous callback Building a rich UI application by using AngularJS with Node.js	[12]
Outcome(s):	On the successful completion of the course, the student will be able to: •Understand asynchronous callbacks and be able to write the code in a Node.js application •Understand Express routing •Understand IBM Watson Natural Language Understanding service •Use the Fetch API to interact with back-end web services	
Text Books:	IBM Study Material.	
Reference Books:		

CS-18.338	Predictive Modeling Analytics	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	• English Proficiency • Basic Internet and web browser usage experience • Basic analytics experience	
Objective(s):	□ To understand how analytics provided a solution to industries using real case studies □ To Explain what is analytics, the various types of analytics, and how to apply it □ To Improve efficiency, sample records, and work with sequence data □ To Integrate and collect data □ To Understand the principles of data mining	
1.	**Business Analytics Overview**: Analytics overview, Analytics trends, Towards a predictive enterprise, Analytics: Industry domains , Case studies and solutions. Business Intelligence and Analytics	[5]
2.	**Introduction to A Predictive Analytics Platform & Data Mining**: Introduction to data mining, Working with modeler, A Data-mining tour ,Collecting initial data , Understanding your data ,Setting the unit of analysis ,Integrating data ,Deriving and reclassifying fields, Looking for relationships ,Introduction to modeling , Exercise: On the basis of all above topics.	[10]
3.	**Advanced data preparation**: Using functions, Data transformations, Working with sequence data, Sampling records, Improving efficiency. Exercise on the basis of all above topics.	[10]
4.	**Automated Data Mining**: Introduction to data mining ,The basics of using a modeler ,Reading data files , Data exploration , Automated data preparation ,Data partitioning, Predictor selection for modeling ,Automated models for categorical targets , Model evaluation , Automated models for continuous targets ,Deploying models Exercise :Adding nodes and creating streams in the modeler ,Reading a data file and typing the data in the source node , Review missing values in modeler and use the data audit node on the charity data , Practice using the ADP node to prepare data for modeling ,Use a partition node to split the charity data for modeling ,Use the feature selection node to select fields and predict a response ,Using the auto classifier node to construct a model in order to predict a response, Evaluate the model created to predict the field response ,Develop a model to predict the total spending , Use a scoring stream to make predictions	[15]
Outcome(s):	On the successful completion of the course, the student will be able to: • Understand the principles of data mining • Use the user interface of modeler to create basic program streams • User a partition node to create training and testing data subsets • Use a model to score new data	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.409	Block Chain	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• Basic knowledge of JavaScript, Node.js, Angular.js, Golang, Docker, and Kubernetes • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	To Explain block chain and how it is applied across industries To Understand the benefits of a blockchain platform To Explain what is Hyperledger Composer, how it fits into blockchain, and its applications To Explain the elements of a business network, the role of channels, and how the world state is maintained To Understand block chain deployment, security and integration capabilities	
1.	**Blockchain overview**: What is Blockchain? The business backdrop, The problem area, Relation to Bitcoin, Difference between Bitcoin and Blockchain, Requirements for a blockchain in a business environment, Requirements deep dive, Apply blockchain to business, Why blockchain is relevant for business, Consensus: Shared Reference Data Example, Provenance: Supply Chain Example, Immutability: Audit and Compliance Example, Finality: Letter of Credit Example, Industry Use Cases, Hyperledger Composer, Hyperledger Fabric, Blockchain for Financial Services	[10]
2.	**Blockchain Foundations**: HTML5 overview, JavaScript programming for web applications, HTML5 features, Working with HTML 5 features, Node.js, Server-Side JavaScript, Creating a Node.js Web Application, Asynchronous I/O with callback programming, Refactor weather project, , Working with JavaScript in HTML documents.	[10]
3.	**Docker Essentials** : Introduction to Docker, Add value CI/CD with Docker Images, Introduction to Orchestration, Get started with Kubernetes, Virtual machines, containers, and Kubernetes, Relationship between Kubernetes and containers, Deploy an application with IBM Watson services.	[10]
4.	**Blockchain Developer:** Blockchain Overview, Introducing Hyperledger Composer, Understanding Blockchain Solution Architecture, Blockchain in-depth, Hyperledger Fabric Application Development, Understanding Blockchain Deployment Options, Understanding Blockchain Security, Blockchain Integrated, Applying blockchain concepts to the vehicle manufacture lifecycle use case, Developing a blockchain user application with Hyperledger Composer SDK, Developing a client application for Hyperledger Fabric, Integrating blockchain with other systems,	[10]
Outcome(s):	On the successful completion of the course, the student will be able to: • Understand blockchain and how it is applied across industries • Understand the role of a shared ledger • Understand the benefits of a blockchain platform • Understand what is Hyperledger Composer, how it fits into blockchain, and its applications • Understand the blockchain solution architecture	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.216	Application Security	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• Basic web development knowledge • Basic knowledge on HTML and HTTP • Basic knowledge of application security • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform
Objective(s):	• To Describe the emerging threats and leaks as the world is becoming digitalized • To Understand the security dynamics of securing the enterprise • To Understand relational database concepts and how to work with database objects • To Describe how to work with select statements, DML statements, and multiple tables • To Understand how to use JOINs in SQL • To Understand the basics of HTML5 (objectives, document types that are supported, browser support etc.) • To Understand glass box scanning, content based scanning, and troubleshooting

1.	**Cyber Security Overview**: Emerging threats and leaks as the world is becoming digitalized, The changing dynamics of securing the enterprise, A new approach to security, The foundation of approach to security the enterprise, IT Security Frameworks, Security Intelligence as a foundation of all security programs, IBM Security.	[5]
2.	**Application Security Foundations**: SQL Fundamentals, Relational database concepts, Working with database objects, Reading data, Inserting, updating, and deleting data, Working with multiple tables, exercises on Relational database exercise, Creating, modifying and deleting database objects ,Inserting, updating, and deleting data.	[9]
3.	**Introduction to HTML5 and JavaScript Programming:** HTML5 overview, JavaScript programming for web applications, HTML5 features, Working with JavaScript in HTML documents, Working with HTML5 features.	[9]
4.	**Web Application Security Fundamentals:** The web application security problem, Web application basics, Injection flaws, Broken authentication and session management, Cross-Site scripting, Insecure direct object reference, Security misconfiguration, Sensitive data exposure, Missing function level access control, Cross-site request forgery (CSRF), Using components with known vulnerabilities, Unvalidate redirects and forwards, Integrating security in the software development lifecycle	[9]
5.	**Web Application Security Solution Fundamentals:** Web application security overview, Installation and setup, Preparing for scan, Configuring first scan, Reviewing the results, Reporting, Logging in and managing sessions, Configuring explore options, Optimizing your scan, Glass box scanning, Content-based scanning, Reviewing scan coverage, Scanning web services, Extending the security web application solution, Troubleshooting,	[8]

Outcome(s):	• Understand relational database concepts and how to work with database objects • Describe how to work with select statements, DML statements, and multiple tables • Understand how to use JOINs in SQL • Understand the basics of HTML5 (objectives, document types that are supported, browser support etc.) • Understand the basics of JavaScript • Describe the web application security problem and web application basics
Text Books:	IBM Study Material.
Reference Books:	

CS 18.407	Advanced Artificial Intelligence	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• English Proficiency • Exposure to the IBM Skills Academy Portal learning environment
Objective(s):	• To Describe the field of AI and its subfields machine learning, NLP and computer vision • To Describe the types of AI • To Describe the types of machine learning: Supervise learning, unsupervised learning, and deep learning • To Describe the purpose of training the various Watson services to adapt them to a closed-domain • To Use Watson API Explorer to interact with the Watson services REST API, to rest your calls to the • To Define chatbots • To Explain the factors that lead to the growing popularity of chatbots • To Identify applications that are good candidates to integrate with chatbots • To Describe the main components that are involved when building a chatbot and explain their purpose • To Describe how to build a chatbot by using the IBM Watson Conversation service

1.	**Artificial intelligence overview**: Introduction to Artificial Intelligence, Machine Learning, Natural Language Processing, Computer vision, Cognitive Computing.	[5]
2.	**Artificial intelligence foundations**: Introduction to IBM Watson, Evolution from DeepQA to Watson services on IBM Cloud, Build with Watson, Exploring Watson services with Watson API Explorer.	[10]
3.	**Artificial intelligence analyst:** Introduction to Natural Language Processing, Pipeline and concepts, NLP and IBM Watson, Exercises on Ingest, Convert, Enrich, and Query with Watson Discovery Service.	[10]
4.	**Chatbots:** Introduction to Chatbots, Chatbot fundamentals, IBM Watson conversation service.	[8]
5.	**Computer Vision:** Introduction to Computer Vision, Computer Vision fundamentals, IBM Watson Visual Recognition service, Exercise on Classifying images with Watson Visual Recognition.	[7]

Outcome(s):	Understand the relationship between AI and NLP Know the history and advancement of Computer Vision Understand Computer Vision components Learn about the Vision services that are available from IBM Watson.
Text Books:	IBM Study Material.
Reference Books:	

CS 18.210	Business Intelligence	Total Lectures: 40
		Credit: 3-0-0-3
Prerequisite(s):	• English proficiency • Microsoft Windows operating system basic experience • Basic Internet and web browser usage experience • Knowledge of an organization's business intelligence and reporting needs • Basic database background is preferred • Basic knowledge of XML is preferred • Exposure to the IBM Skills Academy portal learning environment • Exposure to the IBM Skills Academy cloud hands-on labs platform	
Objective(s):	• To Understand how analytics provided a solution to industries using real case studies • To Explain what is analytics, the various types of analytics, and how to apply it • To Understand how a business analysis software works, and its architecture • To Describe a reporting application, its interface, and the different report types • To Create different types of advanced reports • To Understand Active Reports and how to create them	
1.	**Business Analytics Overview**: Analytics overview, Analytics trends: past, present & future, Towards a predictive enterprise, Analytics: Industry domains, Case studies and solutions.	[5]
2.	**Business Intelligence and Analytics 101 and Business analytics foundations**: Business Intelligence and Analytics 101, IBM Cognos Analytics for Consumers, Business analysis solution for consumers.	[7]
4.	**Business intelligence analyst:** IBM Cognos Analytics: Author Reports Fundamentals, Introduction to IBM Cognos Analytics, Create list reports, Focus reports using filters, Create crosstab reports, Present data graphically, Focus reports using prompts, Extend reports using calculations, Use additional report building techniques, Customize reports with conditional formatting, Drill-through definitions, Enhance report layout, Overview of IBM Cognos Analytics	[12]
5.	**IBM Cognos Analytics: Author Reports Advanced:** Create query models, Create reports based on query relationships, Create advanced dynamic reports, Design effective prompts, Create additional advanced reports, Examine the report specification, Distribute reports through bursting, Enhance user interaction with HTML.	[11]
6.	**IBM Cognos Analytics: Author Active Reports:** Introduction to IBM Cognos Active Reports, Use Active Report connections, Active Report charts, visualizations, and decks.	[5]
Outcome(s):	• Describe a reporting application, its interface, and the different report types • Create different types of advanced reports • Understand Active Reports and how to create them	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.309	Security Intelligence	Total Lectures: 40
		Credit: 3-0-0-3
Prerequisite(s):	• Basic understanding of the security fundamentals • Basic understanding of the IT infrastructure and IT security fundamentals • Basic understanding of Linux, Windows, TCP/IP networking and Syslog • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	Identify enterprise business and IT drivers that influence the overall IT Security Architecture Define the role of a centralized Security Intelligence solution and how it integrates with other IT enterprise security components Explain how a Security Intelligence solution can be used to investigate and stop advanced threats and address IT governance and regulatory compliance Describe how QRadar SIEM collects data to detect suspicious activities Navigate and customize the QRadar SIEM dashboard Investigate suspected attacks and policy breaches Search, filter, group, and analyze security data Investigate the vulnerabilities and services of assets Locate custom rules and inspect actions and responses of rules Use QRadar SIEM to create customized reports Use charts and apply advanced filters to examine specific activities in your environment	
1.	**Cyber Security Overview**: The status quo of IT Security, Security intelligence and operations,	[5]
2.	**Cyber Security Foundations**: Security Intelligence Fundamentals, Designing a security intelligence solution, Security intelligence functional components,	[10]
3.	**SECURITY INTELLIGENCE ENGINEER:** Security Intelligence Solution Foundations, Introduction to Security Intelligence Solution SIEM, How Security Intelligence Solution SIEM collects security data, Using the Security Intelligence Solution SIEM dashboard, Investigating an offense that is triggered by events, Investigating the events of an offense, Using asset profiles to investigate offenses, Investigating an offense that is triggered by flows, Using rules and building blocks, Creating Security Intelligence Solution SIEM reports, Perform advanced filtering	[10]
Outcome(s):	Understand the relationship between AI and NLP Know the history and advancement of Computer Vision Understand Computer Vision components Learn about the Vision services that are available from IBM Watson.	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.214	Developing IoT based Applications	Total Lectures: 40
		Credit: 3-1-0-4
Prerequisite(s):		
Objective(s):	An introduction the idea of collaborative devices working together to achieve a larger goal is not new. Beginning from the simple operational definition, the session will outline the historical perspective right from pre-internet era, specific machine-to-machine communication context aware computing to wearables. It will conclude architecture of Internet of Things (IoT).	
1.	**Unpacking Internet of Things**: What is IoT,Why IoT,Journey of IoT, Business Use cases of IoT, Brainstorming on various IoT use cases on any two Domains like- (Manufacturing , Buildings , Agriculture , Energy & Utilities , Worker Safety),Available programming languages for IoT enabled applications,Basic commands and board configurations,Integration IoT on Arduino.	[5]
2.	**Introduction to basic hardware interfaces and proteus simulation:** Describe a development platform, Describe the architecture of a development platform, Introduction to sensor and hardware (LED, ultrasonic Sensor, Flame sensor, DHT sensor, LCD etc.), Introduction and installation of proteus, Introduction to LED, Writing of LED blinking program on Arduino IDE with hardware implementation,Introduction to seven segment display and its working,Introduction to LCD and describing how digital display works, Writing code for LCD to display sensors results,Descriptive explanation of analog and digital conversion in electronics,Descriptive explanation of Pulse Width Modulation in electronics	[9]
3.	**Introduction to various sensors and their interface with Arduino:** Introduction to ultrasonic sensor and describing how ultrasonic sensors works, Writing code for ultrasonic sensor and display result in Serial Monitor,Introduction to Flame sensor and describing how Flame works, Writing code for Flame sensor to calculate ppm value and display result in Serial Monitor,Introduction to DHT sensor and describing how DHT sensors works, Writing code for DHT and display result in Serial Monitor,Introduction to LDR and describing how it works, writing code it,Introduction, to IR and describing how it works, Writing code for it,Introduction to LM35 and its application	[9]
4.	**Advanced Modules Interfacing And Assignments:** Introduction to Bluetooth and describing how Bluetooth works, Writing code for HOME AUTOMATION,Introduction to GSM and introduction to AT commands, write a code to call/message other phone using AT commands through arduino,write code to upload temperature sensor value on Cloud ,Introduction to Wi-Fi and new modules avail in the market, Write some code on ARDUINO for ESP8266 to upload sensors value on web,Introduction to Acc. describing how it works, Writing code for it	[9]
5.	**ASSIGNMENTS:** Displaying text on LCD ,Scrolling text on LCD,Displaying numbers on LCD ,IOT based agricultural field monitoring and controlling,IOT Based office home security with auto capture on intruder and sending alert,IOT based digital notice board for college ,IOT based contactless liquid level monitoring with empty and full alert ,IoT based home automation with fault switch,IoT based agricultural field monitoring and controlling, Project discussion.	[8]
Outcome(s):	• Unpacking Internet of Things • Getting introduced to IoT • Business Use cases of IoT • Embed various sensors with iot platform and simulate them on virtual simulation software proteus • Creating account on iot cloud platform and setting up communication between arduino and cloud platform.	
Text Books:	IBM Study Material.	
Reference Books:		

CS 17.302 **Advanced RDBMS** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): Database Management System

Objective(s): To acquire fundamental knowledge of Software designing using UML.

1.	Overview of DB2 9 on Linux, UNIX and Windows, Command Line Processor (CLP) and GUI usage, The DB2 environment.	[12]
2.	Creating databases and data placement, Creating database objects, Moving data.	[10]
3.	Backup and recovery, Locking and concurrency, Investigating DB2 locking.	[10]
4.	Problem determination, Application issues and performance, Application performance tools, Security.	[8]

Outcome(s): After completion of this course student get the understandings of advance concepts of Database design and security.

Text Books:

1. RamezElmasri, Shamkant B. Navathe, "Fundamentals of Database Systems",Pearson Education, 7th Edition, 2015.

Reference Books:

2. AviSilberschatz , Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2011.

1. Jeffrey A. Hoffer, Mary B. Prescott and Fred R. McFadden, "Modern DatabaseManagement", Prentice Hall, 8th Edition, 2006.

CS 17.208 **Essentials of Software Engineering (OOAD & SW Lifecycle)** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): Object Oriented Technologies

Objective(s):

- To acquire fundamental knowledge of Software designing using UML.

1. **Software Engineering Overview:** Best Practices of Software Engineering Concepts of Object Orientation Essentials of Visual Modeling Requirements Overview [12]
2. **Requirement analysis**: Analysis and Design Overview Architectural Analysis Use-Case Analysis Identify Design Elements [10]
3. **Design analysis**: Identify Design Mechanisms Describe the Run-time Architecture Describe Distribution Use-Case Design Objectstore Mechanism Security Mechanism. [10]
4. **UML and mapping**: UML to C++ Mapping UML to Java Mapping UML to Visual Basic Map UML to Visual Basic Map [8]

Outcome(s):

- After completion of this course student get the understandings of object-oriented analysis and design concepts, as well as hands-on practical experience applying the techniques within a use-case-driven, architecture-centric, and iterative development process.

Text Books:

1. Pressman R.S., "Software Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Sommerville, Ian "Software Engineering", Pearson Education

Reference Books:

1. Jalote Pankaj, "An Integrated Approach to Software Engineering", NAROSA.
2. Fairely, R.E., "Software Engineering Concepts", McGraw-Hill

CS 17. 204 **R Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language(CS 14.101)

Objective(s):

- To understand and learn programming concepts of R
- To Apply R programming to solve various statistical, graphics and modeling problems

1. **Fundamentals of R** : Evolution of R, Features of R, R environmental Setup, R Script file, Data types- Vectors, Lists, Matrices, Arrays, Factors, Data Frames, Variables, finding and deleting variables, Operators in R. [6]
2. **Control Statements in R**: if-else statement, switch statement, Repeat loop, while loop, for loop, break statement, next statement [8]
3. **Functions, Strings and Vectors :** Function Definition , Function Components Built-in Function, User-defined Function, Calling a Function, Lazy Evaluation of Function, Strings and Strings Manipulation, Vector creation, accessing vector elements, vector manipulation, [10]
4. **Lists, Matrices and Arrays :** List Creation, Naming list elements, Accessing list elements, Manipulating list elements, Merging list, Converting list to Vector, Accessing elements of matrix, matrix computations, Naming row and column of array, accessing array elements, manipulating array elements, calculation across array elements [10]
5. **Data frames, factors and packages:** Extract data from data frame, expand data frames, factors in data frames, changing the order of levels, generating factor levels, packages [6]

Outcome(s): After completing the course the student is expected to

- be able to use and program in the R programming language
- be able to use R programming to solve statistical problems
- be able to apply R Programming concept to solve real world problems

Text Books:

1. Hadley Wickham, Garrett Grolemund, R for Data Science, O'Reilly, January 2017.
2. John Maindonald and John Braun, Data Analysis and Graphics Using R, Cambridge University Press, Cambridge, 2007.

Reference Books:

1. Peter Dalgaard, Introductory Statistics with R, Springer Verlag, 2008.
2. Phil Spector. Data Manipulation with R. Springer, New York, 2008.

CS 17. 254 **R Programming Laboratory** **Credit: 0-0-2-1**

Prerequisite(s): CS14.111(Programming Language Laboratory)

Objective(s):

- To learn R programming constructs
- To learn use R for statistical analysis
- To learn R for modeling.

Contents: Lab manual based upon the theory course CS 17.204 and to achieve the listed course objectives and outcomes.

Outcome(s): On successful completion of this course, the students will be able to

- Write programs using R programming
- Use R programming for statistical analysis of data
- Use R programming for data visualization
- Use r programming for problem modeling

MA-14.101 **Mathematics-I** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

1. **Calculus:** Review of basic concepts, partial differentiation, Euler's theorem on homogeneous functions, Taylor's series and Jacobian, maxima and minima of functions of two variables, asymptotes, tracing of simple Cartesian curves, length of plane curves, area bounded by the curves, multiple integrals (double and triple integrals, change of order of integration), physical interpretations and applications. [16]

2. **Three-dimensional Geometry**: Direction cosines and direction ratios of a straight line, equation of a plane,plane passing through intersections of two planes, equations of astraight line, theshortest distance between two skew lines, theequation of a sphere, intersection of plane and sphere. [10]

3. **Matrix Theory**: Rank of matrix, linear dependence and independence of vectors, solution of system of simultaneous linear equations, Eigen values, Eigenvectors of a matrix, statement of Cayley-Hamilton theorem (without proof) , reduction of a matrix to diagonal form, quadratic forms, linear transformation of a quadratic form, and applications. [10]

4. **Theory of Equations**: Introduction of polynomials, therelation between roots and coefficients, Cardon's method. [4]

Outcome(s):

- After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj, New Delhi, 43rd Edition, 2013.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 3rd Edition 2008.

Reference Books:

1. Kreyszig Erwin, Engineering Mathematics, John Wiley and Sons, New York, ISBN: 04717289777/0471726478, 9th Edition, 2005.
2. Veerarajan T., Engineering Mathematics (for first year), TMH Publishing Company Limited, New Delhi, 2nd Edition 2006.

MA-14.102 **Mathematics-II** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): MA-14.101

Objective(s):

- To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

1. **Computational Methods**: Introduction and importance of numerical analysis, calculus of finite differences, interpolation schemes for equal and unequal intervals (Newton's forward and backward interpolation formulae), divided difference, interpolation for unequal intervals (Newton's divided difference and Lagrange interpolation formulae), solution of algebraic and transcendental equations by Newton-Raphson method, applications to Engineering. [13]

2. **Ordinary Differential Equations:** First order and first-degree differential equations (variable separable, homogeneous, linear, exact equations, linear differential equations of second order with constant and variable coefficients (complementary functions and particular integrals) and applications. [12]

3. **Partial Differential Equations**: Formation of partialdifferential equations, Lagrange's multipliers method for thesolution of first order differential equations, separation of variables for nonlinear differential equations and applications. [5]

4. **Vector calculus**: Vector and scalar point functions, conservative fields, gradient of scalar point functions, divergence and curl of vector point functions (Solenoidal and irrotational vectors), directional derivative of scalar point functions, work done along a curve, integration of vectors, line integral (work done), surface integral, volume integral, physical interpretations and applications. [10]

Outcome(s):

- After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj,New Delhi, 40th Edition, 2007.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited,New Delhi, 2nd Edition 2007.

Reference Books:

1. Kreyszig Erwin, Engineering Mathematics, John Wiley and Sons, New York, , 10th Edition, 2010.
2. Veerarajan T., Engineering Mathematics (for first year), TMH Publishing Company Limited, New Delhi, 5th Edition 2015.

MA 14.201 **Applied Mathematics** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): None

Objective(s):

- To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1. **Linear Programming:** Introduction, graphical method (bounded & unbounded solutions), Simplex method, artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). [12]
2. **Numerical Methods:** Solution of system of equations (Gauss elimination and Gauss – Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods), solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector Runge-Kutta methods) [10]
3. **Complex Analysis:** Function of complex variable, analytic function, Cauchy- Riemann equations (without proof), integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula (without proof), zeros and singularities of complex functions, residues. [6]
4. **Integral Transform**: Laplace transform and inverse Laplace transform, first and second shifting theorems, convolution theorem (without proof), solution of ordinary differential equations with initial conditions by Laplace transforms, Fourier series of periodic functions, even and odd functions, Fourier half-range series, basics of Fourier transform. [12]

Outcome(s):

- After completion of the course, students would be able to apply the knowledge of linear programming, numerical methods, complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH,2nd 2007.
2. Grewal B.S. & Grewal J.S., Higher Engineering Mathematics, Khanna publishers, 40th Edition: 2007.
3. Taha H.A., Operation Research: An Introduction, Pearson,8th edition 2006.
4. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.

Reference Books:

1. Jain R.K. & S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 5th Edition 2016.
2. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
3. James B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Babu Ram, Engineering Mathematics, Pearson, Year 2010.

MA 14.202 **Statistics and Probability Theory** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): Nil.

Objective(s):

- To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

1.	**Introductory Ideas:** Recapitulation of Basic Probability theory; Law of addition and law of multiplication ;conditional probability; total probability; Bayes' theorem and it's applications.	[6]
2.	**Random Variables and Distribution:** Discrete and continuous random variables; types of distribution; probability mass and density functions; mean, variance and standard deviation of distribution.	[4]
3.	**Theoretical Probability Distribution:** Discrete types (Binomial) and Continuous type (Normal, Student's't'); applications of basic ideas to these distributions	[8]
4.	**Sampling Theory:** Sampling distribution of mean and variance; central limit Theorem.	[4]
5.	**Testing of Hypothesis:** Simple and Composite hypothesis; Type I and Type II errors; tests of significance and level of significance.	[4]
6.	**Correlation and Regression:** Simple, partial and multiple correlations; linear regression.	[6]
7.	**Queuing Theory and Queuing Models:** Birth and death process; pure birth and pure death process; Classification of queuing models: M/M/1, M/M/1/N, M/M/S and M/M/S/N.	[8]

Outcome(s):

- After completion of the course, students would be able to apply the knowledge of Statistics and Probability in engineering and solve curriculum problems.

Text Books:

1. A.P.Baisnab and Manoranjan Jas, Elements of Probability and Statistics, TMH, 2003.
2. Pugalararasu, Probability and Queuing Theory, TMH, 2011.
3. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, 2002.
4. Gupta & Kapoor, Fundamental of Applied statistics, SCS Publisher, 2001.
5. B.V. Ramana, Higher Engineering Mathematics, TMH, 2006.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH, 2002.
2. Palaniammal, Probability and Random Processes, PHI, 2012.
3. Spiegel, Probability and Statistics (Schaum's outline Series), TMH, 2004.
4. Miller and Freund's, Mathematical Statistics with Applications, 7th Edition, Pearson, 2003.
5. Richard A. Jonson, Probability and Statistics for Engineers, Pearson, 2005**.**

ME-14.101 **Applied Mechanics** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course will help the student to acquire knowledge of basic engineering mechanics concepts and enhance their ability to solve open-ended engineering problems.
- To provide the student with a clear and thorough understanding of the theory and applications of engineering mechanics, covering both statics and dynamics.
- To provide the student with a thorough understanding of the concept, drawing, and the use of free-body diagrams.
- To be able to determine the Centre of Gravity and Moments of Inertia of simple geometric shapes and understand the physical applications of these properties.
- To understand the use and be able to perform calculations related to friction forces in engineering applications.

1. **Introduction:** Idealization of Mechanics, theconcept of Rigid Body, External Forces (Body forces & surface forces), Laws of Mechanics. [3]

2. **Force Systems and Equilibrium**: Introduction to vector, Statically Equivalent Force systems,Free Body Diagram, Equations of equilibrium and their applications to thevarious system of forces. [8]

3. **Distributed Forces and Moment Of Inertia**: Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, Principle axes and Principle Moment of Inertia. [5]

4. **Friction:** Introduction of friction, Laws of friction, wedge, screw, belt, rolling friction. [5]

5. **Tension,Compression, and Shear:** Normal stress and strain, Linear elasticity, Hooke's Law and Poisson's Ratio, Shear stress and shear strain, Relationship between modulus. [4]

6. **Beams:** Different support & load conditions, SFD, BMD [5]

7. **Kinematics of Particles**: Introduction, Rectilinear motion, Plane curvilinear motion, Rectangular coordinates, Tangential and normal coordinates, polar coordinates, Relative motion (Translating Axes), constrained motion of connected particles. [5]

8. **Kinetics of Particles:** Introduction, Force, Mass and acceleration, Newton's second law of motion, Equation of motion and solution of problems, Work and Energy, Impulse and Momentum. [5]

Outcome(s):

- The students shall develop the ability to identify, formulate, and solve engineeringproblems related to forces and motion.

Text Books:

1. Timoshenko, S, Young, D.H, Rao, J.V, Engineering Mechanics, 4th edition TMH, 2010.
2. Merian, J.L, Kraige, L.G., Engineering Mechanics Vol I & II, 7th edition Wiley India 2015.

Reference Books:

1. Hibbeler, Gupta R. C., Engineering Mechanics, 11th ed.,Pearson India, 2010.

ME-14.111 **Computer Aided Engineering Drawing** **Total Lectures: 40**

Credit: 0-0-4-2

Prerequisite(s): NIL

Objective(s):

- To improve the visualization skills.
- To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
- To impart the knowledge of understanding and drawing of simple engineering products.

1. **Introduction to Computer Aided Sketching**: Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and freehand practice. Board Drawing vs. Computer- Aided Drawing. Introduction to Solid works Environments. Computer screen, thelayout of the software, standard toolbar/menus and description of most commonly used toolbars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP &LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, dimensioning, line conventions, material conventions and lettering. [8]

2. **Orthographic Projections**: Horizontal planes, Vertical planes, Front view, Top view, Side view, Projections, theFirst and Third angle of projection, Projections of points, Principles of orthographic projections, Sketching of different views of given objects. Introduction to sketching in Solid works : 2-Dimensional Sketching, Sketching in Solid works, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination, and perpendicularity. [12]

3. **Projections of Lines, Planes, and Solids**: Lines inclined to both the principal planes, theprojection of Lamina inclined to both principal planes, Projections of solids: Axis inclined to both the reference planes and Intersection of solids. Introduction to thepart module in Solid works: Extrude, Revolve, Sweep, Hole, Filleting, and Chamfering features. [12]

4. **Sections of solids and sectional orthographic views:** Sectional orthographic projections - Full,Half, Partial, revolved and removed surfaces. Introduction to drawing module in Solid works:Standard 3 views, Auxiliary view, Section View, Projected view. [12]

5. **Isometric Projection:** Terminology, Isometric scale, Box method, Coordinate or offset method, Four-center method, theisometric projection of arcs. Solid models practice using Solid works partmodule. [8]

Outcome(s):

- Students will be able to improve their visualization skills so that they can apply these skills in developing new products.
- Students will be able to know and understand the conventions and the methods of engineering drawing using Solid works.
- Students will be able to prepare simple drawings of engineering products.

Text Books:

1. N.D. Bhatt, "Engineering Drawing",Charotar Publishing House, 2017.
2. Prof. Sham Tickoo, Sandeep PremDass Solid works 2013 for Engineers and Designers Wiley Publication, 2017.

Reference Books:

1. Randy H. Shih, Solid works 2017 and Engineering Graphics: An Integrated Approach, SDC Books: Publications. 2017
2. David Planchard, "Engineering Graphics with Solid Works 2014 and Video Instruction", SDC Publications, 2013.

ME-14.112 **Mechanical Workshop** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To learn various hand tools used in fitting, carpentry and sheet metal shop.
- To learn about lathe and drilling machine and their operations.
- To learn how various joints are made using wood and other metal pieces.

1. Fitting Shop: Prepare job that contains various fitting operation like filing, marking, measuring, cutting, drilling etc.

2. Carpentry Shop: Making of carpentry joint (T, L joint etc).

3. Sheet Metal Shop: Making job from thesheet (funnel, tray etc).

4. Machine Shop: Perform various operations like turning, step turning, facing, chamfering, knurling etc. on Lathe.

Outcome(s): Students will able to:

- Understand use of tools of Fitting, Carpentry & Sheet Metalworking operations
- Study and practice on lathe and drilling machine and their operations
- Acquire engineering skills in Fitting, Carpentry & Sheet Metalworking operations

MT 201 **Engineering Economics** **Total Lectures: 24Credit: 2-0-0-2**

Prerequisite(s): NIL

Objective(s):

- To know about the basic concepts of Engineering Economics and its role in Indian economy.
- To understand about the elements of economics with application to the industrial sector and its impact on Economy.
- To discuss about the market demand analysis, production analysis and pricing mechanism for decision making.
- To find the role of consumer perception in market demand and its features and infrastructure development in India.
- To discuss about cost analysis and optimization techniques with multiple objectives.

1.	**Introduction to Engineering Economics:** Origin, principles, engineering economics and design process, engineering for economic competitiveness, engineering economy and the engineer.	[3]
2.	**Elements of Economics:** Definition, demand and supply, income, equilibrium, utility.	[3]
3.	**Economics applied to Industries:** Market demand analysis, production analysis for decision Making, cost analysis, pricing techniques in regards of goods and services, break even analysis, interest, annuities and profits.	[12]
4.	**Replacement Analysis:** Capital recovery, depreciation methods for replacement studies.	[2]
5.	**Optimization Techniques:** Economics and optimization, price mechanism and optimal resource allocation, optimization under constraints, optimization under risk and uncertainty,	[4]

Outcome(s): Students would

- Be able to perform and evaluate payback period and capitalized cost on one or more than one economic alternatives.
- Be able to carry out and evaluate the benefit/cost, break even analysis on one or more alternatives.
- Have the knowledge of fundamentals of Engineering Economics for the purpose of economic condition of the country.

Text Books:

3. **Salvetore Dominick, Managerial Economics, Prentice Hall of India,6th Edition, 2008.**
4. **Christopher Thomas, S Charles Maurice, Managerial Economics, Mc-Graw Hill,11th Edition, 2012.**

Reference Book:

2. **Van Horne,James C., Fundamentals of Financial Management, Pearson Education,13thEdition, 2009.**

PY-14.101 **Engineering Physics** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To make a bridge between the physics in school and engineering courses.

1. **Modern Physics**: Introduction to black body radiation spectrum, photoelectric effect, Compton effect. Wave-particle Dualism, deBroglie hypothesis, de Broglie wavelength, extension to electron particle, Davisson and Germerexperiment,matter waves and their characteristic properties, phase velocity, group velocity and particle velocity, relation between phase velocity and group velocity, relation between group velocity and particle velocity,expression for deBr;oglie wavelength using group velocity. [8]

2. **Quantum Mechanics:** Heisenberg's uncertainty principle and its physical significance, application of uncertainty principle (non-existence of electron in the nucleus, explanation for decay and kinetic energy of electron in an atom), wave function, properties and physical significance of wave function, probability density and normalization of wave function,setting up of one dimensional time independent Schrodinger wave equation, eigenvalues and eigenfunctions, application of Schrodinger wave equation, energy eigenvalues for a free particle,energy eigenvalues and eigenfunctions for a particle in a potential well of infinite depth. [7]

3. **Electrical Conductivity in Metals**: Free–electron concept, classical free electron theoryAssumptions, drift velocity, mean collision time and mean free path, relaxation time,expression for drift velocity, expression for electrical conductivity in metals,effect of impurityand temperature on electrical resistivity of metals,Quantum free electron theory assumptions, Fermi – Dirac statistics, Fermi-energy, Fermifactor, density of states (No Derivation),expression for electrical resistivity / conductivity,temperature dependence of resistivity of metals, electron in a periodic potential, origin of theenergy gap, band theory of solids, distinction of solids into metals, semiconductors andinsulators. [8]

4. **Dielectric & Magnetic Properties of Materials**: Dielectric constant and polarization of dielectric materials, types of polarization, equation for internal field in liquids and solids (one dimensional), Ferro and Piezoelectricity,frequency dependence of dielectric constant, important applications of dielectric materials,classification of dia, para and ferro-magnetic materials, hysteris in ferromagnetic materials, soft and hard magnetic materials,applications. [7]

5. **Lasers and Optical Fibers**: Einstein's coefficients (expression for energy density), requisites of a Laser system, condition for laser action, principle, construction and working of CO_2 laser and semiconductor laser, applications of laser – Laser welding, cutting and drilling, measurement of atmospheric pollutants, holography–principle of recording and reconstruction of images, applications of holography, propagation mechanism in optical fibers, angle of acceptance, numerical aperture, types of optical fibers and modes of propagation, attenuation, application, block diagram discussion of point to point communication. [10]

Outcome(s):

- The student will be able to understand many modern devices and technologies based on lasers and optical fibers. A student can also appreciate various material properties which are used in engineering applications and devices.

Text Books:

1. S. O. Pillai, Solid State Physics, 8th Edition, New Age International, 2018.
2. V. Rajendran, Engineering Physics, TMH,2nd edition 2010.

Reference Book:

1. G. K. Shivkumar, Engineering Physics, Prism Book Pvt. Ltd,2011.

PY-14.111 **Physics Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To make the students gain practical knowledge to co-relate with the theoretical studies.

1. To study the material constant, temperature coefficient of current and Planck's constant.
2. To determine the specific resistance of a given wire by using the Carey Foster's bridge.
3. To determine the ballistic constant, K of a moving coil ballistic galvanometer with a standard capacitor of known capacity.
4. To determine the high resistance by the method of leakage of a condenser with the help of ballistic galvanometer.
5. To study the variations of resistivity with temperature and hence determines the energy band gap of the given semiconductor with help of four probe method.
6. To convert a galvanometer into a voltmeter of a given range.
7. To convert a galvanometer into an ammeter of a given ranges.
8. To plot graph showing the variation of magnetic field with distance along the axis of a circular coil carrying current and to estimate from it the radius of the coil.

Outcome(s):

- After completion of the course, students would be able to develop the skills necessary to perform experiments in physics and acquire an experience of the methods used and analysis needed in experimental physics.

RM 17.101 **Research Methodology** **2-0-0-2**

1. **Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research. [2]

2.**Problem Formulation:** Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature, Research Gaps. [4]

3. **Research Design:** Research Framework, Meaning & Significance of Research Designs, Features of a good Research Design, Types of Research Design. [4]

4. **Data for research:** Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis. [4]

5. **Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [8]

6. **Report Writing:** Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [4]

TextBooks:

1. R.Pannershelvam, "Research Methodology" Prentice Hall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"Research Methodology: Methods and Techniques", New Age International (p) Limited, Publishers New Delhi, 4ndedition, 2018.

References –

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013.
4. Dr. A.K. Phophalia, “Modern Research Methodology: New Trends and Techniques” Paradise Publishers Jaipur, 1st edition, 2012.
5. Pankaj Madan, “Research Methodology”, Global Vision Publishing House, New Delhi, 2nd edition, 2016.

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College of Engineering & Technology

Department of CSE

Course structure for

BCA

CA 16. 101 **Computers Fundamentals** **3-0-0-3**

Total Lectures: 40

1. **Introduction to Computers:** Definition, Block Diagram, characteristics, Applications in Modern Society, History, Classification of computers and Generation of computers. [6]
2. **Functional Units of Computer Processing System:** Hardware, CPU, Memory and secondary storage devices, Input devices, Output Devices, Information Concept and Processing: Data, Information, Knowledge and Wisdom. [8]
3. **Data representation:** Representation of Data, Bits and Bytes, Number System: Decimal, Binary, Octal, Hexadecimal, Conversions b/w number system, Arithmetic Operations in Binary Number, ASCII, EBCDIC and BCD Codes. [8]
4. **Software Concepts:** Types of Software, Generation of Programming Language: Machine Language, Assembly Language, High Level Language, Translator: Assembler, Interpreter, Compiler, Operating System**:** Functions, types of operating system: Batch Processing, Multiprogramming, Multiprocessing, Multitasking, Time Sharing and Real Time System, MS-DOS, MS-Windows. [9]
5. **Data Communication and Computer networks:** The Basic Communication System, Data Transmission Modes, Network types, Network Topologies, Internet and its Applications: E-mail, World Wide Web, Intranet, Extranet, Computer Threats: Virus, Worm, Trojan horse, Malware. [9]

Text Books:

1. Sinha , Pradeep K. and Sinha, Priti, “Computer Fundamentals”, BPB Publications, Third Edition.

Reference Books:

1. ITL Education Solutions Limited, “Introduction to Computer Science”, Pearson Education, Third Edition, New Delhi.
2. Rajaraman, V., “Introduction to Computer”, PHI, New Delhi.
3. Thareja, Reema, “Fundamentals of Computers”, Oxford University Press India, Second Edition.

CA 16.102 **Operating System** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Definition and types of operating systems, Batch Systems, multi programming, time sharing, distributed and real-time systems, Operating system structure, Operating System Components and Services, System calls, System Programs, Virtual Machines. [4]
2. **Process Management:** Process Concept, Process States, Process Control Block, Operations with examples from UNIX (fork, exec) and/or Windows, Inter-process communication (shared memory and message passing), Scheduling Algorithms, Performance Evaluation. [7]
3. **Threads:** multithreaded model, scheduler activations, examples of threaded programs. Scheduling: multi-programming and time sharing, scheduling algorithms, multiprocessor scheduling, thread scheduling. [5]
4. **Process synchronization and Deadlocks:** critical sections, classical two process and n-process solutions, hardware primitives for synchronization, semaphores, monitors, classical problems in synchronization (producer-consumer, readers-writer, dining philosophers, etc.). Deadlocks-System model, Characterization, Deadlock prevention, Avoidance and Detection, Recovery from deadlock, Combined approach to deadlock handling. [8]
5. **Memory Management:** Logical and Physical Address Space, Swapping, Contiguous Allocation, paging and segmentation, demand paging, virtual memory, page replacement algorithms. [5]
6. **File Management:** Directory systems, File System Implementation issue, access methods, Allocation Methods, Free Space Management. [4]
7. **I/O Management:** Disk Structure, Disk Scheduling, Disk Management, Control of Various Devices, Device Drivers, Interrupt Driven and Poll Driven Data Transfer. [4]
8. **Security and Protection Mechanism:** Computer Security classification, Authentication, System threats, Goals of Protection, Access Matrix. [3]

Text Books:

1. Silbersachatz A.H. and Galvin P.B., "Operating System Concepts", Pearson Education.
2. Tannenbaum Andrew S., "Operating Systems", PHI, New Delhi

Reference Books:

1. Stallings William, "Operating Systems: Internals and Design Principles", Prentice-Hall, New Delhi
2. Dhamdhere D. M. "System Programming and Operating System", TMH New Delhi
3. Godbole Achyut S, "Operating Systems", TMH, New Delhi

CA 16.103 **C- Programming** **3-0-0-3**

Total Lectures: 40

1. **Introductory Concepts:** Introduction to computers, Computer characteristics, Types of programming languages, Introduction to C, identifiers and keywords, Data types: declaration and definition, Type conversion. [6]
2. **Operators:** Arithmetic, relational, logical, bitwise, unary, assignment, Increment and Decrement operators, conditional operators and their hierarchy, associativity, Data input/output. [8]
3. **Control Structure:** Introduction, Conditional Statements; Simple If-Else; Nested Statements, switch, Loops- For, While, Do-While; Break, Continue, Go-To Statements, Labels, Printf, Scanf function. [7]
4. **Array:** Defining an array, processing an array, passing arrays to functions, Multidimensional arrays, Arrays and strings. [6]
5. **Function and Pointer:** A brief overview, Defining a function, accessing a function, function prototypes, passing arguments to a function, recursion. Pointers: Declaration, operations on pointers, array of pointers, pointers to arrays. [7]
6. **Advance C Concepts:** Structure, Union, storage classes in C, Concept of files file access in different modes, reading from and writing into a file, Library Functions. [6]

Text Books:

1. Kernighan, Brain W. and Ritchie, Dennis M., "The C Programming Language," Second edition 2013, Pearson Education.
2. Gottfried ,Byron S. and Schaum's, "Programming with C," 2nd Edition, Tata McGraw-Hill, 2006.

Reference Books:

1 Schildt ,Herbert, "C: The Complete Reference," Fourth edition, McGraw- Hill Education, 2000.

2 Kanetkar ,Yashwant, "Let us C," Fifth Edition BPB Publication,2006.

3 Balagurusamy , E, "Programming in ANSI C," Tata McGraw-Hill Education.

CA 16. 104 **Data Structures** **3-0-0-3**

Total Lectures: 40

1. **Introduction**: Overview of data structure, types of data structures and operations. Applications of data structures [2]

2. **Pointer and dynamic memory allocation:** Pointer declaration and initialization, accessing a variable through its pointer, meaning and advantages of dynamic memory allocation, Memory allocation functions. [3]

3. **Array:** Representation of single and multidimensional array. [2]

4. **Sorting and Searching Techniques:** Insertion Sort, Selection Sort, Merge Sort, quick sort, Linear Search, Binary Search [8]

5. **Stack :** Definition and representation of stack, operations on stack, Infix, Postfix, Prefix Expressions, Conversion from Infix to Postfix (Algorithms only). [7]

6. **Queue**: Introduction and types of queues, Primitive Operations on Queues. [7]

7. **Linked List:** Introduction to Linked List, implementation of Linked List, operations on linked list: creation, deletion, search and display [7]

8. **Tree:** Introduction and Terminology, Traversal of Binary Trees [4]

Text Books:

1. Schaum Series, "Data Structures", TMH, New Delhi.

Reference Books:

1 Langsam , Augenstein and Tannenbaum, "Data Structure Using C and C++", PHI, New Delhi.
2 Horowithz and Sahani, "Fundamentals of Data Structure", Galgotia Book Source Pvt. Ltd. , New Delhi.
3 Kanitker Y., "Let us C", BPB Publication New Delhi.
4 Balagurusamy, E , "Programming in C", TMH, New Delhi.

CA 16.105 **Management Accounting** **2-0-0-2**

Total Lectures: 26

1. **Basics of Accounting:** Nature of accounting information, accounting principles – concepts and conventions, accounting equation and financial statements – sole trade, corporate entities (P&L account, balance sheet including adjustments). [6]
2. **Computerized Accounting:** Uses of Microsoft Excel in accounting, analyses of balance sheet with Excel, Tally software - application. [2]
3. **Analysis and Interpretation of Financial Statements:** Ratio analysis as a tool of decision-making; fund flow statement, cash flow statement. [5]
4. **Basic Cost Concepts:** Meaning, nature, classification; inventory valuation, marginal costing and its usage in managerial decision-making. [7]
5. **Long Term Financing and Capital Budgeting:** Sources of long term finance- shares, debentures, capital budgeting – types of projects, non-discounted and discounted cash flow techniques – payback period, internal rate of return and net present value method. [6]

Text Books:

1. Maheshwari S.N., Management Accounting & Financial Control, Sultan Chand & Sons, 14th Ed., 2003
2. Bodhanwala R. J., Understanding and Analyzing Balance Sheets Using Excel Worksheet, Prentice-Hall of India, 2004.

Reference Books:

1. Horngren C. T., Sundem G.L. and Stratton W. O., Management Accounting, Prentice-Hall of India, 12th Ed., 2003.
2. Narayan S. R., Financial Accounting- A Managerial Perspective, Prentice-Hall of India, 2004.
3. Banerjee A., Financial Accounting – A Managerial Emphasis, Excel Publishing House, 2004.

CA 16.106 **System Analysis and Design** **3-0-0-3**

Total Lectures: 40

1. **Introduction to system:** Definition, characteristics and elements of system, types of system, System development life cycle, Role of system analyst. [6]

2. **System Planning and Initial Investigation**: Introduction, bases for planning in system analysis, initial investigation, fact finding, information gathering, information gathering tools, fact analysis, determination of feasibility. [6]

3. **Structured Analysis:** Tools of structured analysis: DFD, data dictionary, flow charts, Gantt charts, decision tree, decision table, structured English, pros and cons of each tool. [7]

4. **Feasibility Study**: Objective, types, Steps in feasibility analysis, feasibility report, oral presentation, cost and benefit analysis, classification of costs and benefits. [5]

5. **System Design**: Objective, logical and physical design, design methodologies, structured design, form-driven methodology (IPO charts), structured walkthrough. [6]

6. **Input/ Output and Form Design**: Objectives of input and output design, form design, classifications of forms, requirements of form design. [5]

7. **System Testing and Implementation**: Objectives of testing, test plan, testing techniques/types of system tests, quality assurance goals in system life cycle, System implementation. [5]

Text Books:

1. Awad Elias M, "System Analysis and Design", Galgotia Pub.(P) Ltd.,2nd Edition,2008

Reference Books:

1 Hawayszkiewyez Igor, "Introduction To System Analysis and Design" PHI, New Delhi

2 Mark Lejk and Deeks David , "An Introduction to System Analysis Techniques" PHI, New Delhi.

3 Whitten , Jeffrey L and Lonnie, D Bentey, "System Analysis and Design Methods", TMH. New Delhi

CA 16. 107 **Mathematics** **3-1-0-4**

Total Lectures: 40

1. **Matrix and Determinant:** Definition, types of matrices, addition, subtraction, scalar multiplication and multiplication of matrices, adjoint, inverse, rank of matrix, dependence of vectors, Eigen values and vectors of a matrix, Cayley-Hamilton Theorem (without proof), solution of system of simultaneous equations, definition of determinant, minors, cofactors, properties of determinants. [12]
2. **Differentiation:** : Limit at a point, properties of Limit, computation of limits of various types of functions, continuity at a point, derivative, derivatives of sum, differences, product and quotients, chain rule, derivatives of composite functions, logarithmic differentiation, maxima and minima of functions of single variable. [12]
3. **Integration:** Indefinite integrals, methods of integration substitution, by parts, partial fractions, integration of algebraic and transcedental functions, definite integrals and properties. [8]
4. **Ordinary Differential Equations:** Definition, order and degree of equation, solution of ordinary differential equations of first order and first degree, equations in which variables are separable, homogeneous and reducible to homogeneous equations, linear and reducible to liner equations, exact and reducible to exact equations.. [8]

Text Books:

1. Narayan, Shanti “Integral Calculus”, S. Chand & Company, 19993.

2 Dass, H.K., “Advanced Engineering Mathematics”, S. Chand & Company.

Reference Books:

1 Zill, Dennis G. ,Warren Jones, S. ,Wright and Barlett Learning “Advanced Engineering Mathematics”, Student Edition, Canada,2011

2 Ramana B. V., “Higher Engineering Mathematics”, McGraw Hill, New Delhi,2006.

CA 16. 108 **Digital Electronics** **3-1-0-4**

Total Lectures: 40

1. **Number System:** Binary, octal, Hexadecimal Number, their addition and substraction, Base conversions, Number code: 8421, Other BCD codes, Grey, ASCII, EBCDIC. Boolean Algebra: Laws and theorems of Boolean algebra. De Morgan's theorem, XOR and XNOR gates, Half and Full Adder and Subtractor circuits. [10]
2. **Fundamentals**: Products, Sum of products and Product of sums, Form of Boolean expressions, Truth Tables and Karnaugh maps, pair reads octets and Karnaugh simplification. Mltiplexers BCD to Decimal to BCD decoders and, decoders' characteristics of digital integrated digitals. [10]
3. **Flip Flop:** RS Flip Flop, Clocked, RS Flip Flop, Edge trigger D Flip Flop. Flip Flop Switching time, OK Flip Flop. JK Master Slave Flip Flop, Clock wave forms, Shift registers: Serial in and serial out, Parallel in and parallel out, Counters: Asynchronous counters Synchronous counters, ring counter. [10]
4. **Memories for Digital:** System: Semiconductor Memories, Memory organization and expansion, classification of memories on' the basis of principles of operation, physical characteristics and fabrication technology, ROM and basic memory cells. [10]

Text Books:

1. Moris Mano, "Digital Logic and Computer Design", PHI Publications, 2002
2. R. P. Jain, "Modern Digital Electronics", TMH, 3rd Edition, 2003.

Reference Books:

1. R.L. Tokheim, "Digital Electronics, Principles and Applications", Tata McGraw Hill, 1999.
2. W. Gothman, "Digital electronics", PHI.
3. S. Salivahanan & S. Arivyhgan. "Digital circuits and design", Vikas Publication, 2001

Testing:

- MS Word

Programs:

- Working with Documents.
- Formatting Documents.
- Setting Page style.
- Creating Tables.
- Drawing.
- Tools.
- Printing Documents.

Testing:

- MS Excel

Programs:

- Spread Sheet & its Applications, Opening Spreadsheet, Menus.
- Entering & Deleting Data.
- Setting Formula.
- Formatting Spreadsheets.
- Working with sheets.
- Creating Charts.
- Using Tools.

Testing:

- MS Access

Programs:

- Starting Access, Access Screen, Creating a New Database.
- Creating Tables.
- Working with Forms.
- Creating queries.
- Finding Information in Databases.
- Creating Reports.
- Types of Reports.
- Printing & Print Preview – Importing data from other databases viz. MS Excel etc.

Testing:

- MS Power Point

Programs:

- Creating a presentation.
- Formatting a Presentation.
- Adding Effects to the Presentation.
- Printing Handouts.

Testing:

- One Dimensional Array
- Two Dimensional Array

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of Linked List
- Operations on Linked list

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of stack using array and Link List.
- Operations on stack.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of Queue using array
- Operations on queue.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Searching
- Sorting

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

CA 16.135 **C Programming Laboratory** **0-0-4-2**

1. Introduction to C
Testing:
• Data Types & Operators
• Type Conversions

Programs:
• Significant number of programmes in order to cover all contents of unit 1 (at least 6)

2. Operators
Testing:
• Arithmetic, Relational, logical operators
• Bitwise, unary, assignment operators
• Increment and Decrement operators
• Conditional operators
Programs:
• Significant number of programmes in order to cover all contents of unit 2 (at least 10)

3. Control Structure
Testing:
• If-Else statements
• Nested If-Else statements
• Switch
• Loops- For, While, Do-While
• Break, Continue, Go-To Statements, Labels
Programs:
• Minimum 12 programmes to cover all contents of unit 3

4. Array
Testing:
- Processing an array
- Passing arrays to functions
- Multidimensional arrays
- Strings

Programs:
• Minimum 6 programmes to cover all contents of unit 4

5. Function and Pointer
Testing:
- Function prototypes and passing arguments to a function
- Recursion
- Pointers declaration, operations on pointers
- Array of pointers, pointers to arrays

Programs:
• Minimum 6 programmes to cover all contents of unit 5

6. Advance C Concepts

Testing:

- Structure
- Union
- Storage classes in C
- Reading and writing from/to a file

Programs:

• Minimum 6 programmes to cover all contents of unit 6.

1. Process and Thread Creation

Testing

- Creation of Process and Thread
- Operations with Process

Programs

- A process to be created with structure or class containing parameters like process- id, arrival time, starting time, end time etc.

2. CPU Scheduling Algorithms

Testing

- Average Waiting Time
- Average Turnaround Time
- Response Time
- Multithreading

Program

- FCFS (with and without arrival time)
- SJF (Preemptive and non-preemptive)
- Round Robin (with and without context switch time)
- Priority scheduling (With and without arrival time)
- Demonstrating time sharing

3. Memory Management Techniques

Testing

- External Fragmentation
- 50% Rule for Fragmentation

Program

- First Fit
- Best Fit
- Worst Fit.

4. Page Replacement Algorithms

Testing

- Belady's Anomaly
- No. of page hits and misses

Program

- FIFO
- LRU
- Optimal Page Replacement Algorithm

5. Deadlock

Testing

- Safety algorithm
- Request algorithm

Program

- Deadlock Avoidance (Banker's Algorithm) for multiple instances of different resource types.
- Deadlock Detection Algorithm for multiple instances of different resource types.

6. I/O

Testing

- Disk Scheduling

Programs

- FCFS algorithm
- Scan algorithm
- C-Scan algorithm

CA 16. 201 **Computer Architecture** **3-1-0-4**

Total Lectures: 40

1. **Design of Simple Computer**: Micro Operation, Macro Operation, Bus and Memory Transfers, Arithmetic and Logic Micro Operations, Shift Micro Operation, Instruction and Instruction Types. [8]
2. **Instruction Cycle**: Timing and Control Instruction Cycle, Memory Reference Instructions, Input Output and Interrupts, Machine Language Instructions. [5]
3. **Computer Arithmetic**: Hardware algorithm and implementation for Addition, Subtraction, multiplication and division operations, floating point arithmetic operations. [6]
4. **Central Processing Unit**: General Register Organization, Stack Organization, Addressing Modes, Risc vs Cisc Pipeline and Vector Processing, Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Risc Pipeline, Pipeline Difficulties. [8]
5. **Input Output Organization**: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Programmed I/O, Interrupt I/O Direct Memory Access. [5]
6. **Memory Organization**: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative, Cache Memory, Virtual Memory and Memory Management Hardware. [8]

Text Books:

1. Mano Morris, M., "Computer System Architecture", 3rd edition, Pearson.
2. Stallings William , "Computer Organization and Architecture", 9th Edition, Pearson

Reference Books:

1. Hwang Kai and Jotwani ,Naresh, "Advanced Computer Architecture", 2nd Edition, Tata McGraw Hill.
2.Blanchet ,Gérard, Dupouy, Bertrand, "Computer Architecture", 1st Edition, Wiley Publication.

CA 16.203 **Database Management System** **3-0-0-3**

Total Lectures:40

1. **Introduction**: An Overview of Database Management System, Comparison of Database System and File System, Characteristics of Database Approach, DBMS Architecture, Data Models, Schema and Instances, Data Independence. Data Modeling Using Entity Relationship Model: Entity, Entity Types, Entity Set, Notation for ER Diagram, Attributes and Keys, Concepts of Composite, Derived and Multivalued Attributes, Super Key, Candidate Key, Primary Key, Relationships, Relation Types, Weak Entities, Inheritance, Specialization and Generalization. [10]

2. **Relational Data Model:** Relational Model Terminology: Domains, Attributes, Tuples, Relations, Characteristics of Relations, Relational Constraints: Domain Constraints, Key Constraints, Relational Database Schema, Relational Database Design By ER To Relational Mapping. Introduction to SQL. [11]

3. **Normalization:** Functional Dependencies, Armstrong's Inference Rule, Normal Form up to Boyce Codd Normal Form. [4]

4 **Relational Algebra:** Selection, Projection, Set Theoretic Operations Union, Intersection, Set Difference And Division, Inner, Outer, Left Outer, Right Outer and Full Outer Join. [8]

5. **Transaction Processing And Concurrency Control:** Definition of Transaction, Desirable ACID Properties, Serializable And Non Serializable Transactions, Concurrency, Lost Update, Dirty Read, Concurrency Control Techniques: Locking, 2PL [7]

Text Books:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, 7th Edition, 2015.

Reference Book:

1. Jeffrey A. Hoffer, Mary B. Prescott and Fred R. McFadden, "Modern Database Management", Prentice Hall, 8th Edition, 2006.

2. Avi Silberschatz , Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2011.

CA 16. 204 **Computer Networks** **3-1-0-4**

Total Lectures:40

1	**Introduction:** Computer networks; Network topologies, protocols and standards, Network devices: repeaters, bridges, gateway, Routers; categories of networks- LAN, WAN and MAN.	[7]
2	**OSI and TCP/IP Model:** Layers and their function, OSI reference model, TCP/IP model, Comparison of models.	[5]
3	**Physical layer:** Transmission Media: guided and unguided; Attenuation, Distortion, Noise, Propagation, Switching, ISDN & its service, Multiplexing: Time division & frequency division multiplexing	[8]
4	**Data Link Layer:** Functionality, Design Issue, Error Detection & Correction Codes, MAC, Static & Dynamic Channel Allocation, Introduction to IEEE standards.	[6]
5	**Network Layer:** Routing Algorithms, Flooding, Broadcast & Multicast routing, congestion Control & internetworking, Quality of services	[7]
6.	**Application Layer :** Network Security & Privacy, Data Compression & Cryptography, Electronic Mail, The WWW, Multimedia, Audio, Video, DNS, FTP, HTTP, SMTP, telnet etc.	[7]

Text Book

1. Tanenbaum A. S., "Computer Networks", Prentice-Hall of India, 4th Ed., 2002.
2. Stallings W., "Data and Computer Communications", Prentice-Hall of India, 5th Ed., 2003.

References Books

1. Forouzan B. A., "Data Communications and Networking", Tata McGraw-Hill, 3rd Ed., 2004.
2. Hayes J. F., "Modeling and Analysis of Computer Communication Networks", Khanna Publishers, 1987.

CA 16. 205 **Management Information System** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Elements, characteristics, objectives and importance, relationship between MIS and Computer, role of MIS in the functions of management. [7]

2. **Information Concept:** Classification of information, levels of information, techniques of data collection, quality aspect of information, value of Information. [7]

3. **Decision Making:** Decision making concepts, rationality in decision making, decision support system, MIS as a technique for programmed decisions, structured Vs Un-structured decisions, formal vs. informal systems, model of decision making, methods, MIS and role of decision making. [8]

4. **Manager and Computers:** Database concept, database models, database design, RDBMS, MIS and RDBMS, network topology, LAN, MAN, WAN and data communication. [6]

5. **Development of MIS:** Strategic and project planning for MIS, conceptual system design, detailed design, implementation, evaluation and maintenance of the MIS, pitfalls of MIS. [6]

6. **Applications of MIS:** MIS for marketing, financial, production management, human resource management. [6]

Text Books:

1. Jawadekar,W. S. "Management Information System", Tata McGraw- Hill Publishing Co. Ltd., New Delhi

Reference Books:

1 Murdick, R, G, Ross J E and Clagget, J,R, "Information Systems for Modern Management", PHI, New Delhi

2 Sadagopan, "Management Information System", PHI, New Delhi.

3 Parker, Case Thomas, "Management Information System: Strategies and Action", Tata McGraw- Hill Publishing Co. Ltd., New Delhi

CA 16. 206 **Computer Graphics** **3-1-0-4**

Total Lectures:40

1	**Basic Concepts:** Application Areas of Computer Graphics, Graphical User Interface, RGB Color model, CMY color models, Advantages of Computer Graphics.	[8]
2	**Graphics Hardware:** Random Scan Displays, Raster Scan Display (with Introduction to Flickering, Interlacing, American Standard Video), Color CRT Monitors, Flat Panel Display (Plasma Panel, Liquid Crystal Display, Electroluminescent Display).	[7]
3	**Raster Graphics Algorithms:** Line Drawing Algorithms-DDA, Bresenham's Algorithm, Circle and Ellipse Drawing Algorithms, Filling (Scan-Converting Polygon Filling, Inside Outside Tests Boundary Fill and Area Fill Algorithm). Cohen- Sutherland Algorithm of clipping	[12]
4	**Transformations:** 2-D Transformations (Rotation, Reflection, Shearing, Scaling), Homogeneous Coordinate Representation, and Translation.	[8]
5	**Animation Introduction:** Conventional and Computer-Assisted Animation, Animation languages, methods of controlling Animation, basic rules of Animation.	[5]

Text Books:

1. Zhigang X. and Plastock R.A., “Theory and Problems of Computer Graphics (Schaum's Outline)”, Tata Mc Graw Hill, New Delhi.

Reference Books:

1 Hearn Donald D. and Baker M.Pauline, “Computer Graphics” , Prentice Hall India, New Delhi.

2 Krishnamurthy N, “Introduction to Computer Graphics”, Tata Mc Graw Hill Edition, New Delhi.

CA 16. 207 **C++ Programming** **3-0-0-3**

Total Lectures:40

1. **Object Oriented Programming:** Basic concepts of object–oriented programming, Structured versus object- oriented programming, merits and demerits of object oriented methodology. [5]

2. **Beginning with C++:** Preprocessor directives, Variables, data types, constants, operators, scope resolution operator, memory management operators, decision and loop control structures, arrays, strings, functions. [7]

3. **Classes and Objects:** Class definition, Structure versus class, accessing member functions within a class, data hiding, arrays within a class, static data and member functions, objects, friend functions and friend classes, constant member functions, pointers to members, constructors and destructor. [8]

4. **Overloading and Exception Handling:** Definition, unary operator overloading, binary operators overloading, overloading of new and delete operators, manipulation of string using operators, type conversion, overloading with friend functions, function overloading, error and exception handling. [8]

5. **Inheritance and Overriding:** Derived and base classes, type of inheritance, derived class constructors and destructor, overriding member functions, public and private inheritance, virtual base classes, abstract classes, this pointer, virtual functions and pure virtual functions, static and dynamic bindings. [8]

6. **Introduction of I/O Streams and the Standard Library:** Header files, I/O stream library, stream I/O for objects, file I/O. [4]

Text Books:

1. Lafore Robert, "Object-Oriented Programming in C++", 4th edition, SAMS.
2. Balagurusamy E., "Object Oriented Programming With C++", 6th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Reference Books:

1 Stroustrup Bjarne,"Programming -Principles and Practice Using C++", Addison-Wesley.

2 Schildt Herbert, "C++: The Complete Reference", 4th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

CA 16. 208 **Electronic Commerce** **3-0-0-3**

Total Lectures:40

1. **Electronic Commerce**: Overview and Scope, Traditional Commerce vs. Electronic Commerce, Impact of E-Commerce, Electronic Markets, Internet Commerce, e-commerce in perspective, Application of E Commerce in Direct Marketing and Selling, advantages and disadvantages, and future of E-commerce. [9]

2. **Business strategy in an Electronic Age:** Value Chains, Supply chain, Porter's value chain Model, Inter Organizational value chains, Strategic Business unit chains and industry value chains. [7]

3. **Business to Business E-Commerce**: Inter-organizational Transitions, Credit Transaction Trade Cycle, a variety of transactions. Electronic Data Interchange (EDI): Introduction, Benefits of EDI, EDI Technology, EDI standards, EDI Communication, EDI Implementation, EDI agreement, EDI security. [9]

4. **Electronic Payment System:** Introduction, Online Payment System, Prepaid Electronic Payment System, Post Paid Electronic System, E-Cheques, Credit Cards, Smart Cards, E-Purses, Debit Cards, Legal Risk of E-Payment System. [8]

5. **Securing Network Transaction:** Security Policy, Procedures and Practices, Transaction Security, Cryptography Algorithm, Public Key Algorithm, Authentication Protocol, Digital Signature, E-Mail Security. [7]

Text Books:

1. Whitely David, "E-commerce Strategy, Technology and application", Tata McGraw Hill Publications, New Delhi.

Reference Books:

1 Kalakota ,R. and Whinston, A. B. "Readings in Electronic Commerce", Addison Wesley.
2 Schneider, Gary P. and Perry ,Jame, "Electronic Commerce" Thomson Publication.
3 P.T. Joseph, S.J., "E-Commerce An Indian Perspective", PHI.

CA 16. 209 **Discrete Mathematics** **3-1-0-4**

Total Lectures:40

1. **Progressions:** Arithmetic Progression, Arithmetic mean, Harmonic Progression Harmonic mean, Geometric Progression, Geometric mean. [6]

2. **Set Theory:** Definition of Sets, Subsets, Cardinality of Sets, types of sets: Equal Sets, Universal Sets, Finite and Infinite Sets, proper set, power sets, Operations on Sets: Union, Intersection, Complement of Sets, set difference, Cartesian Product, Venn Diagrams, and Algebra of sets, duality, counting principle. [10]

3. **Relations and Functions:** Definition, types of relation, Ordered Pairs, properties of relation, equivalence relations, partial ordering relation. Function: Domain and Range, Onto, Into, and One to One Function, Composite and Inverse Functions. [8]

4. **Prepositional Calculus:** Propositions, Logical Connectives: conjunction, disjunction and negation, Truth Tables, Tautologies and Contradictions, Conditional and Bi-conditional statements. [8]

5. **Group Theory:** Definition of a group, properties of group, different types of group, subgroup, finite, infinitely, countable and Cyclic Groups. [8]

Text Books:

1. Lipschutz, Seymour and Lipson, Mar c “Discrete mathematics”, Tata Mc Graw-Hill Publications, Second Edition.

Reference Books:

1 Rremblay, J.P. and Manohar, R., “Discrete Mathematical Structures with Applications to Computer Science”, The McGraw Hill Companies.
2 Ross, Kolman Busby, “Discrete Matheamatical Structures”, Prentice Hall International.
3 Vasishtha, A. R., “Abstract Algebra” , KRISHNA Prakashan Media (P) Ltd.

CA 16. 210 **Java Programming** **3-1-0-4**

Total Lecture:40

1. **Basic Concepts:** Importance of Java, Java Byte code, Java and HTML, the Java buzzwords, using blocks of code, lexical issues, Java Class Libraries. [4]
2. **Java Programming:** Constants, Variables, Data Types, Operators, Type Conversion in Expression, Mathematical Functions, Decision Control Structure, Loop Control Structure, Arrays. [8]
3. **Classes:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, the this keyword, garbage collection, the finalize () method, overloading methods, using objects as parameters, returning objects, recursion, introducing access control, understanding static, introducing final, arrays revisited, introducing nested and inner classes, exploring the string class, using command-line arguments, Vector, Wrapper Classes. [5]
4. **I/O and String Handling:** I/O basics, reading console input, writing console output, the PrintWriter class, reading and writing files, string constructors, string length, special string operations, character extraction, string comparison, searching strings, modifying a string, data conversion using valueOf (), changing the case of characters within a string, StringBuffer. [6]
5. **Inheritance:** Inheritance basics, using super, create a multilevel hierarchy, constructors, method overriding, dynamic method dispatch, abstract classes, final with inheritance, object class. [5]
6. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, creating your own exception subclasses, using exceptions. [7]
7. **Applet Programming:** Applet life cycle, Creating executable application, Designing a web page, Applet Tag, Parameter passing in applets, Graphic Class, lines, rectangles, circle and ellipse, polygons. [5]

Text Books

1. Herbertz Shildt ,"Java The Complete Reference,", 7th ed.,TMH, New Delhi
2. Balagurusamy E, "Programming With Java " , TMH, New Delhi

Reference Books

1. Borror A. B., "Object-Oriented Programming with Java-an ultimate Tutorial", Dreamtech Press, 2000.
2. Budd T., "Understanding Object-Oriented Programming with Java", Pearson Education Asia, 2001.
3. Arnold K., Gosling J. and Holmes D., "The Java Programming Language", Addision-Wesley, 3rd ed., 2000.

CA 16.233 Database Management System Laboratory 0-0-4-2

Unit 1: Basic Commands

Testing: Create Table, Insert, Update, Alter, Delete, Where

Queries based on the above elements.

Unit 2: SQL Scalar functions

Testing: UCASE, LCASE, MID, LEN, NOW

Queries based on the above elements.

Unit 3: Aggregate functions

Testing: Max, Min, Sum, Count, Avg , First, Last

Queries based on the above elements.

Unit 4: Clauses

Testing: Distinct, Alias, Order by, Group by, Having

Queries based on the above elements.

Unit 5: Logical Operators

Testing:

OR, AND, Not, Between, Like, All, Any

Queries based on the above elements.

Unit 6: SQL Constraints

Testing: Not NULL, Check, Primary Key, Foreign Key, Cascade delete, Default

Queries based on the above elements.

CA 16. 234 **Internet Laboratory** **0-0-4-2**

UNIT I: Evaluate e-mail software and Web-based e-mail services

Testing: Mail configuration on different mail sites

Programs:

- Main features of e-mail and how it works
- Describe the Thunderbird and Opera e-mail clients
- Describe and use Web-based e-mail services
- Configure and use Outlook Express to send, receive, and print e-mail messages
- Create and maintain an address book in Outlook Express
- Configure and use Hotmail to send, receive, and print e-mail messages
- Create and maintain an address book in Hotmail

UNIT II: Use search engines and directories effectively

Testing: Web search tools **(**google, Google Scholar, DuckDuckGo**,** Metasearch engines**)**

Programs:

- Determine whether a research question is specific or exploratory
- How to formulate an effective Web search strategy to answer research questions
- Uses of Web search engines, Web directories, and Web meta search engines effectively
- Use Boolean logic and filtering techniques to improve your Web searches
- Use advanced search options in Web search engines
- Assess the validity and quality of Web research resources
- Describe the future of Web search tools

UNIT III: Use FTP and other services to transfer and store data

Testing: File Transfer Protocol

Programs:

- Describe what FTP is and how it works
- Demonstrate how to use an FTP client program and Web browser to transfer files
- Demonstrate navigation of an FTP site using a Web browser
- Demonstrate how to compress and decompress files and how to check them for viruses
- Download an FTP client program using a Web browser
- Install and use a compression program
- Trace the connection between your computer and a remote computer

UNIT IV: Important features of electronic commerce

Testing: E-Business

Programs:

- Important sites that conduct electronic commerce
- Basics of electronic commerce
- How companies generate revenues online
- Companies reduce costs and improve operational efficiency using Internet technologies
- New ways of doing business on the Web such as online auctions etc.
- International, legal, and ethical concerns for electronic commerce

CA 16. 235 **C++ Programming Laboratory** **0-0-4-2**

1. Introduction to C++
Testing:
• Data Types & Operators
• Control Statements
• Arrays
Programs:
• Significant number of programmes in order to cover all contents of unit 1 (at least 6)

2. Classes and Object
Testing:
• Class with function printing hello
• Class with default constructor
• Class with parameterized constructor
• Destructor
• Static and constant data
Programs:
• Apt number of programmes preferably based upon real life examples hotel billing, fee submission etc. (at least 6)

3. Inheritance and Polymorphism
Testing:
• Inheritance
• Function Overloading
• Operator overloading
• Overriding
• Comparisons between private, public and protected
• Virtual function and virtual class
• This pointer
• Exception handling
• Abstract class
Programs:
• Minimum 12 programmes to cover all contents of unit 3

4. I/O handling
Testing:
• Reading and writing from/to a file
• Output formatting
Programs:
• Programmes related with basic file operations (at least 5)

CA 16.236 Java Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types & Operators
- Control Statements
- Arrays

Programs

- Apply logic to print different patterns(at least 3)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- Implementing matrix operations
- Searching and Sorting

2. Classes, Object & Inheritance

Testing

- Objects and reference variables
- Constructors and parameterized constructors
- this, static, command line arguments
- Inheritance, overloading and overriding
- super, abstract classes and Dynamic method dispatch

Programs

- Write a program to illustrate super .
- Show method overloading to calculate the area of different shapes.
- Manipulate the above program to illustrate run time polymorphism.

3. I/O and String Handling

Testing

- Reading console input and writing console output
- BufferedReader class and PrintWriter class
- String operations and comparisons

Program

- Write a program to print the last characters of all the strings given from command line
- Change the case of characters within a string.
- Write an applet to print "HELLO"**.**

4. Package, Interfaces and Exception Handling

Testing

- importing packages
- interfaces and multiple inheritance
- exception-handling fundamentals
- built-in exceptions and creating one's own exception subclasses

Programs

- Write and execute a program which is inside a package "MyPacK".
- Write a program which imports a package.
- Write a program in which implements the concept of multiple inheritance.
- Write a program that handles two Exceptions, each at different run.

- Write a program in which an user defined exception is created.

5. Applet

Testing

- Applet Life Cycle
- Applet tag

Programs

- Write an applet to print “HELLO”**.**
- Write an applet to print different shapes.
- Write an applet to which works according to values passed through html page.

CA 16.301 **Web Technology** **3-0-0-3**

Total Lectures: 40

1. **Introduction:** Clients, Servers, and Communication, The Internet Basic Internet Protocols, The World Wide Web, HTTP request message, response message, Web Clients Web Servers. [5]

2. **HTML:** HTML Document, Markup Tags (HTML, HEAD, TITLE, BODY, PRE, LIST, HR, BR), Formatting Tags (MARQUEE, BOLD, ITALICS, SUBSCRIPT), Linking, URL, Relative Path Vs Absolute Path names, Images, Tables, Frames, Form Elements (Text, Buttons, List, Reset, Submit, Radio buttons, Checkbox); DHTML: Cascading Style sheets, Dragging, Dropping, Layers, Div tag. [8]

3. **JavaScript:** Declaration and Expressions, Control Structure and Functions, Variable scope Global Vs Local, Object in Java Script: Properties and Methods, Array Object, Date Object, Math Object, String Object, Events in java Script: Onblur, Onclick, on change, on focus, Design of Interactive forms; [9]

4. **VBScript:** Fundamentals, Variables, String, Constant, Date and Time, Arrays, control Structure, Design making, looping, Sub procedure, Object Methods and events, data validation. [7]

5. **XML:** Overview, Comparison of XML and html, components of XML, XML document, XML declaration, Root element, An empty element, attributes, Markup Delimiters, Element Mark Up, Attribute Mark Up, Naming Rules, Character References, Predefined Entities, Entity References, Cdata Sections, Processing Instructions, Document Type Declaration, Welformed and Valid Document, DTD and Validation, Internal DTD Subset, External DTD, Developing DTD, Elements and Attributes Of DTDs:- Empty Element, Only Element, Mixed Elements, Any Element, Creating a valid document from a DTD. [11]

Text Books:

1. Young M .L, " Internet Millenum Edition" TMH, New Delhi.
2. Jackson Jeffrey C., "Web Technologies -A Computer Science Perspective", Pearson Education, 2006.

Suggested Reading

1. Noel Jerkr, " Techunedia VB Scraper VB Script Interleave course", New Delhi 1998
2. Marlin Webb, "Java Scraper, Instant JavaScript", Tata McGraw-Hill, New Delhi.
3. Eathier Kay and Houser Alan **,** **"**XML programming in 2 ½ days," IDG Books India (P) Ltd

CA 16. 303 **Software Engineering** **3-0-0-3**

Total Lectures: 40

1. **Introduction:** Software Characteristics, Components and Applications, Software Engineering a layered Technology, Software life cycle models, Waterfall, Prototype, Evolutionary and Spiral Models. [8]

2. **Software Project Management:** Basic Concepts, Project Management: Core functions, support functions, Project Integration Management. [8]

3. **Software Project Planning:** Objectives, decomposition techniques: software sizing, problem based estimation, lines of code based estimation, and function point based estimation, process based estimation, Cost Estimation Models:- COCOMO, Risk Management. [8]

4. **Software Design:** Design Principles, Design Concepts:- abstraction, refinement, modularity, software architecture, structured partitioning, information hiding, effective Modular Design:- functional independence, cohesion and coupling, Object Oriented analysis and Design. [8]

5. **Software Testing:** Testing Fundamentals, Design of Test Cases, White box testing, Basis Path testing, Control structure Testing, Black box testing. [8]

Text Books:

1. Pressman R.S., "Software Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference Books:

1 Jalote Pankaj,"An Integrated Approach to Software Engineering", NAROSA.
2 Sommerville, Ian "Software Engineering", Pearson Education
3 Fairely, R.E., "Software Engineering Concepts", McGraw-Hill

CA 16. 304 **Multimedia Technology** **3-0-0-3**

Total Lectures: 40

1. **Overview** - Multimedia - Definitions, Basic properties, Temporal and non-temporal medium, Multimedia applications, Uses of Multimedia, Stages of multimedia project, requirements to make good multimedia, Multimedia skills and training.

[6]

2. **Multimedia-Hardware and Software**: Production Platforms, Hardware Peripherals, Connections, Memory and Storage devices, Media software tools, Multimedia Authoring tools, Production Standards.

[8]

3. **Multimedia building blocks**: Audio, basic sound concepts, music, speech, MIDI versus digital audio, audio file formats, sound for the web, images and graphics-basic concepts, Digital video production and editing techniques, animation-basic fundamentals, Kinematics, morphing , animation s/w tools and techniques, animation for the web.

[10]

4. **Data Compression:** Need of Compression techniques, Difference of lossless/lossy compression techniques. Storage space and coding requirements, classification of coding, compression techniques-JPEG and MPEG.

[9]

5. **Multimedia and Internet:** HTML and web authoring, Multimedia considerations for Internet, Design considerations for web pages ,Web Browsers, Web page makers and editors, Media Communication, Media Consumption, Media games.

[7]

Text Book:

1. Steinmetz R., and Nahrstedt K., Multimedia - Computing, Communications and Applications, Pearson Education Asia, 2nd Ed., 2003.

References Books:

1. Buford J. F. K., Multimedia System, Addison-Wesley, 3rd Ed., 1994.
2. Vaughan T., Multimedia - Making it Work, Tata McGraw-Hill, 3rd Ed., 2002.

Testing:

Flash editor and toolbox.
Frames and key frame concepts
Color schemes

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using shape tween and motion tween.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

concept of layers
Understanding guide ,mask layer.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using symbols (movie clip, graphic and buttons) and library.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation of text morphing.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Flash editor and toolbox.
Frames and key frame concepts
Color schemes

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using shape tween and motion tween.

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Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation of text morphing.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Markup Tags
Formatting Tags
Frames
Form Elements

Programs:

Design web pages based on above Tags.
Design and formatting a form based on form elements

Testing:

Cascading Style sheets
Dragging
Dropping
Div tag.

Programs:

Based on above CSS formatting on HTML scripts.

Testing:

Java Script Declaration and Expressions
Control Structure and Functions
Java Script: Properties and Methods
Array Object
Date Object
Math Object
String Object
Events in java Script: Onblur, Onclick, on change, on focus.

Programs:

Form validation through JavaScript
Program for Event handling
Working with Date and Time Functions
Program for calculator

Testing:

VBScripts String
Date and Time
Arrays
Control Structure
Looping
Methods and events
Data validation

Programs:

Form validation through VBScript
Program for Event handling
Working with Date and Time Functions

Testing:

XML components
DTD
Creating a Valid Document from a DTD

Programs:

Basic XML Document
Access XML document elements through programs

CA 17. 208 **Electronic Commerce** **3-1-0-4**

Total Lectures:40

1. **Electronic Commerce**: Overview and Scope, Traditional Commerce vs. Electronic Commerce, Impact of E-Commerce, Electronic Markets, Internet Commerce, e-commerce in perspective, Application of E Commerce in Direct Marketing and Selling, advantages and disadvantages, and future of E-commerce. [7]

2. **Business strategy in an Electronic Age:** Value Chains, Supply chain, Porter's value chain Model, Inter Organizational value chains, Strategic Business unit chains and industry value chains. [6]

3. **Business to Business E-Commerce**: Inter-organizational Transitions, Credit Transaction Trade Cycle, a variety of transactions. Electronic Data Interchange (EDI): Introduction, Benefits of EDI, EDI Technology, EDI standards, EDI Communication, EDI Implementation, EDI agreement, EDI security. [7]

4. **Electronic Payment System:** Introduction, Online Payment System, Prepaid Electronic Payment System, Post Paid Electronic System, E-Cheques, Credit Cards, Smart Cards, E-Purses, Debit Cards, Legal Risk of E-Payment System. [8]

5. **Securing Network Transaction:** Security Policy, Procedures and Practices, Transaction Security, Cryptography Algorithm, Public Key Algorithm, Authentication Protocol, Digital Signature, E-Mail Security.

6. **Case Study:** Different case studies of E commerce [5]

CA 17. 362 **Knowledge Management** **3-1-0-4**

Total Lectures: 40

1. **Introduction:** Definition, Evolution, Types, Implication for Knowledge Management [6]

2. **Life Cycle:** Challenges, Difference, Knowledge management system Life Cycle, Comparative Studies Between SDLC and Knowledge Management System Development, Role of Knowledge Developer. [8]

3. **Knowledge Creation and Architecture:** Knowledge Codification, Need of Codification, and Knowledge Tools for Codification, Developer Skills Set. [9]

4. **Knowledge Transfer and Internet:** Internet and Knowledge, E-Business, Ethical and Legal Issues in Knowledge Management. [8]

5. **Executive Information and support Systems**: Business Expert System and AI, OLTO & OLAP; Data Warehousing; Data Marts, Data Warehouse architecture; Tools for data warehousing. [9]

Text Books:

1. Awad, Elias M., "Knowledge Management", TMH, New Delhi

Reference Books:

1 Inmon, W. H., "Building Data Warehousing", Wiley, New Delhi

2 Han, Jiawei, Kamber, Michelinal, "Data Mining Concepts & Techniques", Harcourt India, New Delhi

CA 17. 363 **System Software** **3-1-0-4**

Total Lectures: 40

1. **Overview:** Language processors, data structures for language processors, assemblers, macros and macro processors, compilers, interpreters, linkers and loaders. [5]

2. **Operating System:** Functions of Operating System, Kernel, Shell, Process, Process state diagram, System Calls. [5]

3. **Assemblers:** Design of an assembler ,one pass and two pass Assembler, Databases of Assemblers, table processing [7]

4. **Macro Processors:** Importance of Macro, Macro Definition, Macro call, Macro Expansion, Conditional Macro expansion, Nesting of Macros, Functions of Macro Processor . [8]

5. **Loaders and Linkers:** Function of Loaders, loader schemes - compile and go, general, absolute, subroutine linkages, relocating loaders, direct linking loaders, binders, linking loaders, overlays, dynamic binders. [9]

6. **Compilers :** Types of Compilers, Phases of compiler design, recursion, call and return statements. [6]

Text Books:

1. Donovan J.J., "Systems Programming", New York, Mc-Graw Hill, 1972.

Reference Books:

1 Leland L Beck,"System Software, An Introduction to System Programming", Pearson Education, 13th Indian Reprint, New Delhi, 2003.

2 Dhamdhere, D.M., "Introduction to Systems Software", Tata Mc-Graw Hill 1996.

CA 17. 364 **Artificial Intelligence** **3-1-0-4**

Total Lectures: 40

1. **Overview of A.I.:** Introduction to AI, Importance of AI, AI and its related field, AI techniques.

[4]

2. **Problem space and search**: Defining the problem as a state space search, Production system and its characteristics, Issues in the design of the search problem.

[5]

3. **Heuristic search techniques** : Generate and test, hill climbing, best first search technique, problem reduction, constraint satisfaction

[6]

4. **Game Playing** : Minimax , alpha-beta pruning.

[4]

5. **Predicate logic**: Definition, representation of simple facts in logic, well formed formula, resolution.

[8]

6. **Knowledge representation**: Definition and importance of knowledge, Knowledge representation, Various approaches used in knowledge representation, Issues in knowledge representation.

[8]

7. **Learning:** Introduction learning, Types of learning, Introduction to neural networks.

[5]

Text Book:

1. Rich Elaine and Knight Kevin , Artificial Intelligence, Tata McGraw – Hill, 3rd edition, 2012

Reference Books:

1. Russell Stuart and Norvig Peter, Artificial Intelligence: A Modern Approach, Prentice Hall; 3 edition,2009

2. Patterson D.W., "Introduction to AI and Expert Systems", PHI, 1999

CA 17.365 **Internet Technologies** **3-1-0-4**

Total Lectures: 40

1.	**Introduction:** Layering, TCP/IP Layering, Internet Addresses, The Domain Name System, Client Server Model, Port Numbers, Implementations and Application, Programming interfaces.	05
2.	The Link Layer Ethernet and IEEE 802 Encapsulation Trailer Encapsulation, **SLIP:** Serial Line IP, Compressed SLIP, **PPP**: Point-to-Point Protocol.	04
3.	**IP**: The Internet Protocol, IP Header, IP Routing, Subnet Addressing, Subnet Mask, Special Case IP Addresses.	06
4.	**Introduction to ARP**: Address Resolution Protocol and RARP: Reverse Address Resolution Protocol, ARP Packet Format, Proxy ARP, RARP Packet Format.	07
5.	**ICMP**: Internet Control Message Protocol Introduction, ICMP, Message Types, ICMP Address, Mask Request and Reply , IP Routing, Routing Principles, Introduction to Dynamic Routing; **UDP**: User Datagram Protocol UDP Header, UDP Checksum; **DNS**: The Domain Name System DNS Basics, DNS Message Format, security.	10
6.	**TCP**: Transmission Control Protocol TCP Services, TCP Header TCP Connection, Establishment and Termination, TCP Timeout and Retransmission, Repacketization; Telnet and Rlogin Remote Login Rlogin Protocol, SMTP Protocol; **FTP**: File Transfer Protocol and SMTP: Simple Mail Transfer Protocol.	08

Text Books:

1. Tannenbaum A. S., “Computer Networks”, Prentice-Hall India. New Delhi
2. Forouzan Behrouz A, “Data Communication and Networking”, TMH, New Delhi

Reference Books:

1 Sybex, “Networking Complete”, BPB Publication, New Delhi

2. Stallings Willam, “Data and Computer Communication”, Pearson Education, New Delhi

CA 17. 366 **Information Security** **3-1-0-4**

Total Lectures: 40

1.Introduction: Information, Characteristics of Information, Security Attacks, NSTISSC security model, Concepts of Policies; procedures; Guidelines and Standards. [8]

2.Cryptography: Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, Public key cryptography principles, public key cryptography algorithms, digital signatures, digital Certificates. [10]

3.IP Security: IP Security Overview, Architecture, Authentication Header, Encapsulation Security Payload, Combining Security Association, Key Management, Pretty Good Privacy, S/Mime and Types. [7]

4.Web Security and E-Commerce: Web Security Requirement, SSL and Transport Layer Security, Secure Electronic Transactions, Introduction to E-Commerce, Transactions on E-Commerce, Requirement of Security on E-Commerce. [7]

5. System Security: Recognized Security Threats, Virus, Trojan horse, Worm, Spyware, Adware, Key Logger, Denial of Services, Firewall Design Principles, Trusted Systems, Common criteria for information technology security and evaluation. [8]

Text Book:

1. William Stallings ,"Cryptography and Network Principles and Practice", Fourth Edition, , Pearson.

2. William Stallings, "Network Security Essentials (Applications and Standards)" Pearson.

Reference Books:

1. Forouzan, Mukhopadhyay ,"Cryptography & Network Security", , McGrawHill
2. Godbole "Information Systems Security", , Wiley-India
3. Shah Deven "Information Security Principles and Practice", , Wiley-India

CA 17.367 **Network Security** **3-1-0-4**

Total Lectures: 40

1 **Introduction:** Attacks, Services and Mechanisms, Security Attacks, Security Services, Integrity check, digital Signature, authentication, has algorithms. [3]

2 **Secret Key Cryptography:** Block Encryption, DES rounds, S-Boxes IDEA: Overview, comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB, CBC, OFB, CFB, Multiple encryptions DES. [8]

3 **Hash Functions and Message Digests:** Length of hash, uses, algorithms (MD2, MD4, MD5, SHS) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages. digest computation.) SHS: Overview, padding, stages. [7]

4 **Public key Cryptography:** Algorithms, examples, Modular arithmetic (addition, multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption. Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures [7]

5 **Authentication:** Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs offline guessing, storing. Cryptographic Authentication: passwords as keys, protocols, KDC's Certification Revocation, Interdomain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution, smart cards, biometrics. [6]

6 **Example System:** Kerberos: purpose, authentication, serer and ticket granting server, keys and tickets, use of AS and TGS, replicated servers. Kerberos V4: names, inter-realm authentication, Key version numbers. Kerberos V5: names, realms, delegation, forwarding and proxies, ticket lifetimes, revoking tickets, multiple Realms. [4]

7. **Network Security:** Electronic mail security, IP security, Network management security. Security for electronic commerce: SSL, SET. System Security: Intruders and Viruses, Firewalls, Intrusion Detection. [4]

Text Books:

1. Atul Kahate," Cryptography and Network Security", TMH, New Delhi

2. Kaufman, C., Perlman, R., and Speciner, M., "Network Security, Private Communication in a public world" , PHI.

Reference Books:

1 Stallings, W., "Cryptography and Network Security: Principles and Practice", Prentice Hall.

2. Stallings, W., "Network security Essentials: Applications and standards", Prentice Hall.

3. Behrouz A Forouzan, "Cryptography and Network Security"; McGraw Hill;.

CA 17. 368 **Cyber Law** **3-1-0-4**

Total Lectures:40

1. **Fundamentals of Cyber Law**: Jurisprudence of Cyber Law- Overview of Computer and Web Technology- Introduction to Indian Cyber Law- Overview of General Laws and Procedures in India; Freedom of Expression on the Internet. [10]

2. **E-commerce-Legal Issues:** Electronic Commerce –Digital Signature- Meaning; Creation of Digital Signature; Understanding how digital signatures work, Role in Information Technology; technical issues; legal issues; Crimes relating to digital signature certificates. [10]

3. **Cyber Crimes:** Meaning of Cyber Crimes –Cyber crimes under IPC, Cr.P.C and Indian Evidence Law - Cyber crimes under the Information Technology Act,2000 - Cyber crimes under International Law - Hacking Child Pornography, Cyber Stalking, Denial of service Attack, Virus Dissemination, Software Piracy, Internet Relay Chat (IRC) Crime, Credit Card Fraud, Net Extortion, Phishing etc - Cyber Terrorism - Violation of Privacy on Internet - Data Protection and Privacy ;Concept of Social Networking – Legal Implications of Social Networking [12]

4. **Intellectual Property Issues and Cyberspace : The Indian Perspective;** Overview of Intellectual Property related Legislation-Copyright law & Cyberspace; Trademark law & Cyberspace; Law relating to Semiconductor Layout & Design. [8]

Text Books:

1. Rodney D. Ryder, Guide to Cyber Laws, 2nd Edit, Wadhwa and Company, Nagpur
2. Sharma,Vakul. Information Technology law and Practice. Universal law Publishing,2011
3. Rattan, Jyoti. Cyber law. New Delhi: Bharat law House,2011.

Reference Books:

1 Seth,Kanika. Cyber Law in the Information Technology Act. Nagpur : Lexis Nexis Butterworth Wadhwa,2009
2. Rodney D.Ryder,Guide of Cyber Law,2nd Edition.
3. Faruq Ahmed,Cyber law in India.

CA 17. 369 **E-Business** **3-1-0-4**

Total Lectures:40

1. **Internet as a Business Driver:** Internet, WWW, Benefits of Internet and WWW, Difference between e-Commerce and e-Business, Mobile Internet, Internet Consumers. [8]
2. **Introduction to e-Business Trends:** Trends Driving e-Business, Customer Oriented Trends, e-Service Trends, Organizational Trends, Enterprise Technology Trends and General Technology Trends. [7]
3. **E-Business Models:** Disruptive Technology, e-Business Models, Internet Pricing, e-Cash, Online Retailing, Constructing e-Business ICT Framework. [10]
4. **Leveraging the Web for Marketing:** Business Enhancement, Framework for Web Marketing, Web Usability, Content Management, and Impact of Internet on Marketing. [9]
5. **Online Resources and Deployment:** Meta Search Engines, Boolean Searching on Internet, Best Practice Web Searching, The Invisible Web, [6]

Text Books:

1.Ravi Kalakota, Marcia Robinsion, "E-Business 2.0: Roadmap For Success", 2nd Edition, Pearson.
2.Paul Phillips, "E-Business Strategy", 1st edition, TMH.

Reference Books:

1.Colin Combe, "Introduction to e-Business", 1st Edition, Routledge
2.Azhar Kozami**, "**Business Policy and Strategic Management", 2nd Edition, Tata McGraw Hill.

CA 17. 373 **Software and CASE Tools** **3-1-0-4**

Total Lectures: 40

1. **Software Engineering Fundamentals :** Definition of software product and process, Software Characteristics, Components, Applications, Layered Technologies, Processes and Product, Methods and Tools, Generic View of Software Engineering, Software Crisis and Software development paradigms, [5]

2. **Software Requirements Analysis & Specification:** System specification, Software requirements specification (SRS) standards, Analysis Modeling: Difference between Data and Information, ER Diagram, Dataflow Model, Control Flow Model, Control and Process Specification, Data Dictionary [8]

3. **Software Design:** Software architecture, Modular design - cohesion and coupling, Process-oriented design, Data-oriented design, User-interface design, Real-time software design, introduction to Object Oriented Design. [7]

4. **CASE Tools, Coding and Testing** Computer-aided software engineering, Introduction to CASE, Building Blocks of CASE, Integrated Case Environment, Characteristics of good Programming languages, Introduction to Testing Process, Testing Activities like Unit, Integration & System Testing. [7]

5. **Software Reengineering:** Business Process Reengineering, Reverse Engineering, Software re-engineerin.. [5]

6. **Software Quality and Metrics:** SQA-Software Quality Assurance, Software Reliability, Software quality metrics, SQA plan, ISO 9000 and 9001 Quality Standards. [8]

Text Books:

1. Pressman R.S. , “Software Engineering”, TMH.
2. Rumbaugh James ,Object Oriented Modeling and Design, Prentice Hall- Gale
3. The Unified Modeling Language User Guide - Grady Booch, James Rumbaugh, Ivar Jacobson.

Reference Books:

1 Pankaj Jalote,“An Integrated Approach to Software Engineering”, NAROSA.
2 Designing Flexible Object Oriented systems with UML - Charles Ritcher
3 Fairely, R.E., “Software Engineering Concepts”, McGraw-Hill
4 Object-Oriented Analysis and Design: using UML Mike O'Docherty Wiley Publication

CA 17. 375 **Bioinformatics** **3-1-0-4**

Total Lectures:40

1. **Introduction to Networking:** Definition and scope of networking, Basic network topology, Concept of LAN, MAN and WAN, Introduction to Internet and data transfer protocol (TCPI/P, FTP) [5]

2. **Biological Information Resources:** Introduction to biological data and database management, Biological databases – Protein databanks (Primary and Secondary databank; Sequence and structure databank), Genomic databanks (Sequence and specialized databanks). [5]

3. **Sequence Alignment:** Introduction to biological sequence alignment, Database searching, Algorithm for sequence alignment, Pairwise alignment (Needleman and Wunsch algorithm, Smith-Waterman algorithm), Multiple Sequence Alignment, Concept of Gaps, Gap penalties and scoring matrices. [7]

4. **Tools for Sequence Alignment:** FASTA, BLAST, Variations of BLAST, Alignment scores and statistical significance of database searches. [8]

5. **Genomics:** Genome, Gene structure of prokayotes and eukaryotes, Concept of ORFs, GC-content, Codon Usage, cDNAs and ESTs, Serial analysis of gene expression (Microarrays). [9]

6. **Proteomics:** Introduction to proteome and proteome analysis (2D electrophoresis, Mass spectrophotometry, Protein microarray and X-ray crystallography), Algorithm for modeling protein folding. [6]

7. **Phylogenetics:** Introduction to phylogenetics, Parsimony, Molecular phylogenetics, Methods of phylogenetic tree construction

Text Books:

1. Peruski and Peruski: The Internet and the new Biology: tools for Genomic and Molecular Research, ASM Publishing House, India.

Reference Books:

2 Higgins and Taylor, Bioinformatics, Oxford University Press, US.

CA 17. 377 **Geographical Information System** **3-1-0-4**

Total Lectures: 40

1. **Genesis and Progression:** Basic Concepts, Benefits of Computerization of Information, Users of GIS, Introduction to Real World and Data Model, Geometric Representation of objects, Levels of Measurement, Applications of GIS. [8]

2. **Vector Data Models:** Introduction, Spaghetti Model, Topology Model, Data Compression, Storing Vector Data. [7]

3. **Raster Data Models:** Necessity and Characteristics, Coding and Storage of Raster Data, Compression of Raster Data, Run Length Encoding, Chain Codes, Block Codes, Quad Tree Model, Conversion and Contrast between Vector and Raster Models. [10]

4. **Hardware and Software Requirements for GIS:** Basic Hardware Devices viz Computer, VDU, Quantizers, Printers, Plotters, etc. DBMS, Structure of Databases, Multimedia, WWW. [9]

5. **Basics of Data Collection:** Digitizing Maps, Scanning, Manual Digitizing, Arial Photographs, Photo Interpretation, Remote Sensing, Correction, Surveying. [6]

Text Books:

1. Bernhardsen Tor, "Geographic Information System: An Introduction", 3rd edition, Wiley Publication.
2. Longley Paul, "Geographic Information Systems and Science", 2nd Edition, Wiley Publication.

Reference Books:

1 Bjarne Stroustrup ,"Programming -Principles and Practice Using C++", Addison-Wesley.

2 Herbert Schildt , "C++: The Complete Reference", 4th edition, TMH.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech CS

Total Lectures: 40

CS 509 High Performance Computer Architecture 3-1-0-4

1. Overview: Necessity of high performance, Constraints of conventional architecture, Parallelism in uniprocessor system, Evolution of parallel processors, future trends, Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture, Performance Metrics and Measures, Speedup Performance Laws. [6]

2. Pipeline Architecture: Principles and implementation of Pipelining, Classification of pipelining processors, General pipelining reservation table, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Job sequencing and Collision, Advanced pipelining techniques, loop unrolling techniques, out of order execution, software scheduling, trace scheduling, Predicated execution, Speculative loading, Register Stack Engine, Software pipelining. [8]

3. Vector and Array Processor: Basic vector architecture, Issues in Vector Processing, Vector performance modeling, vectorizers and optimizers, SIMD Computer Organization Masking and Data network mechanism, Inter PE Communication, Interconnection networks of SIMD, Static Vs Dynamic network, cube, hyper cube and Mesh Interconnection network. Parallel Algorithms for Array Processors. [8]

4. Multiprocessor Architecture: Loosely and Tightly coupled multiprocessors, Processor characteristics of multiprocessors, Inter Processor communication network, Time shared bus, Crossbar switch, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP), Processor, Inter Processor Communication and Synchronization. [8]

5. Multithreaded Architecture: Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions. [4]

6. Parallel Programming Techniques: Message passing program development, Synchronous and asynchronous message passing, Message passing parallel programming, Shared Memory Programming, Data Parallel Programming. [6]

Text Books:

1. Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing", McGraw Hill International Edition, 2004.
2. Kai Hwang, "Advanced Computer Architecture", Tata McGraw Hill Edition, 2001.

Reference Book:

1. William Stallings, "Computer Organization and Architecture, Designing for performance" Prentice Hall, Sixth Edition, 2003.1

Total Lectures: 40

CS 511 Adhoc Sensor Networks 3-1-0-4

1. Ad hoc Networks: Introduction and Definitions, Ad hoc Network Applications, Design Challenges. [3]

2. Routing in Mobile Ad hoc Networks: Introduction, Flooding, Proactive Routing, On Demand Routing, Proactive Versus on demand Debate, Location based Routing. [4]

3. Multicasting in Ad hoc Networks: Introduction, Classifications of Protocols, Multicasting Protocols, Broadcasting. Protocol Comparisons, Overarching Issues. [4]

4. Transport layer Protocols in Ad hoc Networks: Introduction, TCP and Ad hoc Networks,Transport Layer for Ad hoc Networks: Overview, Modified TCP, TCP-aware Cross-layered Solutions. Ad hoc Transport Protocol. [5]

5. QoS Issue in Ad hoc Networks: Introduction, Definition of QoS, Medium Access Layer, QoS Routing, Inter- Layer Design Approaches. [4]

6. Security in Mobile Ad hoc Networks: Vulnerabilities of Mobile Ad hoc Networks, Potential Attacks, Attack Prevention Techniques. Intrusion Detection Techniques. [4]

7. Overview of Wireless Sensor Networks (WSNs): Introduction, Constraints and Challenges, Advantages of Sensor Networks, Sensor Network Applications. [2]

8. Routing Protocols: Geographic, Energy-Aware Routing – Unicast Geographic Routing, Routing on a Curve, Energy-Minimizing Broadcast, Energy-Aware Routing to a Region; Attribute-Based Routing – Directed Diffusion, Rumor Routing. [8]

9. Security in WSNs: Introduction: IEEE 802.11b Security Mechanisms, WEP Security Issues, WEP Improvements, Wireless Security Threats and Risks: Types of Security Threats, Physical Security of Wireless Devices, WLAN Attacks. Risk Mitigation and Countermeasures: Basic Countermeasures, AAA Infrastructure Solutions, Additional Enhancements. [6]

Text Books:

1. Prasant Mohapatra and Srihanamurthy, “Ad Hoc Networks Technologies and Protocols”, Springer, Springer International Edition, 2009.
2. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks”, John Wiley & Sons, Inc., Publication, 2007.
3. Zhao, Guibas, “Wireless Sensor Networks” , Elsevier, 2004.

Reference Book:

1. A.Boukereche, “Handbook of Algorithms for Wireless Networking and Mobile Computing”, Chapman and Hall/CRC Computer and Information Science Series, 2007.

Total Lectures: 40

CS 513 Cryptography and Information Security 3-1-0-4

1. Introduction: Elements of Information Security, Category of computer securities, types of attacks and services. [4]

2. Cryptographic Techniques: plain text and Cipher text, Encryption and Decryption, Stenography, Symmetric and Asymmetric key Cryptography, Blowfish, Data encryption standard, (DES), Advanced Encryption Standard(AES) [6]

3. Number Theory: Introduction to ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms. [4]

4. Public key Cryptography: Public Key Cryptography and RSA, Key Management, Diffie-Hellman key Exchange, Elliptic Curve Architecture and Cryptography. [5]

5. Message Authentication and Hash Function: Authentication requirements, authentication functions, MAC, hash functions, MD5, SHA, Digital Signatures: Digital Signatures, authentication protocols, Digital certificates, Kerberos, Certificate authority. [9]

6. Information attacks: Recognizing Security Threats and countermeasure for Phishing, Virus, Trojan Horse, Worms, Spyware, Adware, Key logger, Denial of Service, Spamming, Port Scanning and Password cracking [4]

7. Web and IP Security: Secure Socket Layer(SSL), Secured Hyper Text Transfer Protocol (SHTTP), S/MIME, IP security overview, Authentication Header(AH), Encapsulating Security Payload(ESP), IP key management . [6]

8. Case study: IP spoofing attack, Cyber Laws. [2]

Text Book:

1. William Stallings, "Cryptography and Network Security – Principles and Practices", Prentice-Hall of India, 4/E edition, 2003.

Reference Books:

1. VK Pachghare, "Cryptography & Information Security", PHI, 2009
2. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill, 2003.

CS 517 Adhoc Sensor Networks Laboratory 0-0-2-1

1. Basics of Network Simulation
2. Simulating a Local Area Network
3. Measuring Network Performance
4. Simulation of a Satellite Network
5. Simulating a Wi-Fi Network
6. Simulating a Wi-MAX Network
7. Simulating a Mobile Ad-hoc Network
8. Simulating a Wireless Sensor Network
9. Setting up a Bluetooth Network
10. Setting up a Zig-Bee Network

CS 519 Cryptography and Information Security Lab 0-0-2-1

1. Implementation of Ciphers
a) Play fair
b) Hill cipher

2. Implementation of the concepts from number theory
a) Fermat's & Euler's Theorem
b) Primality testing
c) Chinese Remainder Theorem

3. Implementation of Symmetric key algorithms like AES/ DES

4. Implementation of Asymmetric key Algorithms like RSA/ DSA.

5. Implementing hash code using MD5/SHA. And generate digital signature

6. Generation of Virus.

Total Lectures: 40

CS 530 Network Security 3-1-0-4

1. Introduction to Security in Networks: Characteristics of Networks, Intrusion, Kinds of security breaches, Plan of attack, Points of vulnerability, Methods of defense, Control measures, Effectiveness of controls [6]

2. Sniffers: Passive Sniffing, Active Sniffing, Ethereal tool, Man-in-the-Middle Attacks, Spoofing and Sniffing Attacks, ARP Poisoning and countermeasures. [6]

3. Denial of Service: Denial of Service, Goal of DoS (Denial of Service), different types of attacks and their impacts, securing from these attacks. [10]

4. Secure Sockets: IPsec overview – IP security architecture, IPsec-Internet KeyExchanging (IKE), IKE phases – encoding , Internet security, Threats to privacy , Packet sniffing ,Spoofing - Web security requirements, Real Time communication security, Security Standards–Kerberos.X.509 Authentication Service. [9]

5. Security Protocols: Transport layer protocols – SSL, Electronic mail security – PEM and S/MIME security protocol, Pretty Good Privacy , Web Security, Firewalls design principles , Trusted systems-Electronic payment protocols, Intrusion detection, password management Viruses and related Threats, Virus Counter measures, Virtual Private Networks. [9]

Text Book:

1. William Stallings, "Cryptography and Network Security: Principles and Standards", Prentice Hall India, 3rd Edition, 2003.

Reference Books:

1. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security: Private Communication in a public world", Prentice Hall India, 2nd Edition, 2002.

2. Charles P. Pleeger, "Security in Computing", Pearson Education Asia, 5th Edition, 2001.

Total Lectures: 40

CS 532 Cyber Forensic 3-0-0-3

1. Incident and Incident Response : Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response Phase after detection of an incident. [10]

2. Initial Response and Forensic Duplication: Initial Response & Volatile Data Collection from Windows system – Initial Response & Volatile Data Collection from Unix system - Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic Duplicate/Qualified Forensic Duplicate of a Hard Drive. [10]

3. Storage and Evidence Handling: File Systems-FAT,NTFS - Forensic Analysis of File Systems – Storage Fundamentals-Storage Layer, Hard Drives Evidence Handling-Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure. [10]

4. Network Forensics: Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing - Internet Fraud. [10]

Text Books:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGraw Hill, 2006.
2. Peter Stephenson, “Investigating Computer Crime: A Handbook for Corporate Investigations”, Sept 1999.

Reference Books:

1. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Toolsand Technology", Academic Press, 1st Edition, 2001.
2. Skoudis. E., Perlman. R. Counter Hack: “A Step-by-Step Guide to Computer Attacks and Effective Defenses”, .Prentice Hall Professional Technical Reference. 2001.
3. Norbert Zaenglein, “Disk Detective: Secret You Must Know to Recover Information From a Computer”, Paladin Press, 2000.
4. Bill Nelson, Amelia Philips and Christopher Steuart, “Guide to computer forensics and investigations”, course technology, Cengage Learning; 4thedition, ISBN: 1-435-49883-6, 2009.

Total Lectures: 40

CS 534 Image Information Processing 3-1-0-4

1. **Introduction:** Basics regarding Digital Images, elements of digital image processing systems, different image formats, elements of visible perception ,image model, sampling, quantization, image enhancement, restoration and analysis. [10]
2. **Mathematical Preliminaries and Image Transforms**: Matrix theory, random signals, spectral density function, results from estimation and information theory, Introduction to DFT, 2-DFT, FFT and other transforms such as Walsh, Hadamard, discrete cosine, Haar, slant and KL . [10]
3. **Image Data Compression:** Basic compression techniques such as Huffman coding, arithmetic coding, LZ77, LZ78, Predictive techniques –PCM , DPCM, transform coding theory of images, hybrid coding and vector DPCM, Introduction to speech and video compression, MPEG ,packet video. [10]
4. **Visual Cryptography:** Introduction to information hiding, surveys of different Steganographic and Watermarking techniques, principles of Steganography and water marking techniques, Statistical Steganography- distortion code generation techniques. Detecting, extracting and disabling hidden information, Basic principles , applications, evaluation and benchmarking of water marking systems, Extension from still images to video, Fingerprints classification and analysis. [10]

Text Books:

1. R.C. Gonzalez , "Image Processing" Pearson education 4th edition , 2013.
2. A.K. Jain ,"Fundamentals of Digital Image Processing " PHI 2nd edition , 1995.

Reference Books:

1. Khalid Sayood, "Introduction to Data compression", Morgan Kaufmann Publishers, 2003 reprint.
2. Stefan Katzenbelsser and Fabial A.P. Petitcolas , "Information hiding techniques for Steganography and Digital watermarking " , Artech house publisher , January 2004.
3. Jessica Fridrich , "Steganography in Digital media : Principles ,algorithms and applications ,Cambridge university press,2010.
4. Ingemar Cox,M.Miller,J.Bloom, Jessica Fridrich and T.Kalker,"Digital Watermarking and Steganography", Morgan Kaufmann Publishers,Nov.2007.
5. David Solomon, "Data compression: The Complete Reference", Springer Verlag, 4e, 2007.
6. W.K.Pratt ,"Digital Image Processing",John Willey and Sons,1994 .

Total Lectures: 40

CS 536 Database Security 3-1-0-4

1. Introduction: Introduction to Databases Security, problems in Databases Security Controls. Security Models**:** Introduction, Access Matrix Model, Take-Grant Model, Acten Model, PN Model, Hartson and Hsiao'sModel, Fernandez's Model, Bussolati and Martella's Model for Distributed databases. [7]

2. Advanced Models: Bell and La Padula's Model, Biba's Model, Dion's Model, Sea View Model Jajodia and Sandhu's Model, The Lattice Model for the Flow Control. [6]

3. Security Mechanisms: User Identification/Authentication, Memory Protection, Resource Protection Control Flow Mechanisms, Evaluation Criteria [6]

4. Security Software Design: A Methodological Approach to Security Software Design, Secure Operating System Design, Secure DBMS Design, Security Packages, Database Security Design. [7]

5. Statistical Database Protection and Intrusion Detection System: Statistics Concepts and Definitions, Types of Attacks, Inference Controls evaluation, Criteria for Control, Comparison, IDES System, RETISS System, ASES System. [7]

6. New Generation Database Systems Protection Models: Model for the Protection of Frame Based Systems, Object Oriented Systems, SORION Model for Object-Oriented Databases. Orion Model, Jajodia and Kogan's Model. [7]

Text Books:

1. Database Security and Auditing, Hassan A. Afyouni, India Edition, CENGAGE Learning, 2009.

2. Database Security, Castano, Second edition, Pearson Education.

Reference Book:

1. Database security, Alfred Basta, Melissa Zgola, CENGAGE learning.

Total Lectures: 52

CS 563 Advances in Distributed Computing **4-0-0-4**

1. **Introduction:** Distributed Systems, Cluster Computing, Supercomputing, Cloud Computing. [6]
2. **Synchronous networks:** Leader election in synchronous ring networks. Leader election in rings. Basic computational tasks in general synchronous networks: leader election. [6]
3. **Fault-tolerant Systems:** Consensus, Link failures: the two generals problem. Process failures (stopping, Byzantine). Algorithms for agreement with stopping and Byzantine failures. Exponential information gathering. [6]
4. **Asynchronous distributed computing**: Formal modeling of asynchronous systems using interacting state machines (I/O automata). Proving correctness of distributed algorithms. [6]
5. **Non-fault-tolerant Systems:** Algorithms for asynchronous networks. Leader election. [4]
6. **Synchronizers**. Synchronizer applications. Synchronous vs asynchronous distributed systems. [6]
7. **Time, clocks and the ordering of events**: State-machine simulation. Vector timestamps. Stable property detection. Distributed termination. Global snapshots. Deadlock detection [6]
8. **Asynchronous shared-memory systems**: The mutual exclusion problem. Mutual exclusion algorithms. Bounds on shared memory for mutual exclusion. Resource allocation. The Dining Philosophers problem. [6]
9. **Locking:** Locking algorithms, optimistic algorithms, lock-free algorithms, lazy algorithms, Load scheduling and balancing techniques. [6]

Text Books:

1. Lynch, Nancy, "Distributed Algorithms", Burlington, MA: Morgan Kaufmann, 1996. ISBN: 9781558603486.
2. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems, Concept and Design", 3rd Edition, Pearson Education, 2005.
3. Mukesh Singhal, Niranjan G. Shivaratri, Niranjan Shivaratri, "Advanced Concepts in Operating Systems", TMH, 1994.
4. Sunita Mahajan, Seema Shah, "Distributed Computing", Oxford University Press,2010.

Reference Books:

1. Sukumar Ghosh, "Distributed Systems: An Algorithmic Approach", Chapman &Hall / CRC, 2007.
2. Pradeep K. Sinha, "Distributed Operating Systems: Concepts and Design", PHI, 2007.
3. Randy Chow, Theodore Johnson, "Distributed Operating Systems and Algorithm Analysis",

Total Lectures: 52

CS 565 Advanced Compiler Construction 4-0-0-4

1. **Advanced Issues in Elementary topics:** Compiler, phases and passes, finite state machines, regular expressions and their applications to lexical analysis, implementation of lexical analyzer using LEX, CFG, bottom-up and top-down parsers, implementation of parsers using YACC. [10]

2. **Symbol Table Structure**: Storage classes, visibility and lifetime. Symbol attributes and symbol table entries, local symbol table management, and global symbol table structure, storage binding and symbolic registers. [6]

3. **Intermediate Representations**: Issues in designing intermediate languages, High level, medium level, low level and multi-level intermediate languages. Representing all intermediate languages in informal compiler algorithm notation (ICAN). [8]

4. **Code Optimization**: Introduction, early optimization, redundancy elimination. Loop optimization: Induction variable optimizations, bounds checking elimination.Procedure optimization: Tail-call optimization and Tail-recursion optimization, procedure integration, In-line expansion, leaf routine optimization and shrink wrapping. [8]

5. **Register Allocation**: Register allocation and assignment, local methods, graph coloring, priority based graph coloring. Code Scheduling: Instruction Scheduling, Speculative loads and boosting, speculative scheduling, trace scheduling, percolation scheduling. [8]

6. **Interprocedural Analysis and Optimization**: Call graph, interprocedural data flow analysis, constant propagation, alias analysis, optimizations and register allocation. [7]

7. **Automatic Code Generators**: Syntax directed technique, semantic directed parsing, tree pattern matching and dynamic programming. [5]

Text Book:

1. Steven S. Muchnik, “Advanced Compiler Design Implementation”, Morgan Kauffman publishers, 2005.

Reference Books:

1. Alfred Aho, Monica Lam, Ravi Sethi, Jeffrey Ullman, “Compilers: Principles, Techniques, and Tools”, Second edition, Addison-Wesley, 2006.

2. Fisher, Faraboschi, Young, “Embedded Computing - A VLIW Approach to Architecture, Compilers, and Tools”, Morgan Kaufmann, 2005.

Total Lectures: 52

CS 567 BioInformatics 4-0-0-4

1. Introduction to Bioinformatics: Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics Problems and Applications of Bioinformatics. [6]

2. Bioinformatics Databases: Introduction, Nucleotide sequence database - Protein sequence databases, Sequence motif databases, Protein structure databases, other relevant databases. [6]

3. Data storage and retrieval and Interoperability: Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search.The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts.General Introduction to XML, UMLS, CORBA, PYTHON. [13]

4. Sequence Alignments and Visualization: Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example),Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization. [12]

5. Bioinformatics Softwares: Clustal V, Clustal W 1.7, RasMol, Oligo, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip. [5]

6. Semantic Web Techniques: Bridging databases, browsing space of information, life sciences identifiers, RDF data representation. [5]

7. Bioinformatics and Distributed Computing: Java Distributed computing platform, DPRml, DSEARCH. [5]

Text Books:

1. Dan E. Krane ,"Fundamental Concepts of Bioinformatics", third edition, Pearson Education, 2009.
2. Claverie, J.M. and Notredame C. ," Bioinformatics for Dummies", Wiley Editor , January 2003.

Reference Book:

1. ShaliniSuri, "Bioinformatics", APH Publishing Corporation, 2006.

Total Lectures: 52

CS 569 Advanced Computer Graphics 4-0-0-4

1. **Animation:** Introduction of computer Animation, Principles of Animation, Key framing , Kino-dynamics Planning- motion blending, skinning-skeleton animation, rigid skinning ,linear skinning, dual skinning, physics modeling-Physics-based animation, rigid body systems, articulated rigid bodies, forward and inverse dynamics. [14]

2. **Rendering:** Basic concepts of graphics models-illumination& reflection models Shading-Scanning polygons, Gourad and Phong shading ,texture mapping- bump & environmental maps , mipmaps , shading languages-vertex shedders and fragment shedders. [12]

3. **Modeling:** Representation, Using homogeneous Coordinate systems, Modeling process, terrain-representation, methods , fault formation & weather, plants modeling , animals modeling. [12]

4. **Surface Representation:** 3 dimensional object representation –polygon representations, implicit representation , Beziers ,B-splines-basis function, knot insertion, conversion , rational B-splines (NURBS)-properties and examples , evaluators, subdivision surfaces-coarse mesh and subdivision rule,types of subdivisions , Voxels . [14]

Text Book:

1. Peter Shirley, Stephen Robert Marschner, "Fundamentals of Computer Graphics" , A K Peters Limited, 2009.

Reference Books:

1. Shreiner Dave, "Opengl Programming Guide: The Official Guide To Learning Opengl", Version 2.1, 6/E , Pearson Education India, 2008.
2. Francis S. Hill, Jr., Stephen M. Kelley , "Computer Graphics: Using OpenGL" , Pearson Prentice Hall, 2008
3. James D.Foley, Andries van Dam, Steven K. Feiner, John F. Hughes , "Computer Graphics ,Principles & Practice", 3rd Edition, Pearson Prentice Hall, 2013.
4. Edward Angel, "Interactive Computer Graphics a top-Down Approach using openGL", 5th Edition Pearson Prentice Hall, 2008.

Total Lectures: 52

CS 571 Advances in Algorithm Design 4-0-0-4

1. Pattern matching algorithms: Finite automata and regular expression, recognition of regular expression patterns, recognition of substrings, Two – way deterministic pushdown automata, position trees and substring identifiers. [11]

2. Computability theory: Turing machines, variants of Turing machines, Hilbert's problem, decidable languages, the halting problem, Un-decidable problems from language theory, mapping reducibility, the recursion theorem, decidability of logical theories, Turing reducibility, definition of information. [11]

3. Fast Fourier Transform and Polynomials: Representation of polynomials, the DFT and FFT algorithms, efficient FFT implementation, the FFT using bit operations, products of polynomials, the Schonhage – Strassen integer multiplication algorithm. [11]

4. Randomized Algorithm and Parallel Algorithm: Monte-Carlo algorithm, Las-Vegas algorithm, Game tree evaluation, De-randomization. Models for parallel computation basic techniques; Parallel matrix algorithms: matrix-vector multiplication, matrix multiplication, triangular system solution, sorting networks-parallel merging networks, zero –one principle. [8]

5. Complexity theory: Time complexity, the classes P, NP, NP complete and NP hard, Hierarchy theorems, Relativization, Circuit Complexity, approximation algorithms, probabilistic algorithms, circuit complexity, alteration, interactive proof systems, parallel computation, cryptography. [11]

Text Book:

1. Aho Alfred V., Hopcraft John E., Ullman Jefferey D. "The design and analysis of computer algorithms" Pearson education, tenth impression 2012.

Reference Books:

1. Cormen Thomas H. "Introduction to algorithms" PHI, Third edition – 2012.

2. MICHAEL SIPSER Sipser Michael, "Introduction to the theory of computation" Thomson press, Third edition 2012.

3. Brassard G. Fundamental of Algorithmcs, Prentice-Hall of India, 2003.

4. Horowitz E. Computer Algorithms, Galgotia Publications, 2002.

Total Lectures: 52

CS 572 Web Services Security 4-0-0-4

1. Introduction to web Service Technologies: Introduction to web services, Security for Web Services and Security Goals, Need of security and Privacy in web services, applications of web service security, SOA and Web Services Principles, Web Services Architecture, Web Services Technologies and Standards, SOAP, Web Services Description Language (WSDL). [10]

2. Web Service Threats Vulnerabilities, and Countermeasures: Threats and Vulnerabilities, Threats Modelling, Vulnerability Categorizations and Catalogs, Threats and Vulnerabilities Metrics. [10]

3. Standards for Web Service Security: The Concept of Standard Web Services Security, Standards Framework, An Overview of Current Standards, XML Data Security ,Security Assertions Markup Language (SAML), SOAP Message Security, Key and Trust Management standards, Standards for Policy Specification, Access Control Policy Standards, Implementations of Web Services Security Standards**.** [12]

4. Digital Identity Management and Trust Negotiation: Overview of Digital Identity Management, Overview of Existing Proposals Liberty Alliance, WS-Federation, Comparison of Liberty Alliance and WS-Framework, Other Digital Identity Management Initiatives, Discussion on Security of Identity Management Systems, Business Processes. [10]

5. Access Control for Web Services: Approaches to Enforce Access Control for Web Services, WS-AC: An Adaptive Access Control Model for Stateless, Web Services, The WS-AC Model, WS-AC Identity Attribute Negotiation, WS-AC Parameter Negotiation. [10]

Reference Book:

1. Elisa Bertino, Lorenzo D. Martino, Federica Paci, Anna C. Squicciarini, Security for Web Services and Service Oriented Architectures, Springer Science (2009).

Total Lectures: 52

CS 574 Mobile and Wireless Security 4-0-0-4

1. **Wireless Technologies:** Introduction to Wireless technologies- Wireless data networks-Personal Area Networks -Transmission Media – WLAN standards - Securing WLANS - Countermeasures - WEP (Wired Equivalence Protocol). [10]

2. **Multiple Access Techniques and Wireless Networking**: Introduction- FDMA, TDMA, Spread Spectrum Multiple Access: Space Division Multiple Access- Packet Radio, Introduction To Wireless Networks- Differences Between Wireless And Fixed Telephone Networks, Development Of Wireless Networks, Traffic Routing In Wireless Networks Integrated Services Digital Network (ISDN), Protocols For Network Access. [12]

3. **Wireless Threats**: Kinds of security breaches – Eavesdropping, Communication Jamming, RF interference, Covert wireless channels, DOS attack, Spoofing, Theft of services, Traffic Analysis, Cryptographic threats, Wireless security Standards. [10]

4. **Security in Data Networks**: Wireless Device Security Issues - CDPD security (Cellular Digital Packet Data), GPRS security (General Packet Radio Service), GSM (Global System for Mobile Communication) security, IP security. [10]

5. **Wireless Transport Layer Security**: Secure Socket Layer - Wireless Transport Layer Security - WAP Security Architecture - WAP Gateway. [10]

Reference Books:

1. Nichols and Lekka, “Wireless Security-Models, Threats and Solutions”, Tata McGraw – Hill, New Delhi, 2006.
2. Merritt Maxim and David Pollino,”Wireless Security”, Osborne/McGraw Hill, New Delhi, 2005.
3. William Stallings, “Cryptography and Network Security - Principles and practices, Prentice Hall, New Delhi, 2006.

Total Lectures: 52

CS 576 Information Security Policies 4-0-0-4

1. Cyber Security and its problem-Intervention Strategies: Redundancy, Diversity and Autarchy. Private ordering solutions, Regulation and Jurisdiction for global Cyber security, Copy Right-source of risks, Pirates, Internet Infringement, Fair Use, postings, criminal liability, First Amendments, Data Losing. [13]

2. Copy Right-Source of risks: Pirates, Internet Infringement, air Use, postings, Criminal Liability, First Amendments, Losing Data, Trademarks, Defamation, Privacy-Common Law Privacy, Constitutional law, Federal Statutes, Anonymity, Technology expanding privacy rights. [13]

3. Duty of care &criminal liability: procedural issues, Electronic Contracts & Digital Signatures, Misappropriation of information, Civil Rights, Tax, Evidence. Information security policies and procedures : Corporate policies-Tier 1,Tier 2 and Tier 3 policies, Process management planning and preparation developing policies-asset classification policy developing standards. [13]

4. Information security: fundamentals-Employee responsibilities- information classification-Information handling- Tools of information security- Information processing-secure program Administration. Organizational and Human Security: Adoption of Information Security Management Standards, Human Factors in Security- Role of information security professionals [13]

Reference Books:

1. Jonathan Rosenoer, Cyber Law: The law of the Internet, Springer, 1997
2. Mark F Grady, Fransesco Parisi Thomas R. Peltier, The Law and Economics of Cyber Security, Cambridge University Press, 2005.
3. Kenneth J. Knapp, "Cyber Security and Global Information Assurance: Threat Analysis and Response Solutions", IGI Global, 2009.
4. Thomas R Peltier, Justin Peltier and John blackley,"Information Security Fundamentals", 2nd Edition.

Total Lectures: 52

CS 578 Operating System and Mobile Application Security 4-0-0-4

1. Introduction to android: An open platform for mobile development, android applications, and android SDK features, developing for android, developing for mobile devices, android development tools. Introducing the application manifest, using the manifest editor, the android application lifecycle, externalizing resources, fundamental android UI design, introducing views and layouts, creating new views and menus. [10]

2. Intents, broadcast receiver, adapters and the Internet: Introducing Internet and adapters, using internet resources, introducing dialogs, Data storage, retrieval and sharing techniques for saving data, saving simple application data and loading files, databases in android. [10]

3. Maps, Geocoding and Location based services: setting up the emulator with test providers, Selecting the location provider, finding your location, using proximity alerts, using the geocoder, creating map based activities and mapping earthquakes example Advance Android development paranoid android, using AIDL to support IPC for services, using internet services, building rich user interfaces. [10]

4. Mobile Web Architecture, Standards and Tools: Mobile Internet Access, Mobile Web browser Evolution, Mobile Web Standards and development time, WAP and WAP Standards, XHTML, WML and WML Script, Mobile Web Development Approaches, Content Adaption and Adaption Strategies, How to recognize end user device, Device Detection in PHP, Tools Available for mobile web development, Conversion Engines, Emulators, Mobile Web Checkers, Dynamic content**.** [11]

5. Mobile Application Development Management & Security Mobilized Enterprise Web Architectures, User To Mobile Client Security Issues, Mobile Client Security Issues, Client Server Communications Security Issues, Existing Web Architectures and Back End Systems Security Issues, Project Management, Requirements, Design, Code Development and Integration, Integration and System Testing, Deployment and Release Management, Re Evaluation and Reiteration, Operations and Maintenance. [11]

Reference Books

1. Reto Meier, Professional Android Application Development, John Wiley and Sons, 2010.
2. Rick Rogers, John Lombardo, Zigurd Mednieks, G. Blake Meike, Android Application Development Programming with the Google SDK, O'Reilly, 2009.
3. Valentino Lee; Heather Schneider; Robbie Schell , Mobile Applications Architecture, Design, and Development, Prentice Hall April 16, 2004.

Total Lectures: 52

CS 580 Biometric Security 4-0-0-4

1. Overview: Introduction, benefits of biometrics over traditional authentication systems, benefits of biometrics in identification systems, selecting a biometric for a system, Key biometric terms and processes, biometric matching methods, Accuracy in biometric systems. [11]

2. Physiological Biometric Technologies: Leading technologies: Finger-scan, Facial-scan, Iris-scan, Voice-scan, components, working principles, competing technologies, strengths and weaknesses. Other physiological biometrics: Hand-scan, Retina-scan, components, working principles, competing technologies, strengths and weaknesses, automated fingerprint identification systems. [11]

3. Behavioral Biometric Technologies: Handprint Biometrics, DNA Biometrics, signature and handwriting technology, Technical description, classification, keyboard / keystroke dynamics, Voice, data acquisition, feature extraction, characteristics, strengths, weaknesses, deployment. [10]

4. Multi Biometrics: Multi biometrics and multi factor biometrics - two-factor authentication with passwords - tickets and tokens – executive decision - implementation plan. [10]

5. Biometric Applications: Categorizing biometric applications – application areas: criminal and citizen identification, surveillance, PC/network access, e-commerce and retail/ATM, costs to deploy, other issues in deployment. [10]

Reference Book:

1. Samir Nanavathi, Michel Thieme, and Raj Nanavathi, "Biometrics -Identity verification in a network", Wiley Eastern, 2002.
2. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley Eastern Publications, 2005.
3. John Berger," Biometrics for Network Security", Prentice Hall, 2004.

Total Lectures: 40

MA 531 Advanced Computational Mathematics 3-0-0-3

1. Calculus of Finite Differences and Interpolation: Finite differences and difference operators, Construction of difference tables, Interpolation and extrapolation with equal intervals (Newton- Gregory forward, backward, Stirling and Bessel's formula), Interpolation and extrapolation with unequal intervals (Newton's divided difference and Lagrange's formula). [08]

2. Numerical Differentiation and Integration: Numerical differentiation with equal and unequal intervals, numerical integration (newton-Cotes quadrature formula, Trapezoidal, Simpson's 1/3, Simpson's 3/8, Weddle's and Romberg rules), Double and triple integration using Trapezoidal and Simpson's rules. [07]

3. Numerical Solution of Simultaneous Equations: Gauss elimination method (Partial Pivoting), Jacobie's iteration method, Gauss Jordan method, Gauss Siedel iteration method. [4]

4. Numerical Solution of Algebraic and Transcendental Equations: Bisection method, Regular falsi method (method of false position), Newton Raphson method and its applications, Graeffe's root squaring method with error analysis.

[4]

5. Numerical Solution of Ordinary and Partial Differential Equations: Numerical solution of ordinary differential equations of first order and first degree using Picard's, Taylor series, Euler, Euler's modified, Runge-Kutta method of fourth order and Milne's Predictor -Corrector method.
Classification of partial differential equations (elliptic, parabolic, and hyperbolic). Finite difference approximations to partial derivatives. Jacobi and Gauss Siedel method, Crank - Nicolson method, Solution of Laplace and Poisons equations. [10]

6. Linear Algebra: Review of group, ring and field , Vector Spaces, Subspaces, Linearly dependent and independent, Basis, Dimensions, Isomorphism, Linear transformations and their matrix representations , Rank, Inverse of Matrices, Cauchy- Schwarz inequality, Eigenvalue, Eigenvectors. [07]

Text Books:

1. M.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, 2012.
2. B.S. Grewal, Numerical Methods, BPB publication, 2012.
3. Introduction to Linear Algebra with applications by Jim Defranza and Daniel Gagliardi, TMH, Year 2013.

Reference Books:

1. Numerical Mathematics Analysis by James B. Scarborough.
2. Introduction Methods of Numerical Analysis by S.S. Shastry.
3. Applied Numerical methods with MATLAB by Steven C Chapra, TMH.
4. Introduction of Numerical Analysis by Forberg.
5. V. Rajaraman Computer oriented numerical methods 3rd edition PHI – 2012
6. Linear Algebra and Its applications by David C. Lay, Addison- Wisley(An imprint of Pearson education).

MA 533 Advanced Computational Mathematics Laboratory 0-0-2-1

Implement the following in C/C++/MATLAB:

(1) Newton-Gregory's formulae for forward and backward interpolation.
(2) Stirling formula.
(3) Bessel's formula.
(4) Newton's divided difference formula.
(5)Lagrange's formula.
(6) Numerical differentiation.
(7) Numerical integration: Newton –Cotes quadrature formula..
(8) Trapezoidal rule.
(9) Simpson rules.
(10) Romberg rules.
(11) Solution of differential equations by Euler's method modified Euler's method.
(12) Runge-Kutta method.
(13) Milne's Predictor-Corrector method.
(14) Bisection method
(15) Regula Falsi method
(16) Newton – Raphson method.
(17) Graeffe's root squaring method.
(18) Gauss elimination method (with partial pivoting).
(19) Eigen values and eigen vectors.
(20) Solution of partial differential equations.

RM 17.101 **Research Methodology** **2-0-0-2**

1. **Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches,Research Process,Validity and Reliability in Research. [2]

2.**ProblemFormulation:**Identification, Selection and Formulation of a Research Problem, Criteria ofagood Research Problem, Reviewof Literature, Research Gaps. [4]

3.**Research Design:**Research Framework, Meaning &Significance of Research Designs, Features of a good Research Design, Types of Research Design. [4]

4.**Dataforresearch:**TypesofData,Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis.[4]

5. **Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [8]

6. **ReportWriting:**Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [4]

TextBooks:

1. R.Pannershelvam, "ResearchMethodology" PrenticeHall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"ResearchMethodology: MethodsandTechniques",New Age International (p) Limited,Publishers New Delhi, 4ndedition,2018.

References –

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013.
4. Dr.A.K.Phophalia, “Modern Research Methodology: New Trends and Techniques” Paradise Publishers Jaipur, 1st edition, 2012.
5. Pankaj Madan, “Research Methodology”, Global Vision Publishing House, New Delhi, 2nd edition, 2016.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech VLSI

Total Lecture: 40

EC 502 FPGA ARCHITECTURE & APPLICATIONS 3-1-0-4
(Elective I)

1	**PROGRAMMABLE LOGIC:** ROM, PLA, PAL, PLD, PGA – Features, Programming and Applications using Complex Programmable Logic Devices.	6
2	**FPGA:** Field Programmable Gate Arrays – Logic Blocks, Routing Architecture, Design Flow, Technology Mapping for FPGAs.	4
3	**FINITE STATE MACHINES (FSM):** Top Down Design – State Transition Table, State Assignments for FPGAs. Problem of Initial State Assignment for One Hot Encoding. Derivations of State Machine Charges.	8
4	**REALIZATION OF STATE MACHINE:** Charts with a PAL. Alternative Realization for State Machine Chart using Microprogramming. Linked State Machines. One – Hot State Machine, Perimeters for State Machines – Basic Concepts, Properties.	8
5	**FSM ARCHITECTURES AND SYSTEMS LEVEL DESIGN:** Architectures Centered Around Non-Registered PLDs. State Machine Designs Centered Around Shift Registers. One – Hot Design Method. Use of ASMs in One – Hot Design. K Application of One – Hot Method. System Level Design – Controller, Data Path and Functional Partition.	10
6	**DIGITAL FRONT END DIGITAL DESIGN TOOLS FOR FPGAS & ASICS:** Using EDA Tool ("FPGA Advantage") – Design Flow Using FPGAs of Parallel Adder Cell, Sequential Circuits, Multiplexers.	4

Text Books:

1 P.K.Chan & S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall, 1994.

2 S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Publicatgions,1994.

3 J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley & Sons, Newyork, 1995.

Reference Books:

1 S.Brown, R.Francis, J.Rose, Z.Vransic, Field Programmable Gate Array, Kluwer Pubin, 1992.

Total Lecture: 40

EC 504 **ASIC DESIGN** **3-1-0-4**

(Elective II)

1	**ASIC DESIGN STYLES:** Introduction – categories-Gate arrays-Standard cells-Cell based ASICs-Mixed mode and analogue ASICs – PLDs.	4
2	**ASICs – PROGRAMMABLE LOGIC DEVICES:** Overview – PAL –based PLDs: Structures; PAL Characteristics – FPGAs: Introduction, selected families – design outline.	6
3	**ASICs –DESIGN ISSUES:** Design methodologies and design tools – design for testability – economies.	6
4	**ASICs CHARACTERISTICS AND PERFORMANCE**: design styles, gate arrays, standard cell -based ASICs, Mixed mode and analogue ASICs.	6
5	**ASICs-DESIGN TECHNIQUES:** Overview- Design flow and methodology- Hardware Description languages-simulation and checking-commercial design tools.	6
6	**LOGIC SYNTHESIS, SIMULATION AND TESTING:** Verilog and logic synthesis –VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation- automatic test pattern generation.	6
7	**ASIC CONSTRUCTION:** Floor planning, placement and routing system partition.	2
8	**FPGA PARTITIONING**: Partitioning Methods-Floor Planning- Placement-Physical Design Flow-Global Routing-Detailed Routing –Special Routing-Circuit Extraction-DRC.	4

Text Books:

1 L.J.Herbst, "Integrated circuit engineering", OXFORD SCIENCE Publications, 1996.

2 M.J.S.Smith, "Application - Specific integrated circuits", Addison-Wesley Longman Inc 1997.

3 **Himanshu Bhatnagar, "Advanced ASIC Chip Synthesis: Using Synopsys Design Compiler, Physical Compiler, and PrimeTime", Kluwer Academic Publishers.**

Reference Books:

1 Michael John Sebastian Smith, "Application specific integrated circuits", Addison-Wesley.

Total Lectures 40

EC 541 Semiconductor Device Models for Circuit Simulation 3-1-0-4

1. Principle of circuit simulation and its objectives. [4]

2. Introductions to SPICE- DC, small signal, large signal, high frequency, noise models of diodes and measurement of diode model parameters. [6]

3. DC, small signal, high frequency and noise models of bipolar junction transistors, extraction of bipolar junction transistor model parameters. [6]

4. DC, small signal, high frequency and noise model of MOSFETs. [5]

5. Devices scaling, short and narrow channel MOSFETs. [5]

6. MOSFET channel mobility model, level-1 and level-2 large signal MOSFET Models. [4]

7. Extraction of MOSFET model parameters. [5]

8. JFET and MESFETs, extraction of JFET and MESFET model parameters. [5]

Text Books:

1. Dasgupta N., and Dasgupta A., Semiconductor Devices - Modeling and Technology, Prentice-Hall of India, 2004.
2. Ben G. Streetman, Sanjay Banerjee, "Solid State Electronic Devices", Prentice Hall.
3. Adir Bar-Lev, "Semiconductors and electronic devices", Prentice-Hall International.

Total Lectures 40

EC 542 Analog VLSI Design 3-1-0-4

1. Basic consideration in analog VLSI design. [4]

2. MOS current sources, current mirrors, out buffers and voltage reference circuits. [6]

3. CMOS amplifier. [7]

4. Noise in CMOS amplifier. [3]

5. CMOS comparators. [6]

6. Mixed signal circuits. [6]

7. MOS circuit components. [4]

8. Switched capacitor filters realization by MOS technology. [4]

Text Books:

1. Razavi B., Design of Analog CMOS Integrated Circuits, McGraw-Hill, New York, 2001.
2. D. Johns and K. *Martin*, "*Analog Integrated Circuit Design*", *John* Wiley & Sons.
3. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design", Oxford university press.

Total Lectures 40

EC 543 VLSI Fabrication Technology 3-1-0-4

1. Crystal growth and Epitaxy [3]
2. Diffusion and Ion-implantation [4]
3. Oxidation Processes [3]
4. Film Deposition Techniques [4]
5. Etching and Cleaning [4]
6. Lithographic Processes [5]
7. Metal Deposition and Interconnect Formation [2]
8. Process Integration : Bipolar and MOS (NMOS & CMOS) [7]
9. Packaging [3]
10. Testing [3]
11. Reliability and Yield [2]

Text Books:

1. Gandhi S. K., VLSI Fabrication Principles – Silicon and Gallium Arsenide, John Wiley & Sons, 2nd Ed., 2003.
2. A.I.C.T.E, Design and Fabrication Technology, A.I.C.T.E, Bangalore, 2001.
3. *S. M. Sze*, "*VLSI Technology"*, Second Edition, McGraw-Hill.

Total Lectures 40

EC 544 VLSI Systems and Subsystems 3-1-0-4

1. System specification using HDL. [6]
2. General VLSI Components. [7]
3. Arithmetic circuits in CMOS VLSI. [5]
4. Memories and Programmable logic. [7]
5. System level physical design. [7]
6. VLSI clocking and system design. [6]
7. Reliability and testing of VLSI circuits [2]

Text Books:

1. Hill F. J., and Peterson G. R., Computer Aided Logical Design with Emphasis on VLSI, John Wiley & Sons, 4th Ed., 1993.
2. Wolf W., Modern VLSI Design- System-On-Chip Design, Pearson Education Asia, 3rd Ed., 2002.
3. John P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons.

Total Lectures 40

EC 545 Elements of Digital VLSI Design 3-1-0-4

1.	CMOS Technology & Device Scaling	[6]
2.	Stick Diagram, Layout and Full Custom Mask Design	[4]
3.	MOS inverters : Static and Dynamic Characteristics	[4]
4.	Inverter Delay and Power Dissipation	[5]
5.	Interconnect delay	[2]
6.	Combinational MOS Logic Circuits	[4]
7.	Sequential MOS Logic Circuits	[4]
8.	Dynamic Logic Circuits	[3]
9.	Low power VLSI Circuits	[4]
10.	Introduction to BiCMOS Circuits	[2]
11.	Introduction to FPGA and ASICS	[2]

Text Books:

1. Weste N. H., Principles of CMOS VLSI Design, Pearson Education Asia, 2nd Ed., 2001.
2. Kang S., CMOS Digital Integrated Circuits Analysis and Design, Tata McGraw-Hill, 3rd Ed., 2003.
3. Baker J. R., CMOS - Circuit Design, Layout and Simulation, Prentice-Hall of India, 2000.

Total Lectures 40

EC 546 **Mixed-Signal Systems (Elective III)** **3-1-0-4**

1.	Introduction to mixed-signal systems.	[2]
2.	Continuous time and sampled data signal processing.	[5]
3.	Static and dynamic logic, OTA-C circuits.	[6]
4.	Switched current techniques.	[3]
5.	Switched capacitor techniques.	[3]
6.	Converters and Delta-sigma modulators.	[4]
7.	Filter design strategies.	[6]
8.	Image processing.	[7]
9.	Silicon compilers.	[3]

Text Books:

1. Christoph G., Languages for System Specification - Selected Contributions on UML, SystemC, System Verilog, Mixed-Signal Systems, and Property Specifications from FDL'03, Springer Publisher, 1996.
2. Nishath K. V., Simulation Techniques and Solutions for Mixed-signal Coupling in Integrated Circuits, Springer Publisher, 1994.
3. Baker R. J., CMOS Mixed-Signal Circuit Design, Prentice-Hall of India, 2001.

Total Lecture: 40

EC 548 **VLSI Physical Design and Design Automation (Elective II)** **3-1-0-4**

1.	Basic VLSI design methodologies.	[3]
2.	Algorithmic graph theory and computational complexity.	[4]
3.	Tractable and intractable problems.	[3]
4.	Combinatorial optimization.	[4]
5.	Layout compaction.	[3]
6.	Placement and partitioning.	[4]
7.	Floor planning.	[3]
8.	Routing.	[3]
9.	Simulation.	[4]
10.	Logic synthesis and verification.	[4]
11.	High-level synthesis.	[5]

Text Books:

1. Sarrafzadeh M., and Wong C. K., An Introduction to VLSI Physical Design, McGraw-Hill, New York, 1996.
2. Geiger R. L., Allen P. E., and Strader N. R., VLSI Design Techniques for Analog and Digital Circuits, McGraw-Hill, New York, 1990.
3. Naveed Sherwani, "Algorithms for VLSI Physical Design Automation", Springer International Edition.

Total Lectures 40

EC 550 Embedded System Design 3-1-0-4

1. **Introduction to Embedded System & Design Concepts:** Introduction & examples of embedded system, Concept of embedded system design , design challenges, processor technology & IC technology, Embedded processor & general purpose processor, trades-offs, development phase of embedded system & use of software tools for development of embedded system . [4]

2. **Embedded Processor Architecture/Microcontrollers:** Role of processor selection in embedded system, overviews of 8-bits/16-bits/32-bits microcontrollers, 8051 microcontroller: Architecture, basic assembly language programming concepts, instruction sets, addressing modes, logical operations, arithmetic operations, branching instructions, Boolean instructions, subroutines, timing subroutine, serial data communication & interrupt process, assembly language programming examples [8]

3. **Interfacing, programming & real-time applications:** Memory & I/O interfacing, Timer & counter operation & Programming, Serial communication,& interrupt handling, LCD & keyboard interfacing, DS 12887 RTC interfacing, interfacing ADC/DAC, real world interfacing & applications. [12]

4. **Embedded software Architecture & Development:** Challenges & issues in an embedded software development, real-time programming language & embedded OS, Embedded software architecture: Round-Robin, Round-Robin with interrupt, RTOS architecture, tasks & tasks states, priority based scheduling, Semaphore & shared data, timer function, memory management, encapsulating semaphore & queue, hard real-time scheduling consideration, saving memory space & power. Embedded software development process & tools, implementation aspects of embedded systems, validation & debugging of embedded system. [10]

5. **Networks for Embedded system:** 12C two wire busses, the can bus, SHARC link ports, Ethernet, Myrinet, IEEE 1451.1 & IEEE 1451.2 plugs & play standards, embedded TCP/IP. [6]

Text Books:

1. Dreamtech Software Team, Programming for Embedded Systems, Wiley Publishing, Inc., 2003.
2. Mazidi and Mazidi, "The 8051 Microcontroller And Embedded Systems Using Assembly And C", Pearson Education India.
3. David E. Simon, "An Embedded Software Primer", Addison-Wesley Professional.

Total Lectures 40

EC 553 **DESIGN OF DIGITAL SYSTEMS** **3-1-0-4**
(Elective I)

Introductory concepts: Number System and floating-point numbers, Combinational logic circuits, Flip-Flops and related devices, Digital Arithmetic operations and circuits, counters and registers. [5]

Integrated Circuit Logic family: Evolution of TTL, IIL (merged structure), CML logic, 10K and 100K series of ECL, Stacked ECL, EFL. [7]

Evolution of nMOS logic: Passive load, saturated load, linear load, dynamic behaviour, Gates realization. [5]

CMOS logic families: static and dynamic behaviour, IC interfacing, TTL driving CMOS and vice-versa, different types of circuit realization. [5]

MSI Logic Circuits: Derived logic building blocks such Decoders/ drivers, Encoders, Multiplexers, De-multiplexers, Magnitude Comparators, applications. [5]

MESFET, MESFET Inverter, DCFL, supper buffer FET logic, BFL [8]

Memory Devices: General memory operations, Programmable logic devices, Semi-conductor memories, SRAM, DRAM, FAMOS, FLOTOX. [5]

Text Books:

1. R. J. Tocci : "Digital System: Principles & Applications" – PHI
2. Manufacturers IC – Data Sheet.
3. Leo Chartrand, "Advanced Digital Systems: Experiments and Concepts with CPLDs", Cengage Learning.

Reference Books:

1. John F. Wakerly, "Digital Design: Principles and Practices", Prentice Hall.

Total Lectures 40

EC 556 **Low Power VLSI Technology (Elective III)** **3-1-0-4**

1.	Introduction to low power VLSI technology.	[2]
2.	Voltage scaling and power-delay tradeoff.	[5]
3.	Threshold voltage scaling.	[4]
4.	Multi-threshold CMOS.	[4]
5.	Variable threshold CMOS.	[3]
6.	Estimation and optimization of switching activity.	[5]
7.	Reduction of switched capacitance.	[2]
8.	Adiabatic logic circuits.	[4]
9.	Low-power memories.	[4]
10.	DC-DC converters.	[3]
11.	Low-power architecture.	[4]

Text Books:

1. Weste N. H., Principles of CMOS VLSI Design, Pearsons Education Asia, 2nd Ed., 2001.
2. Geiger R. L., VLSI Design Techniques for Analog and Digital Circuits, McGraw-Hill, New York, 1990.
3. Yeo K., Rofail S. S., and Goh W., CMOS/BiCMOS ULSI Low Voltage, Low Power, Pearsons Education Asia, 2003.

Total Lectures 40

MA 509 Advanced Mathematics 3-1-0-4

1. Computer based numerical methods:
   Methods for numerical solution of algebraic and transcendental equations: Direct methods e.g. Bisection method, Regula-Falsi method; Iterative method e.g. Newton-Raphson method.
   Methods for the solution of simultaneous linear equations: Direct methods e.g. Gauss elimination method; Iterative method e.g. Gauss-Seidel method, Jacobi method
   Finite difference table for equal and unequal intervals in the independent variable values. Newton's forward and backward interpolation formula; Newton's interpolation formula for divided differences. Numerical differentiation. Numerical Integration methods: Simpson's rules, Trapezoidal rule and Romberg's method.
   Numerical solution of ordinary differential equations: Euler method, Modified Euler method and Runge-Kutta methods.
   Numerical solution of elliptic and parabolic differential equations using finite difference approach.
   [20]

2. Statistics and Probability:
   Concept of random variable, total and conditional probability, Bayes' theorem,probability distributions and probability density functions, moments and moment generating functions. Some theoretical probability distributions such as binomial, Poisson, normal, uniform, exponential, rectangular, χ^2, t, F.Sampling theory, sampling distributions and sampling techniques.Estimation theory, Point and Interval estimation of mean and variance of data. Testing of hypotheses. Simple and Composite hypothesis. Correlation and Regression. Multiple and Partial correlation and regression. Concepts of stochastic processes with special reference to Monte Carlo methods. [20]

Text Books

1. Shastri S.S., Introductory Method of Numerical Analysis, Prentice-Hall of India, 3rd Ed., 2002.
2. Trivedi K.S., Probability and Statistics with Reliability Queuing and Computer Science Application, Prentice-Hall of India, 2002.

Reference Book

1. Dass H.K., Advanced Engineering Mathematics, S. Chand and Company Ltd., 1999.

Mody University of Science & Technology, Lakshmangarh (Sikar)

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Department of CSE

Course structure for

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CA 507 **Information Systems** **3-0-0-3**

Total Lectures: 40

1. **Information:**Concepts, Information: a quality product, Classification of information, Methods of data and Information collection, Value of information, General model of a human as a information processor, Summary of information concepts and their implications, organization and information, MIS and Information concepts. [8]

2. **Information Systems, Organizations, management and Strategy:** Organisations and Information Systems, how information system impact organizations and business firms, Type of Information System, Managerial Challenges of Information Technology. Components of information System, Information System Activities. [8]

3. **Information Systems for Functional Areas:** Information for financial, Marketing, Inventory control, Production function, Personnel function, Cases related to information, requirement for above functional areas. [8]
4. **Computer Concepts & Peripherals:** Need of computer Literacy, Use and Definition of Computer, Generation of Computer, Classification of Computer, Peripherals: Input, output and storage technologies. [7]

5. **Computer System & System Software:** Brief history of Computer Hardware, Type of Computer System, Microcomputer System, Mainframe Computer System, System Software: Definition, operating system, programming language, web languages and services, Programming software. [9]

Text Book:

1. Steven Alter "Information Systems the foundation of E-Business", 4th Edition Person education, 2010.
2. Brien James A. O'and MarakasGeorge M., "Management Information System" 9th Edition, Tata McGraw Hill Education Private Limited, 2010.

Reference Book:

1. RajaramanV. "Analysis and Design of Information System", Prentice-Hall of India, 3rd Edition, 1996.
2. BasandraSuresh K. "Management Information System", Wheeler Publication, 2003.

CA 508 **Theory of Computation** **3-1-0-4**

Total Lectures:40

1. **Finite Automata and Regular Expression:** Finite State Systems, Basic definitions, Regular Languages and Regular Expressions, Finite Automata, Kleen theorem, Arden's theorem, Mealy and Moore Machine and their Conversion, Pumping Lemma for Regular Sets, Decision Algorithms, Myhill-Nerode theorem and Minimization of finite automata. [12]

2. **Context-Free Grammars:** Context-Free Grammars, Union, Concatenation of CFGs, Derivation Trees, Simplification of Context-Free Grammars, Chomsky Normal Form, Greibach Normal Form, Ambiguous Grammar, Inherently Ambiguous Context-Free Languages. [9]

3. **Context-Free Languages and Pushdown Automata:** Pushdown Automata and Context Free Languages, Pumping Lemma for CFL, Closure Properties of CFL and Decision Algorithms for CFL. [6]

4. **Turing Machine:** Turing Machine Model, Techniques for Turing Machine Construction, Turing Machines as Language Acceptor, Combining Turing Machines, Properties of Recursive And Recursively Enumerable Languages and Universal Turing Machine. [8]

5. **Chomsky Hierarchy of Languages:** Regular Grammars, Unrestricted Grammars and Turing Machines, Context-Sensitive Grammars and Linear Bounded Automata. [5]

Text Books:

1. Martin John C. "Introduction to languages and the theory of computation", 4th edition, McGraw-Hill, 2003
2 Peter linz , "An introduction to Formal Languages and Automata" , Narosa Publishing House, sixth edition, 2010.

Reference Books:

1 Hopcroft John E., Motwani Rajeev and Jeffery Ullman *D.* , "Introduction to Automata Theory, Languages, and Computation", 3rd edition, Narosa Publishing House, 2006.

2. Sipser Michael, "Introduction to Theory of Computation", 1st edition, Cengage Learning, 2012.

CA 509 **C Programming** **3-0-0-3**

Total Lectures:40

1. **Introduction:**Brief History, Library& Linking, Compilation & Execution, Data Types, Operator and Expression Identifier, Keyword and Token, Constant, Data Declaration and Definition, Operators and Expression, Precedence & Associability of Operators. [7]

2. **Control and Loop Statement:** Introduction, Selection Statements, If, The Conditional Expression, switch, Iteration Statements: for loop, while loop, do-while loop, Jump, Goto label, break and continue, exit() function. [7]

3. **Array, Function and String:** Definition, declaration and Types of Array, Operation and application of array, Brief introduction on string header files and applications of strings. Function, argument passing, scope of variable, call by reference and call by value, recursion, passing array to function. [5]

4. **Structure and Union:** Definition, Declaration and Initialization, Accessing Structure members, Arrays of Structure, Passing Structure to function, Structure to Pointer, Union. [6]

5. **Pointers:** Definition, declaration, Pointer to Pointer, NULL Pointer, De-referencing Pointer, Pointer Arithmetic , array to pointer (1-D array ,2-D array), pointer array, function to pointer. [6]

6. **File handling:** Introduction, Defining and Opening a File in read and writes mode, Closing a file and ending of file, Enumerated data types, Error Handling During I/O Operation, Random Access to Files, Command Line Arguments. [5]

7. **Storage Classes & Preprocessor:** Introduction,Storage Classes. Preprocessor Directive, Macro. [4]

Text Books:

1. Scheldt Herbert, “C The Complete Reference” Tata McGraw hill 6th edition,2010.

2. Kernighan & Ritchie, “C Programming Language” Prentice Hall Second Edition, 1988.

Reference Books:

1 Kanetkar Y.P., “Let us C Solutions” 10th edition, BPB publication, 2010.

2. Balaguruswamy E., “Programming in ANSI C “5th Edition Tata McGraw-Hill Education, 2004.

CA 510 **C++ Programming** **3-0-0-3**

Total Lectures:40

1. **Introduction**: Overview of oops, Differences between OOP and Procedure Oriented programming, Structure of a C/C++ program, Differences between C/C++, Data Types in C++, Identifier and Keywords, Constants,C++ Operators, Type Conversion,Variable declaration, statements, Expressions, Features of iostream.h,Input andOutput, Conditional Expression,Loop statements, Jump statements. [7]

2. **Data Abstraction and Polymorphism:**Class Definition, Controlling access to other functions, Memory Allocation, Different Types of Constructors, Destructor,Dynamic Creation and Destruction of Objects.Overloading functions and operators, Overloading New and Delete operators. [7]

3. **Inheritance:**Definition, DerivedClasses, Syntax of Derived Classes, Base Class, Types of Inheritance, Overloading Inherited Member Functions ,Virtual Base Class. [5]

4. V**irtual functions and polymorphism:** Static and Dynamic bindings,virtual functions, dynamic binding through virtual functions,virtual function call mechanism, implications of polymorphic use of classes , virtual destructors , calling virtual functions in a base class constructor. [6]

5. **I/O and Templates:** Standard I/O Using C functions, stream I/O in C++, formatted I/O, File I/O, generic Classes in C++, Necessity of Templates , generic classes using Macros, class templates, Function Templates, Advantages of Templates. [8]

6. **Exception and File Handling:** Benefits of exception handling, troubles with standard C functions , exception handling mechanism in C++, hierarchy of file stream classes, opening and closing files, file modes, testing for errors,file pointers and their manipulations, ASCII & Binary files, sequential and random access files. [7]

Text Books:

1. Schildt Herbert, C++: The Complete Reference ,4th edition, Tata Mcgraw Hills, 2003.

2. Balagurusamy E., Object Oriented Programming With C++,4thedition, Tata Mcgraw Hills, 2013

Reference Books:

CA 511 **Digital Electronics** **3-1-0-4**

Total Lectures: 40

1 **Number Systems and Codes:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic. [2]

2 **Introduction to Boolean Algebra:** Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [2]

3 **Logic Gates:** Diode and transistor as a switch, basic logic gates, derived logic gates, block diagrams and truth tables, logic diagrams from Boolean expression and vice versa, converting logic diagram to universal logic, positive logic, negative logic and mixed logic. [5]

4 **Simplification of Boolean Functions:** K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method. [5]

5 **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]

6 **Sequential Circuits:** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters. [10]

7 **Logic Families:** Logic gate characteristics (propagation delay, speed, noise margin, fan-in, fan-out, power dissipation), standard logic families (RTL, DCTL, TTL, ECL, MOS) [5]

8 **Programmable Logic:** Introduction to programmable logic array (PLA), programmable array logic (PAL). [1]

Text Books:

1. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Delhi, 4th Edition, 2009.
2. Floyd, T. L. and Jain, R.P., "Digital Fundamental", Pearson Education, Delhi, 8th Edition, 2009.
3. Tocci, R. J., Widmer, N. and Moss, G., "Digital System: Principles and Applications", Pearson Education, Delhi, 10th Edition, 2007.

Reference Books:

1. Puri, V. K., "Digital Electronics: Circuits and Systems", Tata McGraw-Hill, Patel Nagar, New Delhi, 4th Edition, 2001.
2. Karim, M.A. and Chen. X., "Digital Design: Basic Concepts and Principles", CRC Press Taylor & Francis Group, Printed in India by Saurabh Printers, 2nd Indian reprint, 2010.
3. Jain, R. P., "Modern Digital Electronics", Tata McGraw-Hill, Patel Nagar, New Delhi, 4th edition,1999.

CA 512 Systems Analysis and Design **3-0-0-3**

Total Lectures= 40

1. **System Concepts:** Definition, characteristics and elements, Types of system, problems in system development, principles of system building, system engineering [5]

2. **Information Systems**: Information, components and types of information system, computer based information systems. [4]

3. **System Models**: System Development Life Cycle (SDLC), Prototype, Prototype tools and strategy. [5]

4. **Systems Analysis** : Role of systems Analyst, system planning , information gathering tools for determining information requirements, cost/benefit analysis. [6]

5. **Feasibility Study** : System performance constraints, specific system objectives, steps in feasibility analysis, feasibility report. [3]

6. **Structured Analysis** : Definition, Tools of Structured Analysis: data flow diagram, decision tree and decision table. [5]

7. **System Design**: Process and stages in design, input/output and form design, control design, design of database interactions. [6]

8. **System implementation**: System testing and quality assurance, implementation and system maintenance, hardware and software selection, system security and recovery. [6]

Text Books:

1. Awad, Elis M. , " Systems Analysis and Design", Galgotia Publications Pvt. Lid, New Delhi, 1997.
2. Senn, James A., "Analysis & Design of Information ", McGraw Hill Education (india) Pvt. Ltd., New Delhi, 2005.

Reference Books:

1. Goyal, Arunesh , " Systems Analysis and Design", PHI Learning Pvt. Ltd., New Delhi, 2011.
2. Hoffer, J. A., George, J. F. and Valacich, J. S., " Modern Systems Analysis & Design", Pearson Education(Singapore) Pvt. Ltd., Delhi,2005.

CA 514 **Operating system** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Overview, Evolution,Types, operating system functions and characteristics. [3]

2. **Process Management:** The process concept, operating system services for process management, scheduling algorithms and multiple processor scheduling. [5]

3. **Memory Management:** Storage allocation methods, paging, segmentation, virtual memory concept, demand paging, page replacement algorithms and trashing. [5]

4. **Input /Output and File Systems:** Hardware organization, device scheduling policies, Functions of file systems, file access and allocationmethods, directory systems, structured organizations, directory and file protection mechanisms and implementation issues. device dependent and device independent software. [7]

5. **Deadlocks:** Characterization, prevention and avoidance, deadlock detection and recovery and practical consideration. [5]

6. **Process Synchronization:** Critical section problem, semaphores, classical process co-ordination problems and their solutions, inter process communication and message-passing mechanisms. client-server modeling, RPC, threads. [6]

7. **Protection & Security:** Goals of Protection, Principles of Protection. Domain of protection Access Matrix, Implementation of Access Matrix. Access control, Revocation of Access Rights. Capability- Based systems, Language - Based Protection, Security problem, program threats, system and network threats cryptography as a security tool, user authentication, implementing security defenses, fire walling to protect systems [9]

Text Books:

1. Silberschatz A., and Galvin P.B., Operating System Concepts, John Wiley &Sons, 6th Edition, 2005.
2. Tanenbaum A.S., Modern Operating Systems, Pearson Education Asia, 4th Edition, 200

Reference Books:

1 Stallings W., Operating Systems, Pearson Education Asia, 5thEdition, 2008.
2 Tanenbaum A.S. and Woodhull A. S., Operating Systems- Design and Implementation, Pearson Education Asia, 2nd Edition, 2009.

CA 515 Mathematical Foundation of Computers **3-1-0-4**

Total Lectures:40

1. **Matrix Theory :** Introduction to the matrix theory, types of matrices, inverse of matrices, rank of matrices, solving system of linear equations, Eigen values and Eigen vectors, Sparse matrix, diagonalization and triangulization of matrices. [16]

2. **Three -dimensional geometry and Vector calculus:** Basic concepts of three-dimensional geometry (viz. direction cosines and direction ratios), equation of a plane and of a straight line. Basic concepts of vectors, gradient, divergence and curl of a vector. [8]

3. **Calculus:** Introduction of differential and integral calculus, derivatives of various types of functions, basic idea of differential equations, solutions of ordinary differential equations with constant coefficients. [10]

4. **Complex Algebra:** Introduction to the complex algebra, complex numbers, geometrical representation of complex numbers: Argand diagram, De-Moirvre's theorem. [6]

Text Books:

1. Ramana B. V. , " Higher Engineering Mathematics", Tata McGraw – Hill Publishing Company Ltd., P 1390, 2nd edition, 2001

2. Babu Ram, "Engineering Mathematics", Pearson, New Delhi, 2010.

3. Narayan Shanti , "Analytical Solid Geometry", S Chand & Company, New Delhi,1988.

Reference Books:

1. Grewal B. S. and Grewal J. S. , "Higher Engineering Mathematics" , Khanna Publishers, New Delhi, P. 1390, 40th edition,2004

2. Kreyszig Errwin, "Engineering Mathematics", John Wiley& Sons, New York, , p. 1639, 9th Edition,1998.

CA 516 **Data Structures** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Data Structure definition, Requirement of different Data Structures, Abstract Data Type, Analysis of Algorithm. [3]
2. **Linear Data Structure:** One and Two-dimensional Arrays, Array Representation, Selection Sort, Bubble Sort, Quick Sort, Heap Sort and Merge Sort,Sequential Search, Binary Search. **L**inked List and itsrepresentations, Operations on Linked List, Types of Linked List, Stack and its representation, Operations on Stack, Queue and its representation, Operations on Queue, Applications of these data structures. [15]
3. **Tree :** Binary Tree and its travesals (Breadth-First, Depth-First), Expression Trees (Infix, Prefix, Postfix Traversals), Binary Search Trees, Heaps,AVL Tree. [12]
4. **Graph:** Matrix Representation, List representation and applications, Minimum Spanning Tree finding algorithms, Shortest Path finding algorithms. [5]
5. **Hashing Techniques:** Hash Function, Address Calculation Techniques, Common Hashing Functions, Collision Resolution, Linear Probing, Double Hashing, Bucket Hashing, Deletion and Rehashing. [5]

Text Books:

1. Horowitz and Sahani, “Fundamental of data structures”,Galgotia Publication,1998.
2. Lipschutz, “Data Structures Schaum’s Outline Series”, Tata Mcgraw Hills,2006.

Reference Books:

1 TenenbaumAaron M., YedidyahLangsam and Moshe J. Augenstein “Data Structures Using C and C++” , PHI,2009.
2. Kruse R. etal, “Data Structures and Program Design in C”, Pearson Education,2007.

CA 517 **Business Accounting** **3-0-0-3**

Total Lectures: 40

1. **Fundamentals of Accounting:** Meaning, Scope and objective of accounting, Accounting principles, Accounting concepts and conventions, Double entry system. [5]

2. **Financial Accounting:** Rules for Journalisation, Posting in ledger, Trial balance, Preparation of financial statement: Trading account, Profit and loss account, Balance sheet;Analysis of financial statement. [10]

3. **Management Accounting:** Concept andobjectives of Management Accounting, Ratio Analysis: Objectives, Advantages and limitations,Types of ratios; Funds flow analysis and Cash flow analysis, Capital budgeting. [10]

4. **Cost Accounting:** Concept and principles, Classification and elements of cost, Techniques of Cost Accounting: Marginal costing, Standard costing, Budgetary Control -Types of budgets, Preparation of budgets; Working capital. [12]

5. **Computerized Accounting**: Uses of Microsoft Excel in accounting, analysis of balance sheet with excel Tally software-application. [3]

Text Books:

1. Bhattacharya A. K, Financial accounting, Prentice Hall of India, 3rd edition, 2006.

2. Khan M.Y. and Jain P.K., Management Accounting, Tata McGraw-Hill Education,2006

3.SaxenaV.K. &VashistC.D., Advanced Cost and Management Accounting , Sultan Chand and Sons,2002.

Reference Books:

1. Jain S.P &NarangK. L, Financial Accounting, Kalyani Publications, 2013.

2.Kulkarni.Mahesh, Management Accounting, Career Publications, 2008.

3.PatankarSanjay, Management Accounting, NiraliPrakashan, 2010.

4. MaheshwariS. N., Management Accounting and Financial Control, S. Chand & Company, 1996.

5 Gupta S.P., Management Accounting, SahityaBhawan, 2nd Edition, 2000.

CA 518 Discrete Mathematics and Probability Theory **3-1-0-4**

Total Lectures = 40

1. **Set Theory:** Sets, Venn-diagrams, algebra of sets, finger sets, binary relations and equivalence relations [6]

2. **Probability Theory:**Fundamentals:Addition and multiplication of probability, Bayes theorem, Binomial, Poisson and normal distribution. [9]

4. **Graph Theory**: Introduction, graph, undirected graph, simple, multiple graph and pseudo graph, walk, path, cycle and connectivity, sub-graph, types of graph, isomorphic graph and representation of graph in computer memory. [10]

5. **Mathematical Logic:**Prepositional calculus, basic logical operations, statements generated by set conditional statements, converse inverse and contraposition statements. [8]

6. **Boolean Algebra:** Basic theorems on Boolean algebra, duality principle, Boolean functions and Boolean expressions. [7]

Text Books:

1. Rosen Kenneth H, "Discrete Mathematics & its applications with Combinatorics and Graph Theory", TMH,2012.

2. Palaniammal S., "Probability & Random Processes", PHI Learning Pvt. Ltd,2000.

3. DeoNarsingh, "Graph Theory with Applications to Engineering and Computer Science", PHI, 1979.

Reference Books:

1. Hines William W., Montgomery D. C. and Goldman David M., "Probability and Statistics in Engineering", Wiley, 2003.

2. Chart rand G. and Zhang P., "Introduction to Graph Theory", TMH, 2006.

3. Kolman B., Busby R. C. and Rass S., "Discrete Mathematical Structures", Prentice – Hall of India Pvt. Ltd, 2013.

CA 525 **Digital Electronics Laboratory** **0-0-4-2**

1 To study the use of General Purpose Digital Trainer and familiarization with the digital IC Data-Books.

2 To study AND, OR. NOT, NAND, NOR, EX-OR gates and their specified experiments.

3 To set up a 4-bit Binary Counter (74LS93) to demonstrate its sequence of Counting.

4 To study the characteristics curve of TTL and CMOS logic gates.

5 To design and test 4-bit Adder and Subtractor circuits.

6 To compare the magnitude of two 4-bit Binary Numbers A and B.

7 Design a combinational circuit with 4 inputs and 4-outputs that converts a 4-bit Gray Code to an equivalent 4-bit Binary number.

8 Design and implement a BCD to Seven Segment Decoder / Driver.

9 To design and implement a 2 to 1 multiplexer.

10 To design and implement a 1:2 & 1:4 de multiplexer.

11 To investigate the operation of various flip flops SR, JK, T and D using gates and FF ICs.

12 To study the following application of shift register using IC 74LS164 and 74LS194 (Shift Right Logic, Shift Left Logic, Parallel Load).

13 Design and test arithmetic and logic circuit using combinational circuit (logic circuit, multiplexer and 4-bit binary adder/ full adder. (Already covered in experiment no.6, 10 &11)

14 Design and test a 4-bit Up Down binary counter. (Already covered in experiment no.3)

NOTE: All experiments are to be performed on either physical apparatuses or on digital electronics simulator like Virtual Bread Board etc.

CA 527 C Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types & Operators
- Control Statements
- Arrays
- Strings

Programs

- Apply logic to print different patterns(at least 5)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- Implementing matrix operations
- Searching and Sorting
- String Manipulations
- Program to understand the decision making constructs and find the roots of a quadratic equation
- Program to understand the implementation of library function

2. Functions

Testing

- Function & Function Calling
- Storage Classes

Programs

- Function Declaration and Definition
- Function call by value and call by reference
- Illustration of storage classes

3. Pointers, Structure and Union

Testing

- Pointer
- Structure
- Union

Programs

- Declaring and initializing pointers
- Accessing a variable through its pointer
- To Implement and use user defined type structures
- Creating a new data type Date with the help of structure
- To understand the use of pointers in arrays
- To learn dynamic memory allocation and deallocation
- To implement list and pointer to list

4. File Handling

Testing

- FILE

Programs

- program to Create a File & Store Information
- program to illustrate Reading of Data from a File and to delete or replace a specific Line from a Text File
- program to Create Employee Record and Update it

CA 528 **C++ Programming Lab** **0-0-4-2**

1. Introduction to C++

Testing:
• Data Types & Operators
• Control Statements
• Arrays

Programs:

- Apply logic to print different patterns (atleast 3)
- Find average, minimum and maximum of an array elements.
- To print Fibonacci series.
- Multiplication of two matrices
- Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

2. Classes and Object

Testing:
• Class with function printing hello World
• Class with default constructor
• Class with parameterized constructor
• Destructor
• Static and constant data

Programs:

- To demonstrate classes and different types of constructors.
- Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

3. Inheritance and Polymorphism

Testing:
• Inheritance
• Function Overloading
• Operator overloading
• Overriding
• Comparisons between private, public and protected
• Virtual function and [pure]virtual class
• This pointer
• Exception handling
• Abstract class

CA 529 **Data Structures Laboratory** **0-0-4-2**

Arrays Testing:

- Array declaration and initialization
- Addition & multiplication
- Deletion of elements.

Programs:

1. To implement the array concepts for matrix applications.
2. To implement the 1-D, 2-D and 3-D array concepts for data storage and retrieval.
3. Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

Linked List Testing:

- Insertion
- Deletion
- Traversing
- Searching

Programs:

1. To implement various operations over the linked list.
2. To implement variations of linked list e.g. Circular linked list.
3. Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

Stack Testing:

- Array implementation
- Linked list implementation
- Push and Pop

Programs:

1. To implement various operations over the stack.
2. To demonstrate applications of stack e.g. infix to prefix conversion.

Queue Testing:

- Array implementation
- Linked list implementation
- Insertion
- Deletion

CA 603 **Design and Analysis of Algorithms** **3-1-0-4**

Total Lectures:40

1. **Analysis of Algorithms:** Asymptotic notation, proof by induction, solving recurrences, the Master Theorem, analysis of algorithms for time and space complexity, worst case, average case and amortized case analysis. [10]
2. **Algorithm Methodologies:** Recursion, divide and conquer algorithms, greedy algorithms, dynamic programming, backtracking and branch-and-bound with examples, applications and analysis. [12]
3. **Graph Algorithms:** Basic graph search methods (BFS, DFS), spanning trees, Prim, Kruskal algorithms, path finding and shortest path algorithms, topological sorting, bipartite graphs. [10]
4. **Infeasibility:** P and NP classes, NP hard problems, parallel algorithms-principles, models and analysis and applications**.** [8]

Text Books:

1. Cormen T. H., Leiserson C. E., Rivest R. L., and Stein C., "Introduction to Algorithms", Prentice-Hall of India, 2nd ed,2002.
2. Horowitz E., "Computer Algorithms", Galgotia Publications,2008.

Reference Book:

1. Aho A.V., Design and Analysis of Computer Algorithms, Pearson Education Asia, 2000.
2. Brassard G., "Fundamentals of Algorithmics", Prentice-Hall of India,2003.

CA 605 Computer Communication Networks 3-1-0-4

Total Lectures: 40

1. **Introduction:** Layered architecture, OSI, TCP/IP. [5]
2. **Physical Layer:** Transmission media, physical layer protocol, switching techniques. [6]
3. **Data Link Layer:** Design issues- framing, error control and flow chart, stop and wait protocol, sliding window protocol, and performance analysis. [7]
4. **Medium Access Sub Layer:** P-ALOHA, S-ALOHA, CSMA, reservation scheme, CSMA/CD, Ethernet, Token Ring, Token Bus, DQDB, FDDI. [6]
5. **Network Layer:** Rotating algorithms, congestion control, internetworking, IP Layer, X.25, ISDN, etc. [6]
6. **Transport Layer:** Quality of service, connection management, flow control and buffering, multiplexing, crash recovery, ICP. [5]
7. **Application Layer:** Network security, electronic mail, SNMP, DNS, etc. [5]

Text Books:

1. Tanenbaum A. S., "Computer Networks", Prentice-Hall of India, 4th ed.,2003.
2. Stallings W., "Data and Computer Communications", Prentice-Hall of India, 6th ed.,2003

References Books:

1. Forouzan B. A., "Data Communications and Networking", Tata McGraw-Hill, 3rd ed.,2006,
2. Hayes J. F., "Modeling and Analysis of Computer Communication Networks", Khanna Publishers.,2003

CA 606 **Cryptography and Network Security** **3-1-0-4**

Total Lectures:40

1. **Introduction**: Attacks, Services and Mechanisms, Security Attacks, Security Services, Integrity check, digital Signature, authentication. [3]

2. **Secret Key Cryptography:** Block Encryption, DES rounds, S-Boxes IDEA: Overview, comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB, CBC, OFB, CFB, Multiple encryptions DES. [6]

3. **Hash Functions And Message Digests:** Length of hash, uses, algorithms (MD2, MD4, MD5, SHS) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages, digest computation.) SHS: Overview, padding, stages. [7]

4. **Public Key Cryptography:** Algorithms, examples, Modular arithmetic (addition, multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption. Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures. [9]

5. **Authentication:** Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs offline guessing, storing. Cryptographic Authentication: passwords as keys, protocols, KDC's Certification Revocation, Interdomain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution, smart cards, biometrics. [8]

6**. Network Security:** Electronic mail security, IP security, Network management security. SSL, SET Intruders and Viruses, Firewalls, Intrusion Detection. [7]

Text Books:

1. Kaufman, c., Perlman, R., and Speciner, M., "Network Security, Private Communication in a public world", 2nd ed., Prentice Hall PTR,2002.

2. Stallings, W., "Cryptography and Network Security: Principles and Practice", 3rd ed., Prentice Hall PTR,1994.

Reference Books:

1. Stallings, W. "Network security Essentials: Applications and standards", Prentice Hall,2006.

2. Behrouz A Forouzan. "Cryptography and Network Security"; McGraw Hill.,2007.

CA 607 **Database Management Systems** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Databases and database users, database system concepts and architecture, data modeling using the Entity-Relationship (ER) model, Enhanced Entity Relationship model. [7]

2. **Relational Data Model:** Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model. [7]

3. **Structured Query Language (SQL):** SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views. [4]

4. **Database Design:** Functional dependencies and normalization of relational databases, First Normal Form (1NF), 2NF, 3NF, Boyce-Codd normal form (BCNF), multivalued dependency, 4NF. [8]

5. **Transaction Processing:** Introduction, properties, recoverability, serializability. Concurrency control techniques: Two phase locking protocol, Database recovery techniques: Recovery concepts, recovery techniques based on deferred and immediate update. [7]

6. **Object and Object-Relational Databases:** Concepts for object databases, object database standards and design, object relational systems. [7]

Text books:

1. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Management Systems, 5th Edition, Pearson Education,2008.
2. Raghu Ramakrishnan, Database Management Systems, 3rd Edition, TMH,2002.

Referenc books:

1. G.W. Hansen, and J.V. Hansen, Database Management and Design, 2nd Edition, PHI,1999.
2. Korth and Schilberschatz, Database System Concepts, 4th Edition, TMH,2006.
3. C.J. Date, Database Systems, 2nd Edition, TMH,2003.

CA 608 **Management Information Systems** **3-0-0-3**

Total Lectures:40

1. **Organization:** Hierarchy in the organization structure, information flows, concentration of authority, characteristics of managers, problem solving by managers. [5]
2. **Information Needs and Sources of Managers:** Activities of the organization, managerial activities, planning, types of management decisions and information needs, types of information needed, sources of information. [5]
3. **Basics of Management Information Systems**: Overview of information system, MIS concepts, definition, role and impact of MIS, process of management, organization structure and behaviors, decision making, information concepts, levels of information systems, system concepts, types of system, system development model. [10]
4. **Development of Management Information Systems:** Information requirements determination tools, development and implementation of MIS, choice of information technology. [6]
5. **Application of Management Information Systems:** Applications in manufacturing sector-personnel management, financial management, production management, material management, marketing management, applications in service sector, Decision support system. [8]
6. **Special Topics:** Technology of information system, business process reengineering, electronic business technology. [6]

Text Books:

1. Jawadekar W. S., Management Information Systems, McGraw-Hill, New York, 2nd ed,2002.
2. Basandra, S. K., Management Information Systems, Wheeler Publishing, New Delhi,1997.

Reference Books:

1. O' Brien, J. A., Management Information Systems, Galgotia Publications,2003.
2. Post, G. V., and Anderson D. L., Management Information Systems, Tata McGraw – Hill,2006.
3. Davis G. B., and Olson M. H., Management Information Systems, Tata McGraw-Hill,1985.

CA 609 **Java Programming** **3-0-0-3**

Total Lectures: 40

1. **The Genesis of Java:** The importance of Java to Internet, Java's magic-the byte code, the Java buzzwords, the continuing revolution, Java and HTML, using blocks of code, lexical issues, the Java class libraries. [4]

2. **Data Types, Variable, and Arrays:** Java as a strongly typed language, the simple types, integers, floating-point types, characters, Booleans, a closer look at literals, variables, type conversion and casting, automatic type promotion in expressions, arrays, a few works about string, a note to C/C++ programmers about pointers, operators-arithmetic operators, the bitwise operators, relational operators, Boolean logical operators, the assignment operator, the ? operator, operator precedence, using parentheses, control statements-Java selection statements, iteration statements, jump statements. [8]

3. **Classes:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, the this keyword, garbage collection, the finalize () method, a stack class, overloading methods, using objects as parameters, a closer look at argument passing, returning objects, recursion, introducing access control, understanding static, introducing final, arrays revisited, introducing nested and inner classes, exploring the string class, using command-line arguments. [9]

4. **Inheritance:** Inheritance basics, using super, creating a multilevel hierarchy, when constructors are called, method overriding, dynamic method dispatch, using abstract classes, using final with inheritance, the object class, Multithreading. [6]

5. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, creating your own exception subclasses, using exceptions. [7]

7. **I/O, Applets, and String Handling:** I/O basics, reading console input, writing console output, the Print Writer class, reading and writing files, applet fundamentals, the transient and volatile modifiers, string constructors, string length, special string operations, character extraction, operations on string. [6]

Text Books :

1. Schildt Herbert "Java: The Complete Reference" McGraw Hill Education; 9 edition,2014.

Reference Books:

1. Budo Timothy "Understanding Object-Oriented Programming with JAVA" . Pearson,1999.
2. Balagurusamy E " Programming with JAVA, A Primer" Tata Mcgraw Hill,2006.

CA 610 **Mobile Computing** **3-0-0-3**

Total Lectures:40

1**. Introduction,**issues in mobile computing, overview of wireless telephony: cellular concept, GSM: air-interface, channel structure, location management: HLR-VLR, hierarchical, handoffs, channel allocation in cellular systems, CDMA, GPRS. [8]

2. **Wireless Networking,**Wireless LAN Overview: MAC issues, IEEE 802.11, Blue Tooth, Wireless multiple access protocols, TCP over wireless, Wireless applications, data broadcasting, Mobile IP, WAP: Architecture, protocol stack, application environment, applications. [8]

3. **Data Management Issues**, data replication for mobile computers, adaptive clustering for mobile wireless networks, File system, Disconnected operations. [8]

4. **Mobile Agents computing**, security and fault tolerance, transaction processing in mobile computing environment. [8]

5**. Ad Hoc Networks**, localization, MAC issues, Routing protocols, global state routing (GSR), Destination sequenced distance vector routing (DSDV), Dynamic source routing (DSR), Ad Hoc on demand distance vector routing (AODV), Temporary ordered routing algorithm (TORA), QoS in Ad Hoc Networks, applications. [8]

Text Books:

1. Schiller J., “Mobile Communications”, Addison Wesley,2003.

2. Mehrotra A. , “GSM System Engineering”,1997.

3. Heijden M. V. D., M. Taylor, “Understanding WAP”, Artech House,2000.

Reference Books:

1. Perkins Charles, “Mobile IP”, Addison Wesley,1994.

2. Perkins Charles, “Ad hoc Networks”, Addison Wesley,2001.

CA 621 Database Management Systems Laboratory 0-0-4-2

1. **Creating Tables in SQL**

   Testing
   - Create command
   - Update commands
   - Insertion of records
   - Deletion of records
   - Primary Key
   - Foreign Key

   Programs
   - A Database Schema should be created with at least five relations.

2. **Populating records in relations**

   Testing
   - Entity integrity constraint
   - Referential Integrity constraint
   - Domain constraint

   Program
   - Populate the records with the above mentioned constraints for the 5 relations in the schema designed in 1.

3. **Views**

   Testing
   - Creation
   - Deletion
   - Modification

   Program
   - Create 5 meaningful views for the designed database.

4. **PL/SQL**

   Testing
   - Structures
   - Control Statements
   - Variables
   - cursors

CA 623 Computer Communication Networks Laboratory 0-0-4-2

Assignments are based on the course contents of CA 605 Computer Communication Networks.

CA 625 Java Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types and Operators
- Control Statements
- Arrays

Programs

- Apply logic to print different patterns(at least 3)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- 3 application programs based on above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.

2. Classes, Object and Inheritance

Testing

- Objects and reference variables
- Constructors and parameterized constructors
- this, static, command line arguments
- Inheritance, overloading and overriding
- super, abstract classes and Dynamic method dispatch

Programs

- Write a program to illustrate super .
- Show method overloading to calculate the area of different shapes.
- Manipulate the above program to illustrate run time polymorphism.
- application programs based on above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.

3. Package, Interfaces and Exception Handling

Testing

- importing packages
- interfaces and multiple inheritance
- exception-handling fundamentals
- built-in exceptions and creating one's own exception subclasses

Programs

- Write and execute a program which is inside a package "MyPacK".
- Write a program which imports a package.

CA 626 Software Engineering Lab 0-0-4-2

1. Design a software process model for a project based on SRS.

   Testing
   - Waterfall model
   - Prototyping model
   - Iterative model
   - Spiral model etc.

   Design SRS for 5 different projects and use CASE tool to select the model.

2. Software project estimation.

   Testing
   - Effort estimation
   - Development time estimation
   - Schedule estimation
   - Cost estimation

   Design 5 different projects and use CASE tool to estimate the effort, schedule, and cost required to develop a software product.

3. Develop data flow diagrams.

   Testing
   - Context diagrams
   - Level 1/2/3 diagrams
   - Balancing DFDs
   - Synchronous/asynchronous operations

   Draw DFDs for 5 different projects using CASE tool.

4. Develop software code as per coding standards.

   Testing
   - Reading Data
   - Data processing
   - Data storage
   - Data display

   Write code for a complete project that has these features.

5. Black box and white box testing.

CA 628 Mobile Application Development Laboratory 0-0-4-2

1. What is Android? o Setting up development environment o Dalvik Virtual Machine & .apk file extension o Fundamentals: a. Basic Building blocks - Activities,Services,Broadcast Receivers & Content providers b. UI Components - Views & notifications c. Components for communication -Intents & Intent Filters o Android API levels (versions & version names)
2. Emulator-Android Virtual Device o Launching emulator o Editing emulator settings o Emulator shortcuts o Logcat usage o Introduction to DDMS o Second App:- (switching between activities) Develop an app for demonstrating the communication between Intents
3. Basic UI design o Form widgets o Text Fields o Layouts o [dip, dp, sip, sp] versus px, Menu o Option menu o Context menu o Sub menu o menu from xml o menu via code
4. : Intents (in detail) o Explicit Intents o Implicit intents o Examples
5. Styles & Themes o styles.xml o drawable resources for shapes, gradients (selectors) o style attribute in layout file o Applying themes via code and manifest file
6. SQLite Programming o SQLiteOpenHelper o SQLiteDatabse o Cursor o Reading and updating Contacts o Reading bookmarks o
7. Notifications o Broadcast Receivers o Services and notifications o Toast o Alarms

CA 629 Computer Organization and Architecture 3-0-0-3

Total Lectures: 40

1. **Principles of Computer Organisation:** Software hardware interaction layers in computer architecture, central processing unit, machine language instructions, addressing modes, instruction types, instruction set selection, instruction cycle and execution cycle. [10]

2. **Processor and ALU Design:** Number system, computer arithmetic and ALU design, control unit, data path and control path design, microprogramming versus hardware control, RISC Vs CISC, pipelining in CPU design, superscalar processors. [10]

3. **Memory Organisation:** Memory subsystem, storage technologies, memory array organization, memory hierarchy interleaving, cache and virtual memories and architectural aids to implement these. [10]

4. **Input-Output Organisation:** Input-output devices and characteristics, input-output programming, bus interface, data transfer techniques, I/O interrupts, and channels. [10]

Text Books:

1. Mano M. M., "Computer System Architecture", Prentice-Hall of India, 3rd ed.1992.
2. Hayes J. P., "Computer Architecture and Organization", McGraw- Hill, New York, 3rd ed.,1988.

Reference Books:

1. Hwang K., "Advanced Computer Architecture: Parallelism, Scalability and Programmability", McGraw-Hill, New York.,1993.
2. Carter N., "Computer Architecture", Tata McGraw-Hill,2002.

CA 630 **Advanced DBMS** **3-1-0-4**

Total Lectures:40

1. **Parallel and Distributed Databases:** Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing – Three Tier Client Server ArchitectureCase Studies. [10]

2. **Object and Object Relational Databases:** Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance – Complex Objects – Object Database Standards, Languages and Design: ODMG Model – ODL – OQL – Object Relational and Extended – Relational Systems : Object Relational featuresinSQL/Oracle – Case Studies. [8]

3. XML Databases: XML Databases: XML Data Model – DTD - XML Schema - XML Querying – Web Databases – JDBC – Information Retrieval – Data Warehousing – Data Mining. [7]

4. Mobile Databases: Mobile Databases: Location and Handoff Management - Effect of Mobility on Data Management - Location Dependent Data Distribution - Mobile Transaction Models - Concurrency Control - Transaction Commit Protocols- Mobile Database Recovery Schemes. [7]

5. Multimedia Databases: Multidimensional Data Structures – Image Databases – Text/Document Databases- Video Databases – Audio Databases – Multimedia Database Design. [8]

Text Books:

1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Fifth Edition, Pearson Education/Addison Wesley,2010.

2. Thomas Cannolly and Carolyn Begg, “ Database Systems, A Practical Approach to Design, Implementation and Management”, Third Edition, Pearson Education,2009.

Reference Books:

1. Henry F Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, Fifth Edition, McGraw Hill,2005.

2. C.J.Date, A.Kannan and S.Swamynathan,”An Introduction to Database Systems”, Eighth Edition, Pearson Education,2006.

CA 631 **Real Time Systems** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Issues in Real Time Computing, Structure of a Real Time System. Task Classes, Performance Measures for Real Time Systems, Estimating Program Run times. Task Assignment and Scheduling -Classical Uniprocessor scheduling algorithms, UniProcessor scheduling of IRIS Tasks, Task Assignment,Mode Changes, and Fault Tolerant Scheduling. [8]

2. **Programming Language and Tools:** Desired Language characteristics, Data Typing, Control structures,Facilitating Hierarchical Decomposition, Packages, Run-time (Exception) Error handling, Overloading andGenerics, Multitasking, Low Level programming, Task scheduling, Timing Specifications, Programming Environments, Run-time Support. [8]

3. **Real time Databases**: Basic Definition, Real time Vs General Purpose Databases, Main Memory Databases,Transaction priorities, Transaction Aborts, Concurrency Control Issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time systems. [8]

4. **Real-Time Communication**: Communications Media, Network Topologies Protocols, Fault TolerantRouting. Fault Tolerance Techniques - Fault Types, Fault Detection. Fault Error containment Redundancy,Data Diversity, Reversal Checks, Integrated Failure handling. [8]

5. **Reliability Evaluation Techniques**: Obtaining Parameter Values, Reliability Models for HardwareRedundancy, Software Error models. Clock Synchronization - Clock, A Nonfault-Tolerant SynchronizationAlgorithm, Impact of Faults, Fault Tolerant Synchronization in Hardware, Fault Tolerant Synchronization in Software. [8]

Text Books:

1. C.M. Krishna, Kang G. Shin, “Real-Time Systems”, McGraw-Hill International Editions,1997.

1. Stuart Bennett, “Real Time Computer Control-An Introduction”,Second edition Perntice Hall PTR,1994.

Reference Books:

1. Peter D. Lawrence, “Real time Micro Computer System Design – An Introduction”, McGraw Hill,1988.
2. S.T. Allworth and R.N. Zobel, “Introduction to real time software design”, Macmillan, II Edition,1987.

CA 632 **Software Project Management** **3-1-0-4**

Total Lectures:40

1.**Introduction To Software Project Management :**Project Definition – Contract Management – Activities Covered By Software Project Management – Overview Of Project Planning – Stepwise Project Planning. [6]

2. **Project Evaluation :** Strategic Assessment – Technical Assessment – Cost Benefit Analysis – Cash Flow Forecasting – Cost Benefit Evaluation Techniques – Risk Evaluation. [6]

3. **Activity Planning:** Objectives – Project Schedule – Sequencing and Scheduling Activities – Network Planning Models – Forward Pass – Backward Pass – Activity Float – Shortening Project Duration – Activity on Arrow Networks – Risk Management – Nature Of Risk – Types Of Risk – Managing Risk – Hazard Identification – Hazard Analysis – Risk Planning And Control. [9]

4. **Monitoring And Control:** Creating Framework – Collecting The Data – Visualizing Progress – Cost Monitoring – Earned Value – Priortizing Monitoring – Getting Project Back To Target – Change Control – Managing Contracts – Introduction – Types Of Contract – Stages In Contract Placement – Typical Terms Of A Contract – Contract Management – Acceptance. [9]

5. **Managing People And Organizing Teams:** Introduction – Understanding Behavior – Organizational Behaviour: A Background – Selecting The Right Person For The Job – Instruction In The Best Methods – Motivation – The Oldman – Hackman Job Characteristics Model – Working In Groups – Becoming A Team –Decision Making – Leadership – Organizational Structures – Stress –Health And Safety – Case Studies. [10]

Text Books:

1. Bob Hughes, Mikecotterell, “Software Project Management”, Third Edition, Tata McGraw Hill,2011.

2. Ramesh, Gopalaswamy, "Managing Global Projects", Tata McGraw Hill,2001.

Reference Books:

1. Jalote, “Software Project Management in Practice”, Pearson Education,2002.

2. Royce, “Software Project Management”, Pearson Education,2005.

CA 633 **M -Commerce** **3-1-0-4**

Total Lectures:40

1. **Electronic Commerce:** Introduction, e-commerce marketplace, Focus on portals, Location of trading in the marketplace, Commercial arrangement for transactions , auctions business models for e-commerce, Revenue models, E-commerce versus E-business. [6]

2. **Mobile Commerce:** Overview, Infrastructure, Types of Mobile Commerce Services, Technologies of Wireless Business, Benefits and Limitations, Support, Mobile Marketing and Advertisement, Non Internet Applications in M–Commerce. [6]

3. **Mobile Commerce Technology:** Framework of Mobile Commerce,NTT Docomo‘s I– Mode, Wireless Devices for Mobile Commerce, Classification of Framework for Mobile Location Based Services, Wireless Personal and Local Area Networks, The Impact of Technology in Mobile Communications Networks. [7]

4. **Mobile Commerce Theory and Applications:** The Ecology of Mobile Commerce, Wireless Application Protocol, Mobile Business Services, Mobile Portal, Factors affecting the Adoption of Mobile Gaming Services, Mobile Data Technologies and Small Business Adoption and Diffusion. [5]

5. **Business– to– Business Mobile E-Commerce:** Enterprise Enablement, Email and Messaging, Field Force Automation, maintenance and management, Remote IT Support Customer Retention, B2C Services, Warehouse automation security. [6]

Text Books:

1. Chaffey Dave, “E-Business and E-Commerce Management”, Pearson Education, Third Edition, 2009,.

2. Mennecke Brian E., Strader Troy J., “Mobile Commerce: Technology, Theory andApplications”, Idea Group Inc., IRM press,2003.

Reference Books:

1. Louis P. J., “M-Commerce Crash Course”, McGraw- Hill,2001.

2. May Paul, “Mobile Commerce: Opportunities, Applications, and Technologies of Wireless Business” Cambridge University Press,2001.

3. Papazoglou Michael P., Ribbers Peter M.A., “e-business organizational and Technical foundation”,Wiley India,2009.

4. Dr.Pandey , Shukla Saurabh “E-commerce and Mobile commerce Technologies” , Sultanchand ,2011.

CA 634 **Software Engineering** **3-0-0-3**

Total Lectures:40

1. **Introduction To Software Engineering:** Software crisis, Software engineering Approach and Challenges, Software development process models with comparison: Waterfall, Rapid prototyping, Timeboxing and Spiral Models, and Automation through software environments. [8]
2. **Planning The Software Project:** Cost Estimation, Planning Schedule, Staffing, Project Monitoring, Quality Assurance and Risk Management. [8]
3. **Structured Analysis:** Initial Investigation, Feasibility study, Traditional and modern methods of requirement determination, SRS, Structuring the requirements: Process modeling, logic modeling, conceptual data modeling, Metrics. Validation VS verification [8]
4. **Design Fundamentals:** Function and Object Oriented Design concepts, Verification and Metrics. Coding and Maintenance: Coding Process, Metrics, Testing fundamentals, Types of Testing, Metrics, Types of Maintenance. [8]
5. **Software Re-Engineering:** Source Code Translation, Program Restructuring, Data Re-Engineering, Reverse Engineering. [8]

Text Books:

1. Sommerville Ian, “Software Engineering”, Addison Wesley, 6th ed,1995.
2. Hoffer, George, Valacich, “Modern System Analysis and Design” Pearson Education, 3rd ed,2012.

Reference Books:

1. Pressman S. Roger, “Software Engineering”, Tata McGraw-Hill,2009.
2. JalotePankaj, “An integrated Approach to Software”, Engineering, Narosa Publishing House,2014.

CA 642 **Digital Image Processing** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Background, Digital Image Representation, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System. Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry. [8]
2. **Image Transforms:** Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two-Dimensional Fourier Transform, Other Separable Image Transforms. [8]
3. **Image Enhancement :** Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background, Smoothing Filters, Sharpening Filters, Lowpass Filtering, Highpass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. [8]
4. **Image Restoring:** Degradations Model - Definitions, Degradation Model for Continuous Functions, Diagonalization of Circulant and Block-Circulant Matrices, Circulant Matrices, Block Circulant Matrices, Effects of Diagonalization on the Degradation Model, Algebraic Approach to Restoration, Unconstrained Restoration, Constrained Restoration, Inverse Filtering – Formulation, Removal of Blur Caused by Uniform Linear Motion, Restoration in the Spatial Domain, Geometric Transformation. [8]

5. **Image Compression:** Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria. Image Compression Models,The Channel Encoder and Decoder. Elements of Information Theory Measuring Information, The Information Channel, Fundamental Coding Theorems, Using Information Theory. Error-Free Compression. Lossy Compression. [8]

Text Book:

1. Rafael. C. Gonzalez & Richard E.Woods., “Digital Image Processing”, 2/e Pearson Education, New Delhi.2009.

Reference Books:

1. W.K.Pratt., “Digital Image Processing” ,3/e Edn., John Wiley and sons, Inc,2001.

2. M. Sonkaet.al “Image Processing, Analysis and Machine Vision”, 2/e, Thomson, Learning, India Edition,1998.

CA 644 **Artificial Intelligence** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Overview of artificial intelligence (AI) and AI techniques. [3]
2. **Problem Solving:** Searching, state space formulation, depth first & breadth first searches and intelligent searching. [7]
3. **Production Systems:** Design, implementation & limit factors and case studies. [7]
4. **Game Playing:** Minimax and Alpha-beta pruning. [6]
5. **Knowledge and Reasoning:** Propositional & first order topic, semantic networks, inference and logical reasoning systems. [6]
6. **Knowledge Representation:** CD, frames & scripts, learning and neural networks. [6]
7. **Advanced Topics:** Expert system, natural language processing, PROLOG. [5]

Text Books:

1. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 2nd ed,2008.
2. Bratko I., PROLOG Programming for Artificial Intelligence, 3rd ed,2001.

Reference Books:

1. Russell S., and Norvig P., Artificial Intelligence – A Modern Approach, Prentice-Hall of India, 2nd ed,2009.
2. Patterson D. W., Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall of India,1990.

CA 646 **Parallel Processing** **3-1-0-4**

Total Lectures:40

1. **Parallel Processing:** Introduction, data and control parallelism, (concurrency, scalability, speedup, Amolahl's Law), PRAM model of parallel computation, parallel algorithm design. [8]
2. **Multiprocessors and Multicomputers:** Processor organization, shared memory and message passing systems, message passing interface programming with respect to PARAM 10000. [9]
3. **Array Processing:** SIMD array processing, communications, SIMD interconnection networks, algorithms for array processing. [8]
4. **Applications:** Parallel algorithms for matrix multiplication, fast Fourier transform, linear systems, sorting, numerical integration, and optimization. [7]
5. **Parallel Programming Languages:** C, C++ and high performance FORTRAN. [8]

Text Books:

1. Hwang K., "Advanced Computer Architecture", Tata McGraw-Hill,2003.
2. Quinn M. J., "Parallel Computing", Tata McGraw-Hill, 2nd ed,2002.

Reference Books:

1. Hwang K. and Briggs F. A., "Computer Architecture and Parallel Processing", McGraw-Hill, New York.,1984.
2. Sinha P. K., "Distributed Operating System", Prentice-Hall of India,1997.

CA 648 **Service Oriented Architecture** **3-1-0-4**

Total Lectures:40

1. **Roots of SOA**: Characteristics of SOA - Comparing SOA to client-server and distributed internet architectures – Anatomy of SOA- How components in an SOA interrelate - Principles of service orientation. [5]

2. **Web Services**: Service descriptions – Messaging with SOAP –Message exchange Patterns – Coordination –Atomic Transactions – Business activities – Orchestration – Choreography - Service layer abstraction –Application Service Layer – Business Service Layer – Orchestration Service Layer [9]

3**. Service Oriented Analysis**: Business-centric SOA – Deriving business services- service modeling - Service Oriented Design – WSDL basics – SOAP basics – SOA composition guidelines – Entity-centric business service design – Application service design – Task- centric business service design [9]

4. **SOA Platform Basics**: SOA support in J2EE – Java API for XML-based web services (JAX-WS) - Java architecture for XML binding (JAXB) – Java API for XML Registries (JAXR) - Java API for XML based RPC (JAX-RPC)- Web Services Interoperability Technologies (WSIT) - SOA support in .NET – Common Language Runtime - ASP.NETweb forms – ASP.NET web services – Web Services Enhancements (WSE) [10]

5.WS-BPEL Basics: WS-Coordination overview - WS-Choreography, WS-Policy, WS-Security. [7]

Text Books:

1. Thomas Erl, "Service-Oriented Architecture: Concepts, Technology, and Design", Pearson Education,2005.

Reference Books:

1. Thomas Erl, "SOA Principles of Service Design" The Prentice Hall,2007.
2. Newcomer, Lomow, "Understanding SOA with Web Services", Pearson Education,2005.
3. Sandeep Chatterjee, James Webber, "Developing Enterprise Web Services, An Architect's Guide", Prentice Hall Professional, 2004.

CA 709 **Distributed Systems** **3-1-0-4**

Total Lectures:40

1. **Characterization of Distributed Systems:** Definition, distributed systems- Internet, intranet, mobile, ubiquitous computing, resource sharing and World Wide Web challenges- heterogeneity, openness, security scalability failure handling concurrency and transparency. [4]
2. **System Models:** Architecture models- software layers, system architecture, variations on client-server model, interfaces and objects, design requirement for distributed architectures, fundamental models-interaction models, failure model and security model. [5]

3. **Distributed Object and Remote Invocation:** Introduction to remote method invocation (RMI) and interface in distributed systems, communication between distributed objects- objects model, distributed objects, distributed objects model and design issues for RMI, implementation of RMI and distributed garbage collection, remote procedures call and sun RPC case study, events and notifications-participants, JINI distributed event specification, Java RMI case study, building client and server programs, design and implementation of Java RMI. [10]

4. **Time and Global State:** Clocks, events and process states, synchronizing physical clocks- synchronization in a synchronous system, Cristian method for synchronizing clocks, Berkley algorithm and network time protocol, global state and consistent cuts. [5]

5. **Distributed Shared Memory:** Introduction, message passing versus DSM, implementation approaches to DSM, design and implementation issues-structure and synchronization model. [5]
6. **Processes and Processors in Distributed Systems:**Threads, system models, processor allocation, scheduling, fault tolerance. [5]

7. **Distributed File System:** Design, implementation, trends in distributed file system. [6]

Text Books:

1. Coulouris G., "Distributed System Concepts and Design", Pearson Education Asia, 3rd edition, 2003
2. Tannenbaum A. S., "Distributed Operating Systems", Pearson Education Asia,2001.

Reference Books:

1. Sinha P. K., "Distributed Operating Systems", Prentice-Hall of India, 2001.
2. Valduriez O., "Principles of Distributed Database Systems", Pearson Education Asia, 2nd edition, 2002.

CA 711 **Data Mining and Warehousing** **3-0-0-3**

Total Lectures:40

1. **Overview:** Concept of data mining and warehousing, data warehouse roles and structures, cost of warehousing data, roots of data mining, approaches to data exploration and data mining, foundations of data mining, web warehousing, web-warehousing for business applications and consumers, introduction to knowledge management, data warehouses and knowledge bases. [6]

2. **Data Warehouse:** Theory of data warehousing, barriers to successful data warehousing, bad data warehousing approaches, stores, warehouse and marts, data warehouse architecture, data about data - metadata, metadata extraction, implementing the data warehouse, data warehouse technologies. [4]

3. **Data Mining and Data Visualization:** Data mining, OLAP, techniques used to mine the data, market basket analysis, current limitations and challenges to DM, data visualization. [5]

4. **Designing and Building the Data Warehouse:** Theenterprise model approach of data mining design, data warehouse project plan, analysis and design tools, data warehouse architecture, specification and development**.** [5]

5. **Web-Based Query and Reporting:** Delivering information over the web, query and reporting tools and business value, architectural approaches to delivering query capabilities over the web. [3]

6. **Web Based Statistical Analysis and Data Mining:** Analytical tools, business value from analytical tools, humble spreadsheet, statistical products overview – statistical analysis applications, correlation analysis, regression analysis, data discovery tools. [6]

7. **Future of Data Mining and Data Warehousing:** Future of data warehousing, trends in data warehousing, future of data mining, using data mining to protect privacy, trends affecting the future of data mining, future of data visualization. [3]

Text Books:

1. Marakas G. M., “Modern Data Warehousing, Mining and Visualisation”, Pearson Education Asia, 2003.
2. Mattison R., “Web Warehousing and Knowledge Management”, Tata McGraw-Hill,2002.
3. Anahory S., and Murray D., “Data Warehousing in the Real World”, Pearson Education Asia,2002.

CA 715 **Computer Graphics** **3-1-0-4**

Total Lecture:40

1. **Overview:** Display devices – Video, refresh CRT, raster scan, random scan, color CRT, monitors raster scan systems, video controller, raster scan display processor, input devices – trackball and space ball, joy-sticks, digitizers, scanners, touch panels, light pen. [4]
2. **Scan Conversion:** Primitive drawing – DDA and Bresenham algorithm for line, circle, ellipse, general curves, filling – scan line polygon fill algorithm, inside-outside tests, flood-fill, boundary-fill, attributes – area fill attributes, line and text attributes. [8]
3. **Two-Dimensional and Three-Dimensional Transformations:** Basic transformations, matrix representation and homogeneous co-ordinates, composite transformation, reflection, shear transformation. [8]
4. **Three-Dimensional Object Representations:** Polygon surfaces, polygon tables, plane equations, polygon meshes, curved lines and surfaces, quadric surfaces, spheres, curves, spline representations and spline specifications, Bezier and B-spline curves. [8]
5. **Clipping and Viewing:** Line clipping – Cohen Suther Land, Liang-Barsky, polygon clipping – Suther Land – Hodgman, Weiter-Atherton, projection and its transformation – parallel and perspective, vanishing points. [8]
6. **Visibility:** Classification and detection algorithm, back face detection, depth – buffer, scan line, depth sorting and BSP tree, ray casting method and curved surfaces. [4]

Text Books:

1. Hearn D. and Baker P. M., "Computer Graphics", Prentice-Hall of India, 2nd edition, 2004.
2. Newman W., and Sproul R. F., "Principles of Interactive Computer Graphics", McGraw-Hill, New York, 2nd ed, 1992.

Reference Books:

1. Foley J. D., and Van D. A., "Fundamentals of Interactive Graphics", Addison-Wesley, 2nd ed, 1983.
2. Roger D. F., "Procedural Elements for Computer Graphics", McGraw-Hill, New York, 2nd edition, 1985
3. Harrington S., "Computer Graphic", McGraw-Hill, New York, 2nd editon, 1995
4. Xiang Z., and Plastock R., "Theory and Problems of Computer Graphics", McGraw-Hill, New York, 2nd edition, 2000.

CA 725 COMPUTER GRAPHICS LABORATORY 0-0-4-2

1. **Introduction to computer graphics & graphics systems**

   Testing
   - Demonstration of graphics display devices, IO devices.
   - Initialization of graphic in 'C'.
   - Use of graphics primitives – line, circle, rectangle, arc, etc.

   Programs
   - Graphics programs are to be written for the above graphics primitives with color and moving effect (E.g. bus, hut, fish, kite etc).

2. **Scan conversion**

   Testing
   - Line drawing algorithms (DDA, Bresenham, mid-point).
   - Circle generation algorithm (Bresenham, mid-point)
   - Ellipse generation algorithm
   - Filling algorithm (boundary fill, flood fill, scan line polygon fill)

   Program
   - Graphics programs are to be written for each of the above algorithms.

3. **2D & 3D transformation**

   Testing
   - Translation
   - Rotation
   - Scaling
   - Reflection
   - Shearing

   Program
   - Graphics programs are to be written for each of the above algorithms for different axis.

4. **2D viewing & clipping**

   Testing
   - Line clipping algorithm (Cohen Sutherland, Liang Barsky)
   - Polygon clipping (Sutherland Hodgeman, Weiler and Atherton)

   Program
   - Graphics programs are to be written for each of the above algorithms.

CS 218 Computer Organization and Architecture 3-1-0-4

Total Lectures:40

1. **Basic Structure of Computers:** Functional units, basic operational concepts, bus structures, software performance, memory locations and addresses, memory operations, instruction and instruction sequencing, addressing modes, assembly language, basic I/O operations. [8]

2. **Arithmetic Unit:** Addition and subtraction of unsigned and signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication and fast multiplication, integer division, floating-point numbers and operations. [8]

3. **Processing Unit:** Fundamental concepts, execution of a complete instruction, multiple bus organization, hardwired control, microprogrammed control, parallel processing, pipelining, basic concepts of hazards, data and instruction hazards, data path and control hazard consideration. [10]

4. **Memory System:** Basic concepts, semiconductor RAMs, ROMs: speed, size and cost, cache memories, performance consideration, virtual memory, memory management requirements, secondary storage. [8]

5. **I/O Organization:** Accessing I/O devices, interrupts, direct memory access, buses, interface circuits, standard I/O interfaces (PCI, SCSI, USB). [6]

Text Books:

1. Hamacher Carl, Vranesic Zvonko and Zaky Safwat, "Computer Organization", , McGraw-Hill, 5th Edition, 2002.
2. Stallings William, "Computer Organization and Architecture-Designing for Performance", Pearson Education, 8th Edition, 2011.

Reference Books:

1. Mano Morris, "Computer System Architecture", Pearson Education, 3rd Edition, 2007.
2. Hayes John P., "Computer Architecture and Organization", McGraw Hill, 3rd Edition, 1998.
3. Patterson David A. and Hennessy John L., "Computer Organization and Design: The hardware / software interface", Morgan Kaufmann, 2nd Edition, 2002.

CT 509 **Basic Communication Skills** **3-0-0-3**

Total Lectures:40

1. **Spoken English:** Basic sentence types, Tenses (Present, Past, Future), Modals (can, could, shall, should, will, would, may, might, must, ought to, need), Determiners, Question Tags, Phrasal verbs. [8]

2. **Reading and Writing:** Reading Comprehension**:** Efficient reading and note taking, Proof Reading, Précis Writing, Report Writing, Theme (paragraph) Writing, Resume Writing, composing an email. [5]

3. **Advance Communication:** Definition and purpose, Art of Communication, Quizzes, exercise and incidents for practice. [6]

4. **Group Discussion:** Definition, importance, process, points to be borne in mind while participating, Do's and Don'ts in GD, Practice. [6]

5. **Interview skills:** Definition, process, types and preparation (physical, mental), Preparation for FAQ, Dos and Don'ts, Practice. [6]

6. **Communication issues:** Choice of words, sentence formation, essentials of effective communication, barriers to communication. [3]

7. **Different Notions and Concepts:** Request, order, condition, purpose, suggestion, wishes, obligation, possibility, concession. [3]

8 **Phonetics:** Phonology and morphology, body language, pronunciation. [3]

Text Books:

1. Hornby A.S.: "A Guide to Patterns and Usage", Oxford University Press, Delhi,1975.
2. Leech Geoffery: "English Grammar for today", Longman, Delhi,2009.
3. Tonguk R.K, Kumar S.K; "An English Miscellany", Oxford University Press, New Delhi,1999.

Mody University of Science & Technology
Lakshmangarh (Sikar)

College of Engineering & Technology

Department of Nuclear Science & Technology (NST)

Detailed Syllabus for

M. Tech. (Nuclear Science & Technology)

NU- 501 Quantum Mechanics and Electrodynamics 3-1-0-4

Quantum Mechanics

1. Origin of quantum theory and related experiments, wave-particle duality, wave function and its Born interpretation, uncertainty principle, Schrodinger equation, wave functions, wave packets, probability amplitudes, solutions to Schrodinger equation in one dimensions; Barrier penetration, Potential wells, Simple harmonic oscillator, Schrodinger equation in three dimensions.

[7]

2. Formalism of quantum mechanics; Liner vector space, Function spaces, Hilbert space formalism, inner product and probability, completeness of Eigen functions, delta functions, Bra & Ket notation, matrix representation of an operator, change of basis, unitary transformations.

[6]

3. General treatment of angular momentum, spin, identical particles; SHM problem by operator method; Pauli exclusion principle; Scattering theory; some calculations, Perturbation theory, WKB approximation.

[7]

Electrodynamics

4. Coulomb law and electrostatics, Laplace and Poisson equations, Maxwell's equations, partial polarization, Lorentz force, Poynting theorem. Scalar and vector potentials, Gauge transformations and gauge invariance.

[5]

5. Special theory of relativity, four vectors, Field tensor, Relativistic formulation of electrodynamics, Maxwell equations in covariant form

[4]

6. Relativistic charged particle in an electromagnetic field, Motion in uniform electric and magnetic fields and combinations of E and B fields, Non uniform static magnetic field

[4]

7. Green's function for wave equation (relativistic), Radiation from localized moving charges, Multi pole expansion, dipole and quadrupole radiation, Radiation from accelerated charge

[4]

8. Power radiated by point charge, Larmor's formula, Angular distribution of power, Bremsstrahlung and synchrotron radiation, Dispersion theory, Radiative reaction, Radiative damping

[5]

Text Books:

1. Griffiths D. J., Introduction to Quantum Mechanics, 2nd edition, Pearson, 2009.
2. Griffiths D. J., Introduction to Electrodynamics, 3rd edition, Prentice Hall India, 1999.
3. Ghatak A. K. & Lokanathan S., Quantum Mechanics: Theory and Applications, 5th edition, Macmillan India, 2004.

Reference Books:

1. Schiff L. I., Quantum Mechanics, 3rd edition, Tata McGraw-Hill, 2010.
2. Zettili N., Quantum Mechanics: Concepts & Applications, 2nd edition, Wiley, 2009.
3. Jackson J. D. Classical Electrodynamics, 3rd edition, Wiley, 1998.
4. Lifshitz E. M. & Landau L. D., Quantum Electrodynamics (Course of Theoretical Physics), 2nd edition, Pergamon Press, 1981.

NU- 503 **Nuclear Physics** **3-1-0-4**

1. Basic concepts of general properties of nuclei: Charge, Masses and relative abundances, mass defect, size and shape, binding energy, angular momentum, magnetic dipole moments and electric quadrupole moments, Parity, Nuclear radius, Radioactivity, units of radiation, Aplha, Beta and Gamma decay.

[8]

2. Nuclear forces: The Deutron, Nucleon- Nucleon scattering, p-p and n-n interactions, properties of nuclear force, phase shift analysis, Measurement of nuclear parameters, Mossbaur effect

[8]

3. Nuclear models: Liquid drop model, Fermi gas model, Shell model, Collective model, Compound nucleus and Statistical model

[8]

4. Nuclear reactions: Types of reactions and conservation laws, Reaction dynamics, Scattering and reaction cross sections, the Q of Nuclear reaction, Nuclear fission, Nuclear fusion

[8]

5. Elementary particle physics, Hadrons and leptons, their masses, spin parity decay structure, quarks and gluons, Charge conjugation, The CPT theorem and applications of symmetry arguments to particle reactions, symmetries, weak interactions

[**8**]

Text Books:

1. Krane K. S., Introductory Nuclear Physics, John Wiley, 1987.
2. Roy R. R. & Nigam B. P., Nuclear Physics; Theory and Experiments, 1st edition, New Age International, 1967.
3. Burcham W. E. & Jobes M., Nuclear and particle Physics, 2nd edition, John Wiley, 1995.

Reference Books:

1. Wong & Samuel S. M., Introductory Nuclear Physics, 2nd edition, John Wiley, 1999.
2. Cohen B. L., Concepts of Nuclear Physics, Tata McGraw-Hill edition, 2008.

NU 505 **Reactor Physics** **3-1-0-4**

Nuclear Fission; Delayed Neutrons; Reactor Types, Neutron Slowing-down and Thermalization, Critical Reactor; Multigroup Transport and Diffusion Equations for a Critical Reactor [12]

Reactor Calculations and Homogenization, Multigroup Constants, Group Constants in Resonance Region [8]

Perturbation & Variational Methods; Nodal and Finite-Element Transport Theory Methods; Integral Transport Theory [8]

Non-critical Reactors; Point Reactor Kinetics Equations; Solution of Kinetics Equations; Determination of Kinetics Parameters; Feedback; Xenon Oscillations; Fuel Depletion; Spatial Effects. [12]

Text Books:

1. P. F. Zweifel, *Reactor Physics*, McGraw-Hill, New York (1973).
2. Rudi J.J. Stamm'ler and M. J. Abbate, *Methods of Steady-State Reactor Physics in Nuclear Design*, Academic Pr (1983)
3. K. Sriram and Y. R. Waghmare, Introduction to Nuclear Science and Technology, South Asia Book (1990)
4. S.Garg, F. Ahmed and L.S.Kothari, *Physics of Nuclear Reactors*, Tata McGraw Hill, New Delhi (1986).

NU 520 Nuclear Power Plant Operation and Control 3-1-0-4

1. Applications of Reactor Physics for operation, Function of Delayed Neutron Monitoring System and method of identifying failed fuel, Neutron Flux Monitoring, Steady State operation of reactor [6]

2. Subcritical multiplication and reactor startup- Reactor operation without feedback- Analytic solution of reactor kinetics, Dynamic period , Reactor operation with feedback effects- Achievement of feedback effects, Shutdown margin [6]

3. Energy release and deposition, Heat generation parameters, Neutron flux distributions and power profiles in reactor cores, Power peaking factors, Heat generation in the structure, Reactor shutdown [6]

4. Temperature coefficients of reactivity, reactivity feedback, Loss-of-cooling accidents, Reactivity insertion accidents, Containment pressurization process, Response of a PWR pressurizer to load changes, Nuclear Power Plant control [6]

5. Review of fundamentals: Laplace transforms, frequency response and stability analysis, process identification, Advanced control techniques: Feed forward control, ratio control, cascade control, Computer process control: z-transforms, digital signal conditioning, system identification, stability analysis, classical control algorithms (PID etc.), Introduction to Model predictive and adaptive control schemes [8]

6. Sensors for pressure, flow, leak, level, temperature and composition, valve dynamics, neutronic instrumentation, reactor protection instrumentation, process instrumentation [8]

BOOKs

1. Lamarsh, John. Introduction to Nuclear Engineering. 3rd ed. Englewood Cliffs, NJ: Prentice Hall, 2001
2. Reactor Control Engineering by J M Harrer, Van Nostrand, (1963)
3. Control of Nuclear Reactors and Power Plants, by M. A. Schulz , McGraw-Hill Co., New York (1961)

Suggested Readings:

1. D R Coughanowr, Process Systems Analysis and Control, McGrawHill, 1991**.**
2. G Stephanopoulos, *Chemical Process Control*, Prentice Hall, 1985.
3. S Glasstone and A Sesonske, *Nuclear Reactor Engineering*, Vonostrand, 1981

NU- 522 Radiation Physics Instruments and Shielding 3-1-0-4

1. Atomic and Nuclear Structure, Natural and Artificial Radiation, Units and Measurement, Laws of Decay, Properties of Different Types of Radiation, Production of Radionuclides, Interactions of Charged Particles and Photons, Biological Effects of Ionizing Radiation, Radiation Protection Standards and Their Implementation [**10**]

2. Radiation detectors: Gas-filled ionization detectors-Ionization chambers, proportional counters and GM counters, Pulse height spectra and energy resolution, Semi-conductor detectors – Working of a p-n junction detector, partially and totally depleted detectors, surface barrier detectors, Lithium drifted Silicon detectors (Si(Li)), high-purity Germanium(HPGe) gamma detectors, Particle identification and time of flight technique, Scintillation detectors- scintillation mechanism in inorganic crystal scintillators and organic scintillators, Pulse height spectrum using a monoenergetic gamma ray source, Production and detection of neutrons-typical neutron sources, He proportional counters, fission counters. [**10**]

3. Radiation Instrumentation, Portable Survey Instruments, Use of radiation Survey Instruments, Scintillation Counters Radiation Shielding, Shielding Materials for Different Types of Radiation, Requirement for Shielding, Acceptable Radiation Levels for Various Areas, Merits and Demerits of Shielding Material, Criterion for Selecting Shielding Material [**10**]

4. Protection against Radiation Exposure, External radiation protection, Internal radiation protection, Calculation of Radiation Dose, Field, Man-rem and Duration of Work, Biological and Genetic Effects. [**10**]

Books:

1. Knoll G. F., *Radiation Detection and Measurement*, 3rd Edition, John Wiley and Sons (2000)
2. Martin A. A. & Samuel A. H., Introduction to Radiation Protection, 5th edition, Oxford university Press, (2006)
3. Cember H., Introduction to Health Physics, 3rd edition, McGraw-Hill, (1996)

Suggested Readings:

1. Turner J. E., Atoms, Radiation, and Radiation Protection, 3rd edition, Wiley, 1995.
2. Kapoor S. S. and Ramamurthy V. S., *Nuclear Radiation Detectors*, Wiley Eastern Limited, New Delhi (1986).

NU 523 Simulations in Nuclear Engineering 1-0-6-4

Physical simulation- advantage and limitations, Transport phenomena – concept of physical domain and computational domain- assumptions and limitations in numerical solutions [3]

Introduction to Finite difference Techniques, Finite Element Techniques, Finite Volume Techniques [3]

Basics about Monte Carlo Simulation, Algorithms for Monte carlo simulations [4]

Computational methods to analyze nuclear reactor systems described by various differentials, integral and integro-differential equations, Typical problem studies related with radionuclide decay chain, spatial dependence of radiation diffusion, transient heat diffusion [30]

Text Books:

1. Law, A. M. and Kelton, W. D., Simulation, Modeling & Analysis", 3rd Edition, Tata Mc Graw Hill , New Delhi-2003
2. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom, "The Finite Element Method for Engineers".
3. Banks, J, Carson J. S. H. and Nelson, B. L. " Discrete Event System simulations", 2nd edition , PHI, New Jersey, 1999
4. Elmer E Lewis and warren F Miller Jr., Computational methods of Neutron Transport, Wiley – Inter science, 1993

Reference Books:

1. Hector Guerrero Excel Data Analysis: Modeling and Simulation.
2. James; Biersack, J.P.; Ziegler, M.D. Ziegler, "SRIM - The Stopping and Range of Ions in Matter"
3. COMSOL Multiphysics manuals

NU 524 **Physics and Technology of Nuclear Fusion** **3-1-0-4**

1. Plasma- the fourth state of matter, Debye shielding, Collective behavior, Plasma frequency, Plasma Sheath, Plasma in nature and Laboratory, Industrial applications of plasma **[6]**
2. Basic plasma processes, Ionization and Recombination, Coulomb collision, Radiations from plasmas, Plasma Transport processes **[5]**
3. Motion of charged particles in electric and magnetic fields, Adiabatic invariance, Introduction to kinetic theory, Boltzmann equation, Vlasov plasma model, Fluid model from kinetic model, MHD equation, Plasma equilibrium and stability analysis **[6]**
4. Waves and instabilities in plasma **[5]**
5. Plasma generation using DC, RF and microwave power, Plasma diagnostics- Langmuir probe and Spectroscopy **[5]**
6. Energy crisis and role of fusion, Lawson criterion, Ignition criterion and burn physics, Plasma confinement approaches, Open and closed magnetic systems, alternate confinement concepts **[7]**
7. Fusion technology: Plasma heating, First wall sputtering and cooling, Diverter, Blanket physics, Fusion materials **[6]**

Books:

1. Introduction to Plasma Physics, F. F. Chen, 2nd edition, Plenum Press, (1984)
2. Physics of High Temperature Plasma, G. Schmidt , 2nd edition Burlington, MA: Academic Press (1979)
3. Fusion Research, Thomas J Dolan, Pergamon Press, 1982

Suggested Readings:

4. Industrial Plasma Engineering, Vol.1, Principles, J. R. Roth, Institute of Physics, 2001
5. Fusion Plasma Physics, Weston M Stacy, Wiley-VCH, 2001
6. Plasma physics and Fusion Energy, J. P. Freidberg, Cambridge University Press, 2007

NU 525 **Nuclear Power Engineering – I** **3-1-0-4**

Principles of the conversion of nuclear energy to useful power, Over view of various types of nuclear power plants that have been designed, built and operated, Economics of nuclear vs. other types of power plants. Economics of nuclear power plants, accounting for capital costs, fuel costs and O&M (operations and maintenance) costs, as well as environmental aspects - sustainability, proliferation, safety [6]

Neutron induced reactions-Reaction mechanism-microscopic cross sections-variation of cross section with neutron energy-resonances-1/v law, Nuclear fission-fission products-prompt & delayed neutrons-energy balance per fission-mechanism of fission-fissile and fertile materials[6]

Introduction of Nuclear reactor plant design, Reactor Assembly, Coolant Channels, Moderator and Auxiliary Systems, Primary heat Transport and Auxiliaries, Special Safety Systems and Reactor Shield cooling systems, Detailed features of pressurized water reactor components, including steam generators, Pressurisers and chemical-shim control systems. [12]
Problems related to features of gas-cooled reactor cycles and components, and compare/contrast those features with those of conventional LWRs. Difference in neutron spectrum and fuel type between a fast reactor and a LWR affect fast reactor physics and performance. [8]
Advanced future types of nuclear power plants that are in the design or developing stages. Reactor designs of power plants, their energy conversion principles, cycles and load-following characteristicsCompare and contrast the relative merits of different types of power plants. [8]

Text Books:

1. S. Glasstone & A. Sessoske, Vol I & II, CBS Publishers & Distributors, New Delhi (2009)

2. M. M. El-Wakil, *Nuclear Energy Conversion,* American Nuclear Society; Revised edition (1982)

3. John R. Lamarsh and Anthony J. Baratta, *Introduction to Nuclear Engineering*, 3rd Edition, Prentice Hall (2001).

NU-526 Nuclear Power Engineering-II

Chain reaction-classical four factor formula-eta vs. energy curve-conversion & breeding ratios-thermal and fast reactors.- Neutron lifetime-Conversion & breeding though eta vs. energy curve, Macroscopic cross-section, mean free path, neutron flux ,neutron current, beam attenuation-dependence of flux on space, energy, direction and time- simplified model, Neutron balance equation-rigorous Boltzmann and simplified diffusion equation through Fick's law. Multiplying and non-multiplying media

[10]

Boiling Water Reactors : **[10]**
Reactor Internals and Their Functions, Emergency Safeguard Systems, Reactor Safety, Containment System, Spent Fuel Management

Pressurized Water Reactor: **[10]**
Reactor Internals and Their Functions, Emergency Safeguard System, Reactor Safety, Containment System, Spent Fuel Management

Application of Reactor Physics for Operation **[5]**
Design Basis of Reactor Regulation and Protection System **[5]**

NU 528 **Reactor Thermal Hydraulics** **3-1-0-4**

1. Introduction – Different Reactor Types, Introduction – Types of Fuels and Steam Generators [**3**]
2. Conservation Equations, Heat Transfer – Basics, Basic Modes of Heat Transfer, Conduction Heat Transfer Equations [**4**]
3. Thermal Conductivity, Capacity and Diffusivity 1-D Steady-State Heat Conduction without Heat Generation – Plane Wall, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Hollow Cylinder, Sphere, Series-Composite Slab, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Series-Parallel Composite Slab, Composite Cylinder, Heat Flow Through Composite Structures Critical Thickness of Insulation Variable Thermal Conductivity, Conduction Heat Transfer with Internal Heat Generation Conduction Heat Transfer in Multidimensional Systems [**11**]
4. Transient Heat Transfer, Convective Heat Transfer, Heat Transfer Coefficient with Phase Change Thermosyphon cooling, Dimensional Analysis, Radiation Heat Transfer, Pressure Drop Analysis, Pressure Drop Analysis [**10**]
5. Fuel, Clad and Coolant Temperatures, Sub channel Analysis of Rod Bundle Fuels, Sub channel Analysis of Rod Bundle Fuels, Hotspot and Hot channel Factors, Coolant Channel Orificing, Introduction to Two-phase Flow and Basic Relations, Two-phase Flow and Boiling, Reactor Thermal Hydraulics Critical Heat Flux [**12**]

Books:

1. El-Wakil, M. M., Nuclear Heat Transport, McGraw Hill Book Co., New York (1985)
2. Glasstone S. & Sessonske A., Nuclear Reactor Engineering, Vol I and Vol II CBS Publishers & Distributors, New Delhi (2009)
3. Lahey R. T. and Moody F. J., The Thermal-Hydraulics of Boiling Water Nuclear Reactor, 2nd Edition, (1993)

Suggested Readings:

1. Todreas N. E. and Kazimi M., Nuclear Systems Volume I: Thermal Hydraulics Fundamentals, Taylor & Francis Pubs. 2nd Edition, (1989)

List of Nuclear Laboratory Experiments

1. To verify inverse square law using an α- source (^{241}Am) and p-i-n detector
2. Attenuation of α-particles in air and determination of thickness of mylar foil using α-source
3. Characteristic and dead time of a GM Counter, counting statistics using a GM counter
4. To determine the linear and mass attenuation coefficient of lead/ aluminium/ copper using ^{60}Co source (micro- curie) with GM setup
5. Determination of half life of ^{116}In using a GM counter
6. Determination of end point energy of β – particles by absorption method using a GM counter
7. Determination of gamma energy by using a scintillation detector
8. Determination of energy resolution of a Si- surface barrier detector with an ^{241}Am alpha source
9. Determination of the photo peak efficiency of a NaI (Tl) scintillation detector as a function of gamma ray energy.
10. Study of γ-γ directional correlation using a ^{60}Co source and a pair of scintillation Detectors
11. Study of angular distribution of Compton scattered gamma rays using scintillation spectrometer and deduction of total scattering cross section.
12. Determination of rest mass of electron by measuring the energy of Compton scattered gamma rays using a scintillation spectrometer.
13. Measurement of resolving time of a fast-slow coincidence set-up and determination of true-to- chance ratio.
14. Measurement of energy of β-particles using a β–ray spectrometer

NU 532 **Plasma Laboratory** **0-0-2**

List of Plasma Experiments

1. Glow discharge characteristic- Paschen curve
2. Density and electron temperature measurement using Langmuir probes in the glow discharge.
3. To study the conditions of striations in Plasma
4. Plasma confinement studies using magnetic field
5. Dielectric barrier discharge- plasma generation at atmospheric pressure
6. Ion acoustic wave propagation in plasma

Third Semester

NU- 603 Fast Breeder Reactors and Nuclear Engineering Materials 2-1-0-3

1. Fast breeder Reactor : Breeding requirements and fast reactors, Fast reactor system features, Oxide fuels in fast reactors, Carbide/Nitride fuels in fast reactors, Metal fuel development (emphasis on U-Pu-Zr) **[4]**

2. Fast reactor physics, Four-group flux and adjoint flux distributions, Reactivity and stability, System response to accident initiators **[3]**

3. Fast reactor thermal hydraulics: sodium heat transfer, Natural circulation in fast reactors, SGTR mitigation. **[3]**

4. Nuclear Materials and Processing: Nuclear fuels: Metallic, ceramic (Oxides, MOX and Carbide fuels)- fabrication, properties and applications, Reactor Core Materials: Zircalloys, Zr-Nb alloy--- fabrication, properties and applications in reactors, Heavy water: production process, purification and applications **[10]**

5. Fuel Chemistry, Solid Fission Products, Swelling and Fission Gas Bubbles, Fission Gas Release, Corrosion in Nuclear Reactors, Plant Life Extension **[5]**

6. Nuclear waste; types - liquid waste - solid waste - aerial effulent -disposal of fuel or wastes; waste categories – low - level waste - intermediate level waste - high level waste. Basics about Nuclear Waste treatment, PUREX, Waste forms for long-term storage **[5]**

Books:

1. Waltar A. E. and Reynolds A.B., Fast Breeder Reactors, Pergamon Press, New York (1981).
2. Bendict M., Pigford T. and Levi H., Nuclear Chemical Engineering,
3. Wilson P. D., Nuclear Fuel Cycle: From ore to wastes, Oxford Press, 1996

Suggested Readings:

1. Callister D., Fundamentals of Material Science & Engineering, Wiley
2. Raghvan V., Physical Metallurgy: Principles & Practices,
3. Gupta C. K., Materials in Nuclear Applications

NU-605 Nuclear Plant Safety & Regulatory Frame work 2-1-0-3

1. Nuclear power plant safety requirements, Basic concepts in safety and reliability, Loss of coolant accident, Conceptual design of safety systems, Risk and reliability analysis of systems, Operational safety procedures, Manrem budgeting and control, Surface contamination and control

[15]

2. Role of Atomic Energy Regulatory Board (AERB) and Department of Atomic Energy (DAE), Legislation, rules and regulations for safe electricity generation, Legislation for regulation and its effective implementation for nuclear power plants, Role of Central and State Electricity Regulatory Commissions, Applicable AERB Safety Codes, Guides and Technical Specifications, Surveillance requirements and systems, Comparison with the regulatory framework of conventional industry

[15]

Books:

1. Lewis E. E., Nuclear Power Reactor Safety, E. E. Lewis, Wiley-Inter science publication, 1977
2. M. Rosen, Regulatory Codes and Guides issued by the International Atomic Energy Agency (IAEA), (1985)

Suggested Readings:

1. Mishra K. B., Reliability Analysis and Prediction, Elsevier Publications, (1992)
2. Haldar A. and Mahadevan S., Probability, Reliability and Statistical Methods, John Wiley & Sons (2000)
3. Codes and Guides issued by the Atomic Energy Regulatory Board) (AERB), (1982), Niyamak Bhavan, Anushaktinagar, India

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Course structure for

PhD

CS 702 **Advances in Computer Science and Engineering** **Total Lectures: 52**
4-0-0-4

Prerequisite(s): Knowledge of core subjects of computer science and engineering.

Objective(s): To strengthen the knowledge of core subjects of computer science and engineering.
To provide research orientation to the students and latest developments in core areas.

1. **Digital Computer Organization and Architecture:** Boolean algebra, Combinational and sequential circuits. Minimization, Number representations and computer arithmetic (fixed and floating point), Machine instructions and addressing modes, ALU, data-path and control unit, Instruction pipelining, memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode). [10]
2. **Data Structures and Algorithms:** Arrays, stacks, queues, linked lists, trees, binary search, trees, binary heaps, graphs, recursion, searching, sorting, hashing, asymptotic worst case time and space complexity, algorithm design techniques: greedy, dynamic programming and divide-and-conquer, graph search, minimum spanning trees, shortest paths, programming in C. [10]
3. **Theory of computer science and compiler design:** Regular expressions and finite automata, context-free grammars and push-down automata, regular and context-free languages, pumping lemma, Turing machines and undecidability, compiler design: lexical analysis, parsing, syntax-directed translation, runtime environments, intermediate code generation. [10]
4. **Operating System:** Processes, threads, inter-process communication, concurrency and synchronization, deadlock, CPU scheduling, memory management and virtual memory, file systems. [6]
5. **Databases:** ER-model, relational model: relational algebra, tuple calculus, SQL, Integrity constraints, normal forms, file organization, indexing (e.g., B and B+ trees), transactions and concurrency control. [6]
6. **Computer Networks:** Concept of layering. LAN technologies (Ethernet), flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state), TCP/UDP and sockets, congestion control, Application layer protocols (DNS, SMTP, POP, FTP, HTTP), basics of Wi-Fi, network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls. [10]

Outcome(s): This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles of computing to the analysis of computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to maintain life-long learning and continue to be motivated to learn new subjects.

Reference Books:

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd edition, 2008.
2. Thomas H. Cormen, "Introduction to Algorithms", PHI, 3rd edition, 2012.
3. John E. Hopcroft, Rajeev Motwani, J D Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson, 3rd edition.
4. A V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques and Tools", Pearson, 2nd edition, 2014.
5. Galvin, Silberschatz, Gagne, "Operating System Concepts", Wiley India, 9th edition, 2015.
6. Navathe, "Fundamentals of Database Systems", Addison Wesley, 5th edition, 2007.
7. Tanenbaum, "Computer Networks", PHI, 4th edition, 2002

EC702 Advances in Electronics & Communication Engineering **Total Lectures:52**

3-1-0-4

Objective: The course focuses on the basic theory and techniques used in the area of digital signal processing, VLSI design, Microwave Engineering, Antenna & Wave Propagation and Digital Data communication. It also offers a profound understanding of the design, analysis and applications of some complex circuits and devices with the help of computer aided simulation and synthesis tool for hardware design.

Prerequisite:
Basic understanding of core engineering courses given in the syllabus, is required.

VLSI Design Technology

MOS modeling and performance parameters, Design aspects: Review of MOS transistor models , Concept of Scaling and deep submicron VLSI design, Low Power VLSI design, Issues related to high speed VLSI Design (CMOS technology), New trends in Digital VLSI design, Example of Mixed VLSI Design, Advanced Testing and Verification Approaches, Wafer cleaning processes and wet chemical etching techniques. Introduction to hardware description languages (VHDL), logic, circuit and layout verification. MEMS **[10]**

Microwave & Radar Engineering

Maxwell's Equation, Wave Equation and Boundary conditions, Transmission lines, Microwave Passive Components, Measurements of Wavelength, Frequency, Impedance, SWR etc., Q of Cavity, Microwave Linear Beam Tubes, Reflex Klystron. Traveling Wave Tube, Transferred Electron Devices, Principle of operation of Radar, Radar equation, CW and Frequency Modulated Radar, MTI and Pulse Doppler Radar **[12]**

Antenna & Wave Propagation

Introduction of Antenna & its parameters. Reciprocity theorem, Review of microwave antennas- Parabolic Reflector, Cassegrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication. Frequency- independent antennas, Scattering and diffraction. Internal-equation methods, current distribution: Self and mutual impedances. **[10]**

Digital Data Communications

Local Area networks:- token ring, Ethernet, Traditional, Fast and GIGA bit Ethernet, FDDI, DIGITAL MULTIPLEXING :- TDM , T1 carrier , CCITT , CODECS, COMBO CHIPS , North American Hierarchy , Line Encoding , T-carrier , Frame Synchronization Inter Leaving Statistical TDM FDM , Hierarchy ,Wave Division Multiplexing . **[10]**

Signal Processing

Multi-rate Digital Signal Processing: Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion. Linear Prediction And Optimum Linear Filters: Forward and backward linear prediction; Properties of the linear prediction – error filters; Applications of linear prediction., Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters. Power Spectral Estimation: Principle and traditional methods of spectral estimation; Modern methods of parametric estimation; Applications of spectral analysis,. **[10]**

Course Outcomes:

This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles to the analysis of electrical and computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to electrical and computer engineering problems.
4. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
5. Ability to be competitive in the engineering job market.

Text books

1. R.E Collin, "Antennas & Radio Wave Propagation", Mc-Graw Hill
2. D M Pozar,"Microwave Engineering", JohnWilley & Sons
3. Proakis, Rader, Ling, and Nikias, Advanced digital signal processing, Macmillan, 1992
4. John P. Uyemura : Introduction to VLSI Circuits and Systems, John Wiley & Sons,Inc, 2002
5. Electronic communication systems, fundamentals through advanced - W. TOMASI, Pearson 4th Edition.
6. Introduction to Radar, M. I. Skolnik, McGraw Hill.

Reference books

1. Annapurna das & Sisir K das, Microwave Engineering Tata Mcgraw Hill.
2. Data communication and networking - B.A. Forouzen
3. Kin. Lu. Wong, "Compact and Broadband Microstrip Antenna", John Wiley & Sons
4. S. Stergiopoulos (editor), "Advanced Signal Processing Handbook: Theory and Implementation for Radar, Sonar, and Medical Imaging Real-Time Systems", CRC Press LLC, 2001.
5. Neil Weste and David Harris, "CMOS VLSI Design ", 4thEd., Addison Wesley, 2011.

EE 702 **Advances in Electrical Engineering** **Total Lectures: 52**

4-0-0-4

Objective: To provide an exposure on the basic principles and techniques used in the area of ultra-capacitor, control systems and its sliding modes control, Smart Grid, Renewable Energy Integration. It also offers a profound understanding of the design, analysis and applications of Smart Grid, Renewable Energy integration with the help of computer aided simulation and synthesis tools / ETAP Software.

Pre-requisite: Basic understanding of core engineering courses given in the syllabus is required.

1. **Ultra- Capacitor:** Introduction, History, Basic principles of Ultracapacitors, Principles and energy storage mechanism, EC vs. Aluminum (Al) electrolytic capacitors, Capacitors vs. batteries, Benefits and limitations of Ultracapacitors, Ultracapacitor vs. Flywheels, Applications, Cell voltage, Comparison with battery or other energy storage devices, Cost of EC capacitors, Electrochemical Double Layer Capacitor: basic construction, Components of Ultracapacitor, EC capacitor sizes, Future of energy storage industry, Uninterruptible power supply and backup power. [8]
2. **Applications & Future Scenario of Ultra- Capacitor:** Modern day applications of Ultra capacitor, Future application growth, New material developments, Cost reduction, Ultra capacitor may overtake batteries, Market trends, ultra capacitors in the grid, Vehicular applications, Ultra capacitors in wind turbines, Water Desalination/Purification, New Ultra capacitor work at constant voltage, Electrochemical flow Ultra capacitor, Micro Ultra capacitor, Ultra capacitor for resistance welding. [8]
3. **Advanced control systems :** Introduction, Intuitive theory of sliding mode control, Sliding Surface, sliding mode, concept of equivalent control, sliding mode equations, sliding mode observer/differentiator, second order sliding mode. [7]
4. **Classical sliding modes:** Introduction, state feedback sliding mode control: Regular form, Eigen valve placement, quadratic minimization. State feedback control laws design: Single input system, multi-input system, unmatched uncertainty, output tracking with integral action. Output based hyper plane design, control law development. Integral sliding mode control: Problem formulations, control design objective, ISM control design. [8]
5. **Smart Grid:** Introduction, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, The Environmental Impacts of Smart Grid, Technologies Required for Smart Grid. [8]
6. **Renewable Energy Integration:** Introduction, Solar Energy, Wind Energy, Distributed Energy Resources Integration Challenges, Forecasting and Scheduling, Impacts of Renewable Energy into the Grid. [8]
7. **Smart Meter:** Details Description of Smart Meter, Benefits of Smart Meter, Technical Configurations of Smart Meter, Components of Smart Meter Network in Distribution System, Characteristics, Communication Protocols. [5]

Course Outcomes: This course helps our students to apply the knowledge of advanced principles, state of -the-art design techniques, software tools, and research methods for solving challenges of Smart Grid, Renewable Energy Integration and ultra capacitor.

Text Books:

1. R. P. Deshpande, "Ultra -capacitors: Future of Energy Storage", Mc-Graw Hill Education.
2. C-Edwards & S.K. Spurgeon, "Sliding mode control: Theory & Application", Taylor & Francis, 1998.

3. Shawkat Ali A. B. M., Smart Grids Opportunities, Developments and Trends, Springer-Verlag, London , 2013

Reference Books:

1. B. E. Conway, "Electrochemical Super capacitors: Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum Publishers (1999)
2. Utkin V.I., "Sliding modes in control & optimization", Springer-verlay, 1992.
3. Momoh James., Smart Grid Fundamentals of Design and Analysis, John Wiley &Sons, Inc., Hoboken, New Jersey, 2012

ET 901 **Research Methodology** **4-0-0-4**

1. **Introduction:** meaning of research, objectives, motivation for research, types of research, research approaches, research process, validity and reliability in research. [02]

2. **Problem formulation:** identification, selection & formulation of a research problem, objectives of formulation, criteria of a good research problem, review of literature. [03]

3. **Research design:** research framework, meaning & significance of research designs, features of a good research design, types of research design. [04]

4. Data for research: types of data, sources of data, methods of collecting data, data presentation techniques. Methods of data analysis. [10]
*Use of SPSS and MATLAB tools for data analysis.

5. **Mathematical background for research:** approaches to probability, probability distributions; binomial, Poisson, uniform, exponential and normal distributions. Review of basic statistical measures; measures of central tendency, measures of variation. Sampling methods, correlation analysis, simple regression, multiple regression, time series analysis, cluster analysis, clustering techniques. Queuing theory; introduction, simple Markovian queuing models. [10]

6. **Algorithmic Research:** introduction, types of algorithmic research problems, types of solution procedures, steps of development of algorithm. [04]

7. **Simulation:** introduction, need for simulation, simulation analysis of a case study. [03]

8. **Thesis writing:** format; general format of cover page, dedication, certificate, declaration, acknowledgement, abstract, list of contents, list of figures, list of tables, appendices, and references. Contents of thesis; background to research, literature review, problem statement, objectives of research, rationale for the study, motivation to the study, methods, definitions, research models, research design & analysis, results, findings, implications, contributions, significance of research, future directions, and conclusion. [04]
*Practical classes to be taken.

Reference Books.

1. Mr. R. Pannershelvam, "Research Methodology", Prentice Hall India, 2006.
2. Mr. C. R. Kothari, "Research Methodology : Methods and Techniques", Second edition, New Age International Publishers, 2006.
3. Mr. Ranjit Kumar, “Research Methodology: A step by step guide for beginners” , Second edition, Pearson, 2006

Outcome(s): *This course supports the achievement of the following outcomes*

- *Current trends in the rapidly evolving field*
- *The intellectual and philosophical framework necessary to explore wide spectrum of research in mechanical engineering.*
- *To contribute to expanding the frontiers of knowledge and to provide research training.*
- *Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, and research methods for solving engineering problems*

Text Books:

1. Timoschenko S.P. and Goodier J.N, "Theory of elasticity" McGraw-Hill Publishers
2. Dally and Riley, "Experimental stress analysis", McGraw-Hill Publishers
3. B.H. Amstead, Philip F, Ostwald and Myron L, "Manufacturing Processes" Begeman, John Wiley and sons, eighth edition.
4. Sunil Chopra & Peter Meindl, "Supply Chain Management: Strategy, Planning & Operation", Pearson Education Asia
5. Rao S. S, "Engineering Optimization- Theory and Practice", New Age International
6. Nag P. K, "Basic and Applied thermodynamics", TMH, Latest Edition
7. William M. Kays, Michael E. Crawford, "Convective Heat Transfer"**,** McGraw-Hill Publishers.

Reference Books:

1. Boresi & Sidebottom, "Advanced Mechanics of materials", Wiley International.
2. Garg and Venkitakrishnan, "Enterprise Resource Planning: Concepts and Practice", 2nd Ed, PHI
3. G.F. Benidict, "Advanced Manufacturing Processes",Marcel Deker Publisher.
4. Van Wylen G.H. & Sonntag R.E, "Fundamentals of Classical Thermodynamics", John Wiley & Sons.

NT-702 Advances in Nanoscience and Technology Total 52 lectures
3-1-0-4

Objective: The course focuses on the basic theory and techniques used in the area of nano Science & Technology. The paper covers important areas and gives profound understanding about nano world, synthesis of nano materials, various characterization techniques for nano materials and applications of nano Science & technology in the area of modern electronics, medical sciences and environmental sciences. It may guide and help the student in deciding about the research area in which he/ she may like to contribute further.

Pre-requisite:
Basic understanding of core science and engineering courses given in the syllabus

Course Outcomes:

This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles to the analysis of nano science & technological problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems
3. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to nano science & technology problems.
4. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
5. Ability to be competitive in the innovative research areas and relevant job market.

Syllabus details

1. Nano World : [12]

Introduction, History of nanomaterials, what is nano? Beginning of Nanoscience, Moore,s law, Nanoscience: The multidisciplinary science, Different types of nanomaterials, Properties of nanomaterials, Zero dimensional, one-dimensional and two dimensional nanostructures-clusters of metals and semiconductors, nanwires, Size dependent properties-size dependent absorption spectra-phonons in nanostructures, seeing nano-objects

2. Synthesis of Nanomaterials: [16]

Physical Methods: Top-down and bottom-up approach, Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxial, Chemical vapour deposition method and other variants, Electro deposition.

Chemical Methods: Chemical reduction method, Sol- gel, Micelles and microemulsions, Solvothermal synthesis, hydrothermal methods, photochemical synthesis, electrochemical synthesis, Thermolysis routes, Sonochemical routes, Liquid-liquid interface, Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, template synthesis, organic block copolymers, porous silicon, and Pulsed electrochemical deposition. Nanoporous Materials, Silicon, Zeolites, mesoporous materials, nanomembranes and carbon nanotubes, AgX photography, smart sunglasses, and transparent conducting oxides, molecular sieves, nanosponges.

Biological Methods of Synthesis: Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis

3. Characterization Techniques : [12]

X-ray diffraction, Scanning Probe Microscopy, SEM, TEM, Optical microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurements, Magnetic and electrical measurements. Lithographic Techniques: AFM based nanolithography and nanomanipulation, E beam lithography and SEM based nanolithography and nanomanipulation, Ion beam lithography, oxidation and metallization. Mask and its application. Deep UV lithography, X-ray based lithography

4. Applications of Nanomaterials: [12]

Electronic Applications:

Applications of nano for IC chips, STM based lithography-Molecular electronics- LEDs- Memories – CNT and Graphene based Electronic devices - transistor based sensors and its general applications- Applications of Nanomaterials in Space

Applications of Nanomagnetic materials

Nanomagnetism- Bionanomagnetism- type of magnet materials –tag and drag drug delivery – hyperthermia- hypothermia-MRI

Environmental Applications:

Bioremediation- removal of bacteria and microbes- sensors for DNA- Proteins, and Biological applications – self assembly systems- tissue culture- nanopharma

Text Books:

1. Nanoworld: An introduction to Nanoscience and technology – C N R Rao
2. A Textbook of Nanoscience and Technology: T. Pradeep
3. Nano: The Essentials-T. Pradeep
4. Introduction to Nanotechnology, Wiley, Charles P. Poole Jr. & Frank J. Owens
5. Lehninger Principles of Biochemistry, Sixth Edition, Nelson and Cox, W.H. Freeman and Company

References:

1. Physical Chemistry: Gilbert W. Castellan
2. Physical Chemistry of Surfaces: Authur W. Adamson, Alice P. Gast
3. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C. N. R. Rao, Achim Müller, A. K. Cheetham, Wiley
4. NANO: The Next Generation-Mohan Sundar Rajan, National Book Trust, India

SESSION 2017-2018

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

B.Tech CSE

CS-14.101 **Programming Language** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To learn principles of programming by the structured native language 'C'.
- To comprehend the rudiments, constructs, syntax, and statements with essentials of efficient compiling, running and debugging processes.

1. **Introduction:** The role of programming languages, programming paradigms, language description and syntax structure, basics of structured programming, object-oriented programming, functional programming, logic programming, concurrent programming. [10]

2. **Fundamentals of 'C' language** : Character set, variables data types constants, arithmetic,relational and logical operators, type conversion,increment,decrement, bitwise and assignment operators, conditional expressions, statements and blocks, *if-else*,*switch*, loops-*do-while*, *while*, *for*; *break*, *continue* and *goto* statements, labels. [10]

3. **Functions, pointers and Arrays**: Basics of functions, automatic, external, static and register variables, scope rules, and header files, recursion and C preprocessor, arrays, pointers and addresses, pointers and arrays address arithmetic, character pointers and functions, pointer arrays, pointers to functions, pointers and multidimensional arrays, command line arguments. [10]

4. **Structures, unions and file processing:** Basics of structures, structures, and functions, arrays of structures, pointers to structures, self-referential structures, unions, bit fields, theconcept of files, standard input and output, formatted output, file access in different modes, reading from and writing to a file. [10]

Outcome(s):

- Students would be able to apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner.

Text Books:

1.Brain W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second edition, Pearson Education, 2013,

2.Ravi Sethi&K.V.Viswanatha, Programming Languages-Concepts, and Constructs, Second edition, Pearson Education,2013,

Reference Books:

1.Herbert Schildt, C: The Complete Reference, Fourth Edition, McGraw-Hill Education, 2017

2.E Balagurusamy, Programming in ANSI C, Tata McGraw - Hill Education,6th edition,2012

CS-14.201 **Discrete Structures** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): None

Objective(s):
- To Introduce fundamental concepts and applications of discrete structure in the field of computer science

1.	**Sets, Relations and Functions**: Set theory, combination of sets, multi-sets, ordered pairs, set identities, relations, operations on relations, properties of relations, composite relations, equality of relations, order of relations, functions, classification of functions, operations on functions, recursively defined functions.	[8]
2.	**Partially Ordered Sets:** Definition, combination of partial order sets, Hasse diagram, lattices: definition, properties of lattices: bounded, complemented, modular and complete lattice, morphisms of lattices.	[6]
3.	**Algebraic Structures:** Groups, subgroups and order, cyclic groups, cosets, Lagrange's theorem, normal subgroups, permutation and symmetric groups, group homomorphisms, rings, fields, integers modulo n.	[6]
4.	**Propositional Logic:** Proposition, well formed formula, truth tables, tautology, satisfiability, contradiction, algebra of proposition, theory of inference, natural deduction, predicate logic: first order predicate, well formed formula of predicate, quantifiers, and inference theory of predicate logic.	[7]
5.	**Counting:** Basic principles, permutations, combinations, summations, principle of inclusion and exclusion, pigeon-hole principle, generating functions and recurrence relations.	[6]
6.	**Graph Theory:** Graphs, isomorphic and homomorphic graphs, subgraphs, Eulerian chains and cycles, Hamiltonian chains and cycles, graph traversal algorithms, chromatic number, plannar graph.	[7]

Outcome(s): On the successful completion of the course, the student will be able to:
- Understand the theory and techniques of logic, graphs and trees, and algebraic systems.
- Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.

Text Books:
1. Bernard Kolman, Robert C., Busb Sharon, Cutler Ross, Discrete Mathematical Structures, PHI, 6th Edition, 2009.
2. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw- Hill, 7th Edition, 2011.

Reference Books:
1. Swapan Kumar Chakraborty, BikashKanti Sarkar, Discrete Mathematics, Oxford Higher Education, 2011
2. C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, Tata Mcgraw-Hill, 3rd Edition, 2008.

CS-14.202 **Java Programming** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 14.101 (Programming Language)

Objective(s): The objective of this course is to:

- cover issues related to the definition, creation and usage of classes, objects and methods.
- discuss the principles of inheritance and polymorphism.
- provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- cover the basics of API and to explore the java abstract programming interface.

1.	**Overview:** Introduction to Java, importance of Java, interactive Development Environments: Eclipse/Net Beans, basics of OOP.	[4]
2.	**Data Types, Variable, and Arrays:** Primitive data types, type casting, arrays, operators and control structures, identifiers, constants and literals.	[6]
3.	**Classes and Objects:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, this keyword, garbage collection, the finalize() method, overloading methods, using objects as parameters and return type, introducing access control, understanding static, introducing final, introducing nested and inner classes, exploring the string class, using command-line arguments.	[9]
4.	**Inheritance:** Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final in inheritance, the object class.	[4]
5.	**Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, JAVA's built-in exceptions, user defined exception.	[6]
6.	**Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managing threads, thread class built-in functions.	[4]
7.	**I/O and String Handling:** I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer.	[7]

Outcome(s): Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifies, automatic documentation through comments, error exception handling).
- Use of development environment like Eclipse for collaborative programming

Text Books:

1. Herbert Schildt, Java The Complete Reference, Herbert Schildt, 8th Edition, 2011.
2. John Jukowski, Mastering Java, 2002.

Reference Books:

1.Allen B. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
2. Paul Deitel, Harvey Deitel , Java How To Program (Early Objects), 10th Edition, 2014.

CS -14.203 **Data Structures** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1.	**Introduction:** Basic terminology, elementary data organization, algorithm, efficiency of an algorithm, time and space complexity, asymptotic notations, time-space trade- off, abstract data types.	[4]
2.	**Array:** Definition, single and multidimensional arrays, representation of arrays: row major order, and column major order, application of arrays, sparse matrices and their representations.	[4]
3.	**Searching & Sorting:** Sequential search, binary search, comparison and analysis, hash function, collision resolution strategies, insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort.	[6]
4.	**Linked list:** Singly linked lists, doubly linked list, circular linked list, insertion, deletion, traversal, polynomial representation and addition, generalized linked list.	[6]
5.	**Stack:** Primitive stack operations: push and pop array and linked list implementation of stack, application of stack: prefix and postfix expressions, evaluation of postfix expression, recursion, and tower of Hanoi problem.	[4]
6.	**Queue:** Queue operations, circular queues, array and linked list implementation of queues, dequeue and priority queue	[4]
7.	**Tree:** Binary trees, binary tree representation, tree traversal algorithms: inorder, preorder and postorder, threaded binary trees, Huffman algorithm, binary search trees AVL trees.	[6]
8.	**Graph:** Terminology, sequential and linked representations of graphs: adjacency matrices, adjacency list, adjacency multi list, graph traversal: depth first search and breadth first search, spanning trees.	[6]

Outcome(s): On the successful completion of the course, the student will be able to:

- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:

1. Lipschutz, "Data Structures" Schaum's Outline Series, TMH, Revised Edition Feb. 2014

Reference Books:

1.Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI, 2nd Edition, 2012.

2. Horowitz and Sahani, Fundamentals of Data Structures, University Press, 2nd Edition2008.

3. Jean Paul Trembley and Paul G. Sorenson, An Introduction to Data Structures with applications, McGraw Hill, 2nd Edition, 2003.

4. G. A. V. Pai, Data Structures and Algorithms, TMH, 2008

CS-14.204 **Database Management Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS 14.207(Computer Information System), CS14.203 (Data Structures).

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS & RDBMS in the organization.

1.	**Introduction:** Databases and database users, database system concepts and architecture, data modeling using the entity-relationship (ER) model, enhanced entity relationship model.	[7]
2.	**Relational Data Model:** Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model.	[7]
3.	**Structured Query Language (SQL)**: SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views.	[4]
4.	**Database Design:** Functional dependencies and normalization of relational databases, first normal form (1NF), 2nf, 3nf, boyce-codd normal form (BCNF), multi valued dependency, 4NF, join dependency, 5NF.	[8]
5.	**Transaction Processing:** Introduction, properties, recoverability, serializability, concurrency control techniques: two phase locking protocol, concurrency control based on time-stamp ordering, database recovery techniques: recovery concepts, recovery techniques based on deferred and immediate update, the ARIES recovery algorithm.	[7]
6.	**Object and Object-Relational Databases:** Concepts for object databases, object database standards and design, object relational and extended relational systems.	[7]

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.

Text Books:

1. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Management Systems, Edition, Pearson Education, 2013.

2. Raghu Ramakrishnan, Database Management Systems, 3rd Edition, Tata McGraw Hill, 2008.

Reference Books:

1. G.W. Hansen, and J.V. Hansen, Database Management and Design, 2nd Edition, Prentice Hall India, 2000.

2. Korth and Schilberschatz, Database System Concepts, 5th Edition, Tata McGraw Hill, 2006.

3. C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CS -14.205 **C++ Programming** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To get a basic knowledge of object-oriented concepts.
- To master in programming related to classes inheritance using C++.

1.	**Object Oriented Programming:** Basic concepts of object-oriented programming, Structured versus object oriented programming, merits and demerits of object oriented methodology.	[5]
2.	**Beginning With C++:** Preprocessor directives, Variables, data types, constants, operators, scope resolution operator, memory management operators, decision and loop controls, arrays, strings, functions	[5]
3.	**Classes And Objects:** Class definition, Structure versus class, accessing member functions within a class, data hiding, arrays within a class, static data and member functions, objects, friend functions and friend classes, constant member functions, pointers to members, constructors and destructor	[7]
4.	**Overloading and Exception Handling:** Definition, unary operator overloading, binary operators overloading, overloading of new and delete operators, manipulation of string using operators, type conversion, overloading with friend functions, function overloading, error and exception handling	[8]
5.	**Inheritance and Overriding:** Derived and base classes, type of inheritance, Derived class constructors and destructor, overriding member functions, public and private inheritance, virtual base classes, abstract classes, this pointer, virtual functions and pure virtual functions, static and dynamic bindings	[8]
6.	**I/O Streams and The Standard Library:** Header files, I/O stream library, stream I/O for objects, File I/O.	[4]
7.	**Templates:** Class templates, function templates, overloaded function templates, member function templates.	[3]

Outcome(s): On the successful completion of the course, the student will be able to:

- To gain the basic knowledge on object oriented concepts.
- To understand the role of inheritance, polymorphism, dynamic binding and generic structures in building reusable code.
- To implement features of object oriented programming to solve real world problems.

Text Books:

1. Herbert Schildt, "C++: The Complete Reference "4th edition, TMH July 2017.
2. Robert Lafore, "Object-Oriented Programming in C++", 4th edition, SAMS.

Reference Books:

1. Bjarne Stroustrup,"Programming-Principles and Practice Using C++", Addison-Wesley,4th Edition 2013
2. E. Balagurusamy,"Object Oriented Programming With C++",5th edition 2011, TMH

CS -14.206 **Theory of Computation** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): CS 14.201(Discrete Structures)

Objective(s): The goal of this course is to

- Provide students with an understanding of basic concepts in the theory of computation.
- To understand variety of issues in the mathematical development of computer science theory, particularly finite representations for languages and machines, as well as gain a more formal understanding of algorithms and procedures.

1. **Finite Automata and Regular Expression:** Finite state systems, basic definitions, regular languages and regular expression, finite automata ,Equivalence of DFA and NDFA , Kleen's theorem, pumping lemma for regular sets, regular expression with algebraic method Using Arden's Theorem, closure properties of regular sets, minimization of finite automata, Mealy and Moore machine - conversion of Mealy machine into Moore machine and vice versa. [11]
2. **Context-Free Grammars:** Context-free grammars, union, concatenation of CFG, derivation trees, simplification of context-free grammars, Chomsky normal form, Greibach Normal form, ambiguous context-free grammar. [9]
3. **Context-Free Languages and Pushdown Automata:** Pushdown automata and context-free languages, pumping lemma for CFL, closure properties of CFL, decision, algorithms for CFL. [8]
4. **Turing Machine:** Turing machine model, techniques for Turing machine construction, Turing machines as language acceptor, combining Turing machines, properties of recursive and recursively enumerable languages, universal Turing machine. [8]
5. **Chomsky Hierarchy of Languages:** Regular grammars, unrestricted grammars and Turing machines, context-sensitive grammars and linear bounded automata. [4]

Outcome(s):

- Be able to prove the equivalence of languages described by finite state machines and regular expressions.
- Be able to construct pushdown automata and the equivalent context free grammars.
- Be able to prove the equivalence of languages described by pushdown automata and context free grammars.
- Be able to construct Turing machines and Post machines.
- Be able to prove the equivalence of languages described by Turing machines and Post Machines.

Text Books:

1. Peter Linz, An Introduction to Formal Languages and Automata, Third Edition, Jones and Bartlett, 2001.
2. Hopcroft, Motwani, Ullmann, Introduction to Automata Theory, Languages and Computation, Pearson Education, Second Edition, 2005.

Reference Books:

1. Daniel I. A. Cohen, Introduction to Computer Theory, Prentice-Hall, Second Edition,1997.
2. Martin, Introduction to Languages and the theory of Computation, Tata McgrawHill, Third Edition, 2006

CS-14.207 **Computer Information Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): None

Objective(s):

- To give essential knowledge about computer information system and its components

1.	**Introduction:** Evolution of computers, generation of computers, classification of computers, block diagram of digital computers, memory unit, ALU,CPU, I/O devices, basic bus architecture, software classification, machine language, assembly languages and high level languages, assembler, compilers and interpreters, process of compilation, programming language generations, introduction to operating systems and role of the operating system.	[8]
2.	**Digital Logic:** Introduction to Boolean algebra and logic gates, K-map representation and Boolean function simplification, number systems: conversion from one number system to another, binary operations, complement representation of numbers, alphanumeric codes, floating point representation of numbers, floating point arithmetic operations.	[6]
3.	**Digital Circuit Building Blocks:** Adders, subtractors, comparators, encoders, decoders, multiplexers, de-multiplexers, latches, flip-flops, master slave flip flops, shift registers and counters.	[10]
4.	**Internet Technologies**: Introduction to computer networks, Internet, WWW and E-mail, web browsers, introduction to LAN,MAN, WAN, introduction to the design of web pages, HTML tags and CSS, web servers, server scripting, XML.	[8]
5.	**Software Development:** a systematic approach to program design, coding, testing, and debugging, application of these skills to the construction of robust programs, use of programming environments and tools to aid in the software development process.	[6]
6.	**Computers and Society**: Impact of computers in social life, education, business, issues of security and privacy, computer ethics.	[2]

Outcome(s):

- On successful completion of this course, students will be able to take specialized courses with strong fundamentals of Computer Information Systems.

Text Books:

1. P.K. Sinha, Computer Fundamentals, BPB Publications, 6th Edition, 2017
2. M. Morris Mano, Digital Logic & Computer Design, Pearson, 2nd Edition, 2010
3. Roger S. Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill Higher Education, 8th Edition, 2014
4. Thomas Powell, HTML and CSS: The Complete Reference, Tata McGraw-Hill, 5th Edition, 2010

Reference Books:

1. Andrew S.Tanenbaum, Computer Networks, Pearson Education, 5th Edition, 2013
2. Rajaraman, Fundamentals of Computers, PHI, 6th Edition, 2014

CS-14.232 **Computer Organization and Architecture** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.207 (Computer Information System)

Objective(s):

- To have a thorough understanding of the basic structure and operation of a digital computer.
- To discuss in detail the operation of the arithmetic unit including the algorithms &
- implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
- To study the different ways of communicating with I/O devices and standard I/O interfaces. To study the hierarchical memory system including cache memories and virtual memory.

1.	**Introduction:** Von-Neuman architecture, register transfer and micro operations: register transfer language, arithmetic micro-operations, logic micro-operations, shift micro- operations, bus and memory transfers, computer organization and design: instruction cycle, computer registers, common bus system, computer instructions, addressing modes, design of a basic computer.	[8]
2.	**Central Processing Unit:** General register organization, stack organization, instruction formats, data transfer and manipulation, program control, RISC, CISC characteristics, pipeline and vector processing: pipeline structure, speedup, efficiency, throughput and bottlenecks, arithmetic pipeline and instruction pipeline	[8]
3.	**Computer Arithmetic:** Hardware implementation of addition and subtraction, multiplication algorithms, Booths multiplier, array multiplier, division algorithms, floating point arithmetic: floating point representation, add, subtract, multiplication, division.	[8]
4.	**Memory & I/O Organization:** Memory hierarchy, RAM, ROM chips, memory address map, memory connection, associative memory, cache memory and virtual memory: paging and segmentation, auxiliary memory: magnetic disks, magnetic tapes, Input-output interface, Asynchronous data transfer, modes of transfer, priority interrupt, DMA, IOP.	[8]
5.	**Hardwired and Microprogrammed Control:** Hardwired control, microprogrammed control: microinstruction, microprogram sequencing, wide-branch addressing, microinstruction with next-address field, prefetching microinstruction.	[6]
6.	**Advance Topics:** Case study on Pentium series processors.	[2]

Outcome(s): On the successful completion of the course, the student will be able to:

- Understand basic structure of a digital computer.
- Perform arithmetic operations of binary number system.
- Know the organization of the control unit, arithmetic and logical unit, memory unit and the
- I/Ounit.

Text Books:

1. M. Morris Mano, Computer System Architecture, Pearson Education, 3rd edition, 2008.
2. Carl Hamacher, ZvonkoVranesic and SafwatZaky, Computer Organization, Tata McGraw Hill, 5th edition, 2002.

Reference Books:

1. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/ Software interface, Elsevier, 3rd edition, 2005.
2. William Stallings, Computer Organization and Architecture – Designing for Performance, Pearson Education, 6th edition, 2000.
3. John P. Hayes, Computer Architecture and Organization, Tata McGraw Hill,3rd edition,1998.

CS-14.301 **Design and Analysis of Algorithms** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): CS-14.201(Discrete Structures), CS-14.203(Data Structures)

Objective(s):
- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms power.

1.	**Introduction:** Fundamentals of algorithms and problem solving, asymptotic notations, time complexity and analysis of algorithms, solutions of recurrence relations, master theorem and summations techniques.	[8]
2.	**Analysis of Sorting and Searching Algorithms:** Linear, binary and interpolation search, insertion, selection, merge, quick and heap sort, stability and other issues, hashing.	[8]
3.	**Algorithm Design Approaches:** Greedy method (knapsack problem, job sequencing problem), dynamic programming (assembly line scheduling, matrix chain multiplication), backtracking (8 queens problem, sum of subsets), branch and bound (0/1 knapsack problem), divide and conquer algorithms (Strassen matrix multiplication), problems based on these design paradigms.	[8]
4.	**Tree and Graph algorithms:** Spanning trees, Prim and Kruskal's algorithm, Huffman coding, BFS and DFS, disjoint set operations, connected components, shortest path algorithms in a graph such as Dijkstra, Bellman Ford, Warshall's etc.	[8]
5.	**Complexity Classes:** P,NP,NP hard and NP complete problems, reducibility, decision and optimization problems, examples of NP complete problems such as 3 CNF, clique, vertex cover and traveling salesman problem, basic introduction of approximation algorithms.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:
- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.
- Modify existing algorithms to improve efficiency.

Text Books:
3. Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, PHI Learning Private Limited, 3rd edition, 2016.
4. Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, Computer Algorithms, Silicon Press, 2nd edition, 2008.

Reference Books:
3. Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 3rd edition, 2012.
4. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, 1st edition, 2006.
5. Donald E. Knuth, The Art of Computer Programming, Volumes 1& 3, Pearson Education, 2009.
6. Steven S. Skiena, The Algorithm Design Manual, Springer, 2nd edition, 2008.

CS-14.303 **Operating System** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.207 (Computer Information System)

Objective(s):

- Understand the fundamental operating system abstractions like processes, threads, files, semaphores, IPC and deadlocks.
- Understand operating system from user's perspective as well as from system's perspective.
- Understand the principles of concurrency and synchronization.
- Understand basic resource management techniques.
- Understand different theoretical principles in depth through hands on high level programming.

1.	**Overview:** Definition, types of operating systems: mainframe, server, multiprocessor, personal computer, real-time, embedded and smart card, system calls and utilities, batch, multiprogramming and multitasking operating system.	[3]
2.	**File Systems:** File concept, user and system programmer view of file systems, different modules of a file system, disk structure, disk-space allocation methods: contiguous, linked, indexed directory structures, file protection, disk scheduling algorithms.	[6]
3.	**Process Management:** Process concepts, threads, scheduling concepts, types of schedulers, scheduling algorithms, process state diagram, comparison of various CPU scheduling algorithms, multi-level queue scheduling.	[6]
4.	**Memory Management:** Logical and physical address spaces, base, limit and relocation registers, address binding, dynamic loading and linking, partitioning, swapping, contiguous memory allocation, non-contiguous memory allocation: segmentation, paging and segmentation.	[8]
5.	**Process Synchronization and deadlock:** Independent and concurrent processes, shared memory approach and message passing approach, mutual exclusion, synchronization, inter process communication, critical section problem and its solution to semaphores: binary and counting semaphores, wait/signal operations and their implementation, classical problems of synchronization, deadlock.	[11]
6.	**Case Studies:** Windows, UNIX and Linux: scheduling and memory management.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Analyze the primary functionalities of operating system.
- Manage system resources efficiently as an operating system designer.
- Develop new operating systems as well as work on existing ones to develop them further.

Text Books:

1. Galvin, Silberschatz, Gagne, Operating System Concepts, Wiley India, 9th edition, 2015.

Reference Books:

1. Andrew S. Tanenbaum, Modern Operating Systems - Prentice-Hall, Inc., 4th edition, 2015.
2. Deitel, Operating Systems, Pearson Education , 3rd edition, (2012 reprint).
3. **Stallings, Operating Systems: Internals and Design Principles, Pearson education, 7th edition 2013.**

CS-14.305 **Logic in Computer Science** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.201(Discrete Structures), CS-14.207(Computer Information Systems)

Objective(s):

- To introduce the main notions of mathematical logic: logical notations (syntax) and how to assign meaning to them (semantics).
- To study formal frameworks (in the sense of being rigorous as well as in the sense of manipulating "form") for constructing logical arguments (proof theory).
- To study some deductive systems for propositional and first-order logic.
- To introduce the concept of fuzzy logic.

1.	**Introduction:** Role of logic in computer science, problem representation, review of the principle of mathematical induction, the principle of structural induction, review of Boolean algebra, language, models, interpretations, validity, proof, decision problems in logic, decidability.	[6]
2.	**Propositional Logic:** Syntax, semantics, logical and algebraic concepts, identities and normal forms, tautology checking, propositional satisfiability, propositional resolution and tableaux method.	[10]
3.	**First Order Predicate Logic:** Quantifiers, first order models, validity and satisfiability, forward and backward chaining, Skolmization, normal forms, unification, Horn formulas and programs, resolution and tableaux.	[12]
4.	**Binary Decision Diagrams:** Representing Boolean functions, algorithms for ordered reduced binary decision diagram (OBDD), geometric templates from spatial relations, image based rendering, symbolic model checking, relational Mu-calculus, coding CTL models and specification.	[8]
5.	**Fuzzy Logic:** Classic sets, fuzzy sets and membership, fuzzy set operations, Cartesian product, operations and properties of crisp relationship, operations and properties of fuzzy relationship.	[4]

Outcome(s): On successful completion of this course, the students will be able to

- Use propositional and first-order logic.
- Apply of logic in specifying properties.
- Develop proof by induction.
- Design binary decision diagrams.
- Identify the scope for fuzzy logic.

Text Books:

3. Huth M and Ryan M, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press, 2nd edition, 2004.
4. Enderton H B, A Mathematical Introduction to Logic, Academic Press, 2nd edition, 2001.

Reference Books:

5. Arindama Singh, Logics for Computer Science, Prentice Hall of India, 1st edition, 2004.
6. M. Ben-Ari, Mathematical Logic for Computer Science, Springer, 2nd edition, 2003.
7. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 3rd edition, 2009.
8. C. L. Chang and R. C. T. Lee, Symbolic Logic and Mechanical Theorem Proving, Academic Press, 1st edition, 1973.

CS 14.309 **Microprocessor and Assembly Language Programming** **Total Lectures: 40**
Credit: 3-0-0 -3

Prerequisite(s): CS 14.207 (Computer Information System)

Objective(s):
- To study architecture and memory management of 8-bit and 16-bit microprocessor (8085 & 8086)
- To study assembly language programming and use it to solve various problems.

1.	**Introduction:** Evolution of Microprocessor and its types, 8085 microprocessor architecture, buses, registers, flags, 8085 pin configuration & function.	[6]
2.	**8085 Instruction Set:** Addressing modes of 8085, 8085 instruction set, data transfer arithmetic, logical and branch instructions, 8085 interrupt structure, limitations of 8085 microprocessor.	[8]
3.	**Interfacing:** Memory mapped I/O, I/O mapped I/O, address decoding, interfacing of memory with 8085, interfacing of I/O with 8085.	[8]
4.	**Advance Microprocessors:** 8086 microprocessor architecture, 8086 pin configuration & function, addressing modes of 8086, instruction set of 8086, 8086 interrupts, study of advance processors of the family (8088, 80286, 80386, 80486 and Pentium).	[10]
5.	**Assembly Language Programming:** Introduction, assembler directives, looping, condition and jump, subroutines, procedures, macros, parameter passing.	[8]

Outcome(s): On successful completion of this course, students will be able to:
- Draw block diagram of 8085/86 processor and know the pin function
- Know the instruction set and addressing modes
- Write the assembly language program for different problems and know the use of procedures and macros.
- Design interface of memory chips.

Text Books:

3. **Gaonkar R. S., "Microprocessor Architecture, Programming and Applications", 6th Ed., Penram International, 2013.**
4. **Hall D. V.,SSSP Rao, "Microprocessors and its Interfacing (SIE)", 3rd Ed., Tata McGraw-Hill Publishing Company Limited, 2012.**

Reference Books:

5. Stewart J, "**Microprocessor Systems- Hardware, Software and Programming", Prentice Hall International Edition, 1990.**
6. Short K. L., "Microprocessors and Programmed Logic", 2nd Ed., Pearson Education, 2008
7. Ray, A.K. and Bhurchandi, K.M., "Advanced Microprocessor and Peripherals Architecture, Programming and Interfacing", Tata Mc-Graw Hill, 2006
8. Chhabra, "The Intel 8086/8088 microprocessor architecture programming design & interfacing", Dhanpat Rai Publication

CS 14.315 **Python Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language (CS 14.101)

Objective(s): Python is a general-purpose, versatile and popular programming language. It's great as a first language because it is concise and easy to read, and it is also a good language to have in any programmer's stack as it can be used for everything from web development to software development and scientific applications.

1.	**Introduction**: The basic elements of python, python syntax, compiled vs interpreted languages, formal and natural languages, built in python types, python as a calculator, basic input, branching programs, control structures, strings, tuples, lists and input iteration.	[6]
2.	**Functions and Abstraction**: Functions and scoping flow of execution, specifications, recursion, global variables, modules, stack diagrams, files, system functions and parameters, input and output, making your own module.	[7]
3.	**Structured Types and Higher-Order Functions**: Mutability strings, tuples, lists and dictionaries, lists and mutability, functions as Objects.	[5]
4.	**Classes and Object-Oriented Programming and Data Structure**: Abstract data types and classes, inheritance, encapsulation and information hiding, simple algorithms and data structures, list, tuple, sequence, set, search algorithms, sorting algorithms, hash tables.	[8]
5.	**Testing and Debugging**: Exceptions and assertions, types of testing – black-box and glass-box, debugging, handling exceptions, assertions.	[6]
6.	**Advance Python:** Regular expressions – REs and Python, plotting using PyLab, networking and Multithreaded Programming – sockets, threads and processes, chat Application, security – encryption and decryption, classical cyphers, graphics and GUI programming – drawing using Turtle, Tkinter and Python, Other GUIs.	[8]

Outcome(s): Upon completion of this course students will be

- Familiar with Python syntax.
- Able to use python to implement a given logic.

Text Books:

3. John V Guttag, Introduction to Computation and Programming using Python, Prentice Hall of India, 2nd Edition, 2013.
4. Swaroop C H. , A Byte of Python, URL: https://python.swaroopch.com

Reference Books:

4. Zed A. Shaw ,Learn Python the hard way: a very simple introduction to the terrifyingly beautiful world of computers and code, Third edition, 2014.
5. Richard L. Halterman,Learning to Program with python, 2011.
6. Allen Downey ,Think Python How to Think Like a Computer Scientist, Version 2.0.17, Green Tea Press Needham, Massachusetts,2012.

CS-14.316 **Computer Graphics** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.101 (Programming Languages), MA-14.101 Mathematics I

Objective(s):

- To introduce the students with the graphics mode, with the help of basic algorithms and methodologies.
- The objective of the course is to equip students with fundamental knowledge and basic technical competence in the field of computer graphics.
- Provide an understanding of how a computer draws the fundamental graphics primitives.
- To learn Computer Graphics methodologies/Algorithms and techniques and their implementations.

1. **Introduction to Computer Graphics and graphics primitives**: Overview of interactive graphics model, applications of computer graphics, graphics devices, random and raster scan systems, color models: RGB, YIQ, scan conversion: point, line, circle and ellipse. [7]
2. **2D Transformation and Viewing**: Basic transformations (translation, rotation, scaling), homogeneous coordinates, composite transformations, reflection and shearing, filling: scan line filling, flood filling, boundary filling, clipping: point clipping, line clipping, polygon clipping, and character generation. [7]
3. **Curves and Surfaces**: Introduction to curves, conic curves, polygon surfaces, tables, quadric surfaces, spline representation, cubic spline interpolation methods, Bezier curves and surfaces, B-spline curves and surfaces, fractals and its applications. [7]
4. **3D Transformation and Viewing**: 3D transformation, composite transformation, viewing pipeline, parallel and perspective projection, visible surface detection: classification of visible surface detection algorithms, back face detection, depth buffer method, A-buffer method, scan-line method, depth sorting method. [7]
5. **Illumination Model and Surface Rendering Techniques**: Basic illumination models, Halftone patterns and dithering techniques, polygon rendering methods, ray tracing methods. [6]
6. **Introduction to Animation and Multimedia:** Introduction to animation, key-frame animation, construction of an animation sequence, animation techniques, multimedia: introduction, features of multimedia system, components of multimedia systems and application of multimedia systems. [6]

Outcome(s): On successful completion of this course, students will be able to

- Understand basic concepts of computer graphics.
- Acquire knowledge about drawing basic shapes such as lines, circle ellipse, polygon.
- Perform processing of basic shapes by various processing algorithms /techniques.
- Implement two and three dimensional transformations.
- Apply various algorithms of clipping.
- Acquire knowledge about illumination models, color models and surface rendering.

Text Books:

3. Donald D. Hearn & M. Pauline Baker, Computer Graphics-C Version, Pearson Education, 2nd edition, 2002.
4. James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, Computer Graphics Principles and Practice, 2nd Edition in C, Addison Wesley, 1995.

Reference Books:

3. Donald Hearn and M Pauline Baker, Computer Graphics with OpenGL, Pearson Education, 4th edition, 2010.
4. David F. Rogers, Procedural Elements for Computer Graphics, Tata McGraw Hill Publications, 2nd edition, 2001.

CS-14.317 **Advance Web Technology** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.207 (Computer Information System)

Objective(s):

- To learn the platform neutral fundamentals of secure, dynamic web application development.
- To learn how to implement a web application using one specific set of open source server side tools: PHP and MySQL.

1. **Introduction:** HTTP protocol : request and response, web browser and web servers, concepts of effective web design, web design issues including browser, bandwidth and cache, display resolution, look and feel of the website, page layout and linking, user centric design, sitemap, planning and publishing website, designing effective navigation. [4]

2. **JavaScript and XML:** Client side scripting with JavaScript, variables, functions, conditions, loops and repetition, pop up boxes, advance JavaScript: JavaScript and objects, JavaScript own objects, the DOM and web, browser environments, manipulation using DOM, forms and validations, Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas, using XML with application, transforming XML using XSL and XSLT. [12]

3. **PHP:** Introduction and basic syntax of PHP, decision and looping with examples, PHP and HTML, arrays, functions, browser control and detection, string, form processing, files, advance features: Cookies and sessions, Object Oriented Programming with PHP. [12]

4. **PHP and MySQL:** Basic commands with PHP examples, connection to server, creating database, selecting a database, listing database, listing table names, creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PhpMyadmin and database bugs. [12]

Outcome(s): Upon completion of the course students will be able to:

- Use the JavaScript to develop the dynamic web pages.
- Use server side scripting with PHP to generate the web pages dynamically using the database connectivity.
- Develop the modern Web applications using the client and server side technologies and the web design fundamentals.

Text Books:

3. Luke Welling, Laura Thomson: PHP and MySQL Web Development, Pearson, 2016.
4. Robin Nixon: Learning PHP, MySQL, and JavaScript, O'Reilly Media, 2012.

Reference Books:

4. Elizabeth Naramore, Jason Gerner, Yann Le Scouarnec, Jeremy Stolz, MichaelK. Glass, Beginning PHP5, Apache, and MySQL Web Development, Wrox, 2005.
5. Developing Web Applications in PHP and AJAX, Harwani, McGrawHill, 2010.
6. W. Jason Gilmore: Beginning PHP and MySQL 5 From Novice to Professional, Apress, 2010.

CS-14.318 **Artificial Intelligence** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.101 (Programming Language), CS-14.207(Computer Information Systems)

Objective(s):

- To understand the basic problem solving in Artificial Intelligence.
- To learn different blind as well as heuristic search strategies.
- To understand the various ways of knowledge representation in Artificial Intelligence.
- To know the concepts of game theory and natural language processing.

1. **Overview of Artificial Intelligence:** Introduction to artificial intelligence and intelligent agents, brief history of artificial intelligence, related research fields, AI techniques, AI problems, applications of AI, future of AI, basic concepts of LISP and PROLOG. [6]
2. **Problem Solving and Search Techniques:** Basics of problem solving, Problem representation paradigms, defining problem as a state space representation, uninformed search, depth first search, breadth first search, heuristic search, heuristic functions, generate and test, hill climbing, best first search, A* algorithm, problem reduction, AND/OR graph, AO* algorithm. [10]
3. **Knowledge Representation and Logic:** Representation and mappings, procedural versus declarative knowledge, approaches and issues in knowledge representation, introduction to logic-based problem solving, Boolean logic, first order logic, higher order logic, unification and resolution for performing logical inference, fuzzy logic, probabilistic logic. [8]
4. **Game Theory:** Minimax search, alpha-beta cutoffs, iterative deepening, references on specific games. [5]
5. **Natural Language Processing:** Introduction to NLP, syntactic processing, semantic analysis, discourse and pragmatic processing. [5]
6. **Learning:** Learning from observation, rote learning, inductive learning, explanation basedlearning, statistical learning methods, supervised and unsupervised learning, basics of neural network, reinforcement learning discovery, analogy. [6]

Outcome(s): On successful completion of this course, students will be able to

- Solve the basic problems and apply searching techniques used in Artificial Intelligence.
- To select knowledge representations to solve AI problems.
- Apply various game playing algorithms.
- Work with natural language processing and apply learning techniques.

Text Books:

3. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 3rd edition, 2009.
4. Russell S., and Norvig P., Artificial Intelligence – A Modern Approach, Prentice-Hall of India, 3rd edition, 2014.

Reference Books:

8. Patterson D. W., Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall of India, 1st edition, 2015.
9. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 5th edition, 2009.

CS- 14.319 **Advanced Java** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.202 (Java)

Objective(s): This course extends the study of Web Programming Fundamentals. Advanced concepts of program design, implementation and testing will be introduced with J2EE framework. Student will learn various concept of advance Java for implementation of small to medium sized application programs that illustrate professionally acceptable coding and performance standards.

1.	**Introduction:** OOPS principle, class and objects, basics of HTML, web development introduction, web framework, J2EE building blocks, web application structure	[3]
2.	**Servlets:** Servlet needs, servlet request-response model, servlet life cycle (init, service, doGet, doPost), servlet configuration, scopes (session, request, page), servlet parameters, servlet context, forms processing (get, post), HTTP header processing, HTTP responses.	[5]
3.	**Java Server Pages**: JSP life cycle, JSP a servlets, creating dynamic content with use of JSP elements: expressions, scriptlets & declarations, JSP composition, redirecting, forwarding, accessing default objects (request, response, session, application, config, pageContext), error processing with use of JSP, Servlets vs. JSP pages	[8]
4.	**Session management**: Http session, the Http session interface session tracking: cookies, hidden fields, cookies and JSP, sending and receiving cookies.	[4]
5.	**Using Beans and tag libraries**: Separating presentation and business logic, JSP actions, JavaBeans, working with properties, <jsp:useBean>, <jsp:getProperty> and <jsp:setProperty>,using form parameters with Beans, custom tags, types of tags.	[10]
6.	**Web application:** Case study of a web application, the web.xml deployment descriptor, web.xml – document definition, web.xml – adding servlets, web.xml – mapping servlets, web.xml – sending parameters, web.xml – pre-loading servlets, web application archive, deployment of web application	[10]

Outcome(s): Upon successful completion of this course you should be able to:

- Demonstrate knowledge of the advance Java along with object oriented development process and apply this understanding to the analysis and design of solutions for small to medium scale problems.
- Implement web application using all the feature of J2EE covered in the course.

Text Books:

3. By Martin Bond, Debbie Law, Andy Longshaw, Dan Haywood, Peter Roxburgh, Sams Teach Yourself J2EE in 21 Days, 2nd Edition,SAMS , 2004.
4. Phillip Hanna , Osborne, JSP 2.0: The Complete Reference, 2nd edition, McGraw-Hill, 2003.

Reference Book:

3. Bryan Basham, Kathy Sierra & Bert Bets, Head First Servlets and JSP, 2nd Edition, , Oreilly publication, 2008.

CS-14.320 **Cryptography** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.201 (Discrete Structures), CS-14.207 (Computer Information Systems)

Objective(s):

- To understand the classical encryption and decryption algorithms, their techniques as well cryptanalysis.
- To acquire basic knowledge of finite fields and number theory.
- To understand the various block ciphers, stream cipher models, principles of public key cryptosystems, hash functions and digital signatures.
- To understand the different authentication techniques.

1. **General Overview and Classical Cryptography:** General overview of threats, risks and consequences, sources of threats, attacks, classification and preventive measures, introduction to some simple ciphers such as shift cipher, substitution cipher, affine cipher, Vigener cipher, hill cipher, permutation cipher and stream ciphers, rigorous cryptanalysis of all the above ciphers. [8]
2. **Symmetric/Secret Key Cryptography:** Block ciphers and their principles- boxes, P-boxes, DES, 3 DES, AES. [6]
3. **Elementary Number Theory:** Euclid's algorithm, extended Euclid's algorithm, groups, solving modular linear equations, Chinese remainder theorem, modular exponentiation, discrete logarithm problem, prime numbers and primality testing, factorization problem, Fermat's and Euler's theorem, computation of generators of primes. [8]
4. **Key Exchange/Distribution Schemes:** Diffie - Hellman key exchange, man- in- the-middle attack, Fiat-Naor key distribution, Needham – Schroeder scheme and attack possible on it, Kerberos. [6]
5. **Asymmetric Key/Public Key Cryptosystems:** RSA description, different attacks on RSA and remedies, other public key crypto systems such as ElGamal and Rabin cryptosystems and possible attacks on them. [6]
6. **Digital Signature Schemes:** Security requirements for digital signatures, ElGamal digital signature scheme and its security analysis, the digital signature algorithm (DSA), Schnorr digital signature scheme, provably secure signature schemes and undeniable signatures. [6]

Outcome(s): On successful completion of this course, students will be able to :

- Analyze the security threats.
- Design robust cryptographic algorithms.

Text Books:

2. Douglas R. Stinson, Cryptography: Theory and Practice, (Discrete Mathematics and Its Applications) Chapman and Hall/CRC, 3rd edition, 2005.

Reference Books:

4. Jonathan Katz , Yehuda Lindell, Introduction to Modern Cryptography, (Cryptography and Network Security Series), Chapman and Hall/CRC; 2nd edition, 2014.
5. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, 6th edition 2013.
6. Wenbo Mao, Modern Cryptography Theory & Practice, 1st edition, 2004.

CS-14.321 **Windows Programming** **Total Lectures:40**
Credit : 3-1-0-4

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To provide knowledge of windows programming using Visual Basic .NET.
- To focus on Visual Basic program structure, language syntax and implementation details.

1.	**Overview of Windows Programming:** The Windows environment, history of Windows, aspects of Windows, Windows programming options, APIs and memory models, programming environment	[4]
2.	**Visual Basic 2010:** The Visual Studio development environment, writing the code, building and deploying the application, working with Toolbox control, working with specific data types, working with operators, if…then structure, select case structure, the for…next loop, using counter variable, complex for…next loop, do loops, using timer object, processing errors by using try…catch statement, using finally clause, the exception object, using nested try…catch, the exit try statement.	[12]
3.	**Modules and Procedures:** Working with modules, creating public variables, creating procedures, writing sub procedure, passing arguments by value, working with array, using ReDim, the array class, working with object collections, for each…next loop, creating your own collection.	[8]
4.	**Designing User Interface:** Managing windows forms and controls at run time, adding graphics, the system drawing namespace, adding animation to your program, inheriting forms and creating base classes, working with printers.	[6]
5.	**Database:** Exploring text files, reading and writing text files, getting started with ADO.NET, SQL statements and LINQ, data presentation using Data Grid View control.	[6]
6.	**Web Programming:** Creating websites and webpages using Visual Web Developer and ASP.NET, difference between webpages and web forms, server controls, HTML controls, using webpage designer, adding server controls to a webpage.	[4]

Outcome(s): Upon completion of the course the student should be

- Able to analyze program requirements.
- Design/develop programs with GUI.
- Code program and develop interface using Visual Basic .NET.
- Perform tests, resolve defects and revise existing code.

Text Books:

1. Michael Halvorson, Microsoft Visual Basic 2010, Microsoft Press, 2010
2. Bradley and Millspaugh, Programming in Visual Basic 2010, Mcgraw-Hill, 2010

Reference Books:

1. Shelly Hoisington, Microsoft Visual Basic 2010 for Windows, Web, Office and Database Applications: Comprehensive, Cengage Learning, 2010.
2. Sheldon Bill et. al., Professional Visual Basic 2010 and .NET 4, John Wiley & Sons, 2010
3. Andrew Moore, Visual Studio 2010 All-in-one for Dummies, John Wiley & Sons, 2010

CS-14.322 **Data Mining** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS-14.204 (Database Management System), CS-14.301(Design and Analysis of Algorithms), MA-14.202 (Statistics and Probability Theory).

Objective(s):

- Understand the functionality of the various data mining and data warehousing components.
- Appreciate the strengths and limitations of various data mining and data warehousing models.
- Compare the various approaches to data warehousing and data mining implementations
- Describe and utilize a range of techniques for designing data warehousing and data mining systems for real-world applications.

1.	**Overview:** Evolution of the database system technology, concept of data mining and warehousing, data warehouse roles and structures, cost of warehousing data, approaches to data exploration and data mining, foundations of data mining, web warehousing, introduction to knowledge management and knowledge bases.	[5]
2.	**Data Warehouse:** Overview of data warehousing, data marts, data warehouse architecture, multidimensional data model, online analytical processing (OLAP), OLAP operations, data about data - metadata.	[4]
3.	**Data Mining and Data Visualization:** Data mining general approach, classification and clustering, introduction to DM tool (Weka, Rapidminer), techniques used to mine the data, current limitations and challenges to DM, data visualization, visualization tools.	[6]
4.	**Data Preprocessing:** Overview, data cleaning, data integration, data reduction strategies, principal component analysis, sampling, histograms, clustering, data cube aggregation, data transformation and discretization.	[6]
5.	**Machine Learning:** Supervised and unsupervised machine learning, market basket analysis (Apriori algorithm), fuzzy logic and linguistic ambiguity, artificial neural networks, genetic algorithms, genetically evolved networks, applications for machine learning.	[7]
6.	**Text Mining:** Information retrieval and search, text classification, text clustering, unsupervised learning, mining frequent patterns and correlations, classification concepts, back propagation, decision tree induction, rule based classification, clustering basic concepts and methods, K-means centroid based technique.	[6]
7.	**Web Based Statistical Analysis:** Delivering information over the web, query and reporting tools and business value, business value from analytical tools, statistical analysis applications, data discovery tools overview, data discovery applications, search engines and the web, search engine architecture, future of data mining.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Identify, formulate, and solve data science related problems by applying principles of the course.
- Understand both analysis and synthesis in the design process with the help of data mining and data warehousing tools.
- Develop and conduct appropriate experiments, analyze and interpret data, and use data visualization to draw conclusions.
- Function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

Text Books:

4. George M Marakas, Modern Data Warehousing, Mining and Visualization, Pearson Education, 1st edition, 2002.
5. **Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 3rd edition, 2011.**
6. Mattison R., Web Warehousing and Knowledge Management, Tata McGraw-Hill, 1st edition, 1999.

Reference Books:

4. W.H. Inmon, BuildingtheData Warehouse, Wiley Publishing Inc., 3rdedition, 2005.
5. Anahory and Murray, Data Warehousing in the Real World, Pearson Education/Addison Wesley, 1st edition, 1997.
6. Prabhu C.S.R., Data Warehousing, Prentice-Hall of India, 2ndedition, 2002.

CS -14.323 **Shell Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language (CS 14.101)

Objective(s):
- To familiarize students with the Unix/Linux environment
- To learn the fundamentals of shell scripting/programming
- To familiarize students with basic Unix/Linux administration

1. **UNIX-Basic Concepts:** Introduction, file systems, visual editors, Unix philosophy and features, understanding the Unix commands and general purpose utilities and navigating the file system, the shell and kernel. [8]

2. **UNIX-Advanced Features:** File and directory structures, file systems and peripheral devices, handling ordinary files, file attributes. UNIX system administration, data blocks and i-nodes. [8]

3. **Unix Editors and Filters:** Vi Editor, simple filters, regular expression and grep family, advanced filters: sed and awk, awk pattern scanning and processing, awk arithmetic, operators and variables. [8]

4. **Shell Fundamentals:** Command syntax, Shell variables, pattern matching, escaping, command substitution, input /output redirection, pipes, tees, [6]

5. **Shell Scripting:** Bourne shell, C shell; scripts, meta characters and environment, shell programming and scripts, logical operators, control and looping statements and programs. Shell reliability, maintainability, efficiency, portability and usability. [10]

Outcome(s): After completion of the course students will be able to
- Work confidently in Unix/Linux environment
- Write shell scripts to automate various tasks
- Master the basics of Unix/Linux administration
- Understand the basic difference between high level programming and shell programming

Text Books:
3. Sumitabha Das, UNIX, Tata McGraw-Hill Companies, 4th edition, 2011.
4. **Cameron Newham, Learning the bash Shell:Unix Shell Programming, 3rdedition,O'Reilly Media,2009.**

Reference Books:
1. Bill Rosenblatt , Learning the Korn Shell, O'Reilly Media, 2002.
2. Mark G. Sobell ,A practical guide to Linux commands, editors, and shell programming, 2nded. Prentice Hall, 2013.

CS-14.324 **Data Compression** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): MA-14.202 (Statistics and Probability Theory)

Objective(s):

- To develop theoretical foundations of data compression.
- To know the concepts and algorithms for lossy and lossless data compression.
- To understand signal modeling and its extension to compression with applications to speech, image and video processing.

1. **Introduction:** Compression techniques, measures of performance, modeling and coding, information theory, Shannon coding theory, physical models, probability models, Markov models, composite source model, fixed and variable length codes, uniquely decodable codes, prefix codes, Kraft's theorem. [10]

2. **Lossless Compression:** The Huffman coding algorithm: minimum variance Huffman codes, adaptive Huffman coding, Golomb codes, rice codes, Tunstall codes, coding a sequence, generating a binary code, comparison of binary and Huffman coding, diagram coding, dictionary based compression techniques, adaptive dictionary, LZ77, LZ78 and LZW approach, predictive coding, prediction with partial match, the Burrows-Wheeler transform, facsimile encoding, dynamic Markov compression. [10]

3. **Lossy Compression:** Distortion criteria, distortion measurement models, scalar quantization, uniform quantizer, adaptive quantization, non-uniform quantization, advantages of vector quantization over scalar quantization, the Linde-Buzo-Gray algorithm, tree structured vector quantizers, structured vector quantizers. [10]

4. **Multimedia Compression:** M-law and A-law commanding, DPCM and ADPCM audio compression, MPEG audio standard, frequency domain coding, lossless techniques of image compression, gray codes, transform coding, GIF**,** JPEG, predictive techniques, PCM and DPCM, video compression and MPEG industry standard, wavelet based compression. [10]

Outcome(s): On successful completion of this course, students will be able to

- Understand the concepts, applications and models of data compression.
- Apply the methods of lossy and lossless data compression.
- Apply the methods and standards of image, audio and video data compression.

Text Books:

2. **Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers, 4th edition, 2012.**

Reference Books:

3. Mark Nelson and Jean-Loup Gailly: The Data Compression Book, M&T Books, 2nd edition, 1996.
4. David Salomon, Data Compression: The Complete Reference, Springer, 4th edition, 2006.

CS-14.332 **Software Engineering** **Total Lectures:40**

Credit:3-0-0-3

Prerequisite(s): CS-14.101 (Programming Language), CS-14.203 (Data Structures)

Objective(s):

- To understand the basic software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To know about software requirements specification, requirement elicitation, structured system analysis and introduction of object-oriented analysis and design, design techniques.
- To acquire knowledge on implementation issues such as modularity and coding standards.
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study web based-system and application, software re-use, software re-engineering, agile software engineering, software engineering and testing tools.
- To develop teamwork and have project based experience.

1. **Introduction:** Programs versus software products, software crisis, need for software engineering, attributes of effective software, software myths, software characteristics, and role of management in software development, overview of quality standards like ISO 9001, SEI-CMM. [6]

2. **Software Processes and Requirement Analysis:** Software engineering: a layered technology, the software process, software process models, component based development, problem analysis, requirement engineering, requirement elicitation, requirement analysis, software requirement and specifications, data flow diagrams, data dictionaries, entity-relationship diagrams. [8]

3. **Software Project Planning:** Responsibilities & skills of a project manager, project planning, and project size estimation: LOC, function point & feature point metric, project estimation techniques, COCOMO model, staffing level estimation, scheduling, risk management, software configuration management. [9]

4. **Software Design:** The design process, design principles, design concepts, effective modular design: cohesion & coupling, classification of cohesiveness & coupling, design notations, design techniques, structure charts, introduction to object-oriented design. [8]

5. **Coding and Testing:** Software testing fundamentals, test case design, white box testing:-basis path testing, control structure testing, black box testing: boundary value analysis, equivalence class testing, decision table testing, cause effect graphing, level of testing, debugging, testing tools &standards, testing for client/server architecture, real time systems and GUIs testing. Brief of software re-use, reverse engineering, software re-engineering, agile software engineering. [9]

Outcome(s):

On successful completion of this course, students will be able to

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Author a software requirements document and understanding of the proper contents of a software requirements document.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.
- Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

3. R. S. Pressman, Software Engineering – A practitioner's approach,Tata-McGraw- Hill Int. Ed., 8th edition, 2014.
4. K. K. Aggarwal, Yogesh Singh, Software Engineering, New Age International, 1st edition, 2008.

Reference Books:

4. Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publisher, 3rdedition, 2005.
5. Rajib Mall, Fundamentals of Software Engineering, Prentice-Hall, 2ndedition, 2004.
6. Robert C. Martin, Agile Software Development, Principles, Patterns and Practices, 1st edition, 2002.

CS-14.336 **Computer Networks** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.203 (Data Structures), CS-14.207 (Computer Information Systems)

Objective(s):

- To become familiar with layered communication architectures (OSI and TCP/IP).
- To understand the client/server model and key application layer protocols.
- To construct large-scale computer networks
- To understand fundamentals of computer networks and major protocols.
- To analysis and evaluate major Internet protocols.
- To program simple network applications using socket API
- To learn and adopt newly introduced computer network technologies by themselves.

1.	**Introduction to Network Model:** History and development of computer networks, networks topologies, MANET, categories of networks, layering and protocols.	[5]
2.	**Physical Layer:** Different types of transmission media, transmission impairments, encoding schemes (NRZ, NRZI, Manchester, 4B/5B, Manchester etc.), packet and circuit switching.	[5]
3.	**MAC Layer:** Aloha, CSMA/CA, CSMA/CD protocols, performance evaluation and characteristics.	[3]
4.	**Data Link Layer:** Framing concept, error detection (parity, CRC), sliding window, stop and wait protocols, stop performance and efficiency.	[5]
5.	**Local Area Network:** IEEE 802.3, 802.4, 802.5, 802.11, performance evaluation.	[5]
6.	**Network Layer:** IPv4, IP address classes, classless addressing, IPv6, ARP, RARP, DHCP, ICMP, routing algorithms: distance vector, metrics, RIP, OSPF, BGP, congestion control algorithms, leaky bucket, token bucket.	[8]
7.	**Transport Layer:** Duties of the transport layer, connection, TCP, TCP services, TCP header, UDP, evaluating protocol such as TCP/UDP using simulator like NS2.	[5]
8.	**Application Layer:** DNS, FTP, HTTP, SMTP, POP, basics of network security (cryptography, digital signature and firewall).	[4]

Outcome(s): On successful completion of this course, students will be able to

- Analyze computer network component and devices.
- Synthesize how communication works in a network and internet.
- Formulate the concept of topologies and their applications.
- Analyze protocol at different layers and how they play important role in network implementation.
- Identify and analyze the latest technology with existing one.
- Enumerate the layers of OSI and TCP/IP models.
- Configure network and wireless technology including client/server programming.

Text Books:

1. Tanenbaum A. S., Computer Networks, Prentice-Hall of India, 5th edition, 2010.
2. Stallings W., Data and Computer Communications, Prentice-Hall of India, 10th edition, 2013.

Reference Books:

3. Forouzan B. A., Data Communications and Networking, Tata McGraw-Hill, 5th edition, 2013.
4. Hayes J. F., Modeling and Analysis of Computer Communication Networks, Plenum Press, 1st edition, 1987.

CS-14.371 **Colloquium** **Credit: 0-0-0-1**

Prerequisite(s): NIL

Objective(s):

- To observe and analyze some popular technology and gain insights
- To comprehend the acquired knowledge.
- To present the acquired knowledge to larger audience.

Content: Students have to comprehend and present on some popular technology in the field of computing.

Outcome(s): On successful completion of this course, the students will be able to

- Communicate effectively to arrange of audience.
- Recognize the need for continuous learning.
- Recognize the social impact of engineering solutions.

CS-14.374 **Comprehensive-II** **Credit: 0-0-0-4**

Prerequisite(s): CS-14.220 (Comprehensive-I), CS-14.301 (Design and Analysis of Algorithms), CS-14.303 (Operating System), CS-14.305 (Logic in Computer Science), CS-14.309 (Microprocessor and Assembly Language Programming), CS-14.332 (Software Engineering), CS-14.334 (Compiler Design), CS-14.336 (Computer Networks)

Objective(s):

- To examine the understanding of the student in different fields of computer science in concise manner.

1. **Design and Analysis of Algorithms:** Sorting, divide and conquer, graph theory, greedy algorithms, dynamic programming, backtracking, NP complete.
2. **Operating System:** Batch processing, multiprogramming, multiprocessing, and multitasking, process management, CPU scheduling, I/O scheduling, resource scheduling, deadlock and scheduling algorithms. Banker's algorithm for deadlock handling, memory management: virtual memory, paging, segmentation, concurrent processing: mutual exclusion, critical regions lock and unlock, scheduling.
3. **Logic in Computer Science:** Propositional (Boolean) logic, predicate logic, well–formed–formulae (WFF), satisfiability and tautology.
4. **Microprocessor:** Introduction to microprocessor, microprocessor instruction set, architecture of microprocessor, register set, mapping of memory and I/O devices, addressing modes, counters and time delays.
5. **Software Engineering**: Information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.
6. **Compiler Design:** Context free languages and push-down automata, recursively enumerable sets and Turing machines, undecidability, lexical analysis, syntax and semantic analysis, intermediate code generation, code generation and optimization.
7. **Computer Networks:**ISO/OSI stack, LAN technologies (Ethernet, token ring), flow and error control techniques, routing algorithms, congestion control, TCP/UDP and sockets, IPv4, application layer protocols (ICMP, DNS, SMTP, POP, FTP, HTTP), basic concepts of hubs, switches, gateways, and routers, network security, basic concepts of public key and private key cryptography, digital signature, firewalls.

Outcome(s):

- At the end of this course students will be able to comprehend her knowledge gained in the entire year.

CS 14.401 **Soft Computing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 14.305(Logic in Computer Science)

Objective(s):

- To familiarize with soft computing concepts
- To introduce the idea of neural networks, fuzzy logic and use of heuristics based on human experience
- To introduce the concept of genetic algorithm and its applications to soft computing using some applications

1.	**Introduction**: Introduction of soft computing, types of soft computing, applications of soft computing, introduction of artificial intelligence, production system, various search techniques, hill climbing, best first search, knowledge representation, monotonic and non-monotonic reasoning.	[8]
2.	**Neural Networks:** Structure and function of a single neuron, definition of ANN, characteristics of ANN, applications of ANN, single layer networks, perceptron training algorithm, linear separability, various learning rules, delta rule, ADALINE, MEDALINE, multi-layer networks, activation functions, error back propagation algorithms, characteristics of EBPA.	[8]
3.	**Neural Network Architectures**: Counter propagation networks, architecture, functioning, characteristics, Hopfield network, configuration, associative memory, limitations and applications, Hopfield vs Boltzman machine, adaptive resonance theory, architecture, classification, implementation and training	[8]
4.	**Fuzzy Logic :**Fuzzy logic, fuzzy set theory, fuzzy set vs crisp set, crisp relation and fuzzy relation, introduction and features of membership functions, fuzzy rule based system, fuzzy propositions, formation, decomposition and aggregation of fuzzy rules, fuzzy reasoning, fuzzy interference system, fuzzy decision making, applications of fuzzy logic.	[8]
5.	**Genetic Algorithms :**Genetic algorithm, fundamentals, basic concepts, working principle, encoding, fitness function, reproduction, genetic modelling, inheritance operator, cross over, inversion and deletion, mutation operator, bitwise operator, generational cycle, convergence of GA, applications and advances in GA, difference and similarities between GA and other traditional methods.	[8]

Outcome(s): On successful completion the students will be able to:

- Identify and describe soft computing techniques and their roles in building intelligent machines
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
- Apply genetic algorithms to combinatorial optimization problems
- Apply neural networks to pattern classification and regression problems
- Evaluate and compare solutions by various soft computing approaches for a given problem

Text Books:

4. S. N. Sivanandan and S.N. Deepa, “Principles of Soft Computing”, Wiley India, 2007
5. J.S.R.Jang, C.T.Sun and E. Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, 2004
6. Pravir K. Chawdhry, Rajkumar Roy, Raj K. Pant “Soft Computing in Engineering Design and Manufacturing”Springer, 2012.

Reference Books:

4. S. Rajasekaran and G.A.V. Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003
5. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, McGraw-Hill, 3rdEdition, 2009.
6. Davis E. Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Pearson Education , 2006

CS 14.402 **Distributed Systems** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): CS 14.202 (Java Programming), CS 14.303 (Operating Systems), CS 14.306 (Computer Networks)

Objective(s): To make students aware of:

- What a distributed system is, its example, use and utilities.
- Hardware and software requirements/constraints for implementation of distributed systems.
- Abstractions like, RMI, distributed objects, RPC, distributed shared memory etc.
- Notion of time in a distributed system.
- Databases in a distributed system.

1.	**Characterization of Distributed Systems:** Definition, distributed systems-Internet, intranet, mobile, ubiquitous computing, resource sharing and World Wide Web challenges-heterogeneity, openness, security scalability failure handling concurrency and transparency.	[3]
2.	**System Models:** Architecture models- software layers, system architecture, variations on client-server model, interfaces, design requirement for distributed architectures, fundamental and interaction models, and failure and security models.	[4]
3.	**Distributed Object and Remote Invocation:** Introduction to remote method invocation (RMI) and interface in distributed systems, communication between distributed objects-objects model, distributed objects, distributed objects model and design issues for RMI, implementation of RMI and distributed garbage collection, remote procedures call and sun RPC case study, events and notifications participants, JINI distributed event specification, Java RMI case study, building client and server programs, design and implementation of Java RMI.	[8]
4.	**Time and Global State:** Clocks, events and process states, synchronizing physical clocks-synchronization in a synchronous system, Cristian method for synchronizing clocks, Berkley algorithm, network time protocol, global state and consistent cuts.	[5]
5.	**Distributed Shared Memory:** Introduction, message passing versus DSM, implementation approaches to DSM, design and implementation issues-structure and synchronization model.	[5]
6.	**Distributed Database Systems:** Distributed DBMS architecture, distributed database design, alternate design strategies, distribution design issues, fragmentation, and allocation.	[5]
7.	**Processes and Processors in Distributed Systems:** Threads, system models, processor allocation, scheduling, fault tolerance.	[5]
8.	**Distributed File System:** Design, implementation, trends in distributed file system.	[5]

Outcome(s): On successful completion of the course the student will be able to:

- Understand the concept of distributed systems.
- Explain the principles underlying the functioning of distributed systems as well as how these principles are applied in distributed systems.
- Comprehend the problems and challenges of distributed systems.
- Understand and estimate the impact of different design choices, system features on distributed systems.

Text Books:

3. Colouris, “Distributed Systems Concepts and Design”, Addison Wesley, 5th edition, 2011.
4. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair,"Distributed Systems" , Pearson Education Limited, 2013

Reference Books:

3. Pradeep K. Sinha,"Distributed Operating Systems",PHI Learning Pvt. Limited, 2011.
4. MukeshSinghal, NiranjanShivrathri, “Advanced Concepts in Operating Systems”, TMH, 2011.

CS 14.403 **Parallel Computing** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.208 (Computer Organization and Architecture)

Objective(s):

- To provide students with contemporary knowledge in parallel computing.
- To equip students with skills to design and analyze parallel applications.
- Describe the various design issues in a parallel computing System e.g. system performance and reliability, distributed file system etc.
- Describe and program the communication among processes at different hosts to facilitate parallel computing.

1. **Introduction**: scope and issues of parallel and distributed computing, taxonomy of parallel structures, control mechanism, address-space organization, interconnection connection networks: static and dynamic interconnection networks, evaluating static interconnection networks, embedding other networks (linear array, mesh, binary tree) into a hypercube, routing mechanisms for static interconnection networks: store and forward (SF) routing, cut - theory (CT) routing, cost-performance trade-off, architectural models for parallel algorithm design. [8]
2. **Basic Communication Operation**: Simple message transfer between two processors, one-to-all broadcast, all-to-all broadcast, reduction and prefix sums, one-to-all personalized communication, all-to-all personalized communication, circular shift. [7]
3. **Performance and Scalability of Parallel Systems**: Performance matrices for parallel systems: run time, speed up, efficiency and cost, the effect of granularity and data mapping on performance, scalability of parallel systems, ISO-efficiency metric of scalability. [7]
4. **Models of Distributed Computing**: Mini computer model, workstation pool model, client-server model, pool of processors model, hybrid model. [6]
5. **Inter Process Communication and Remote Procedure Calling**: Building blocks, client-server communication, group communication, case study: inter processor communication in Unix, design issues in remote procedure calling, implementation. [6]
6. **Parallel Computing Algorithms**: Various sorting and searching algorithms, performance metrics for parallel algorithm implementations. [6]

Outcome(s): At the end of this course, student will be able to accomplish following.

- Define terminology commonly used in parallel computing, such as efficiency and speedup.
- Describe different parallel architectures, inter-connect networks, programming models, and algorithms for common operations such as matrix-vector multiplication.
- Given a problem, develop an efficient parallel algorithm to solve it.
- Given a parallel algorithm, analyze its time complexity as a function of the problem size and number of processors.
- Given a parallel algorithm, an input to it, and the number of processors, show the steps performed by that algorithm on that input.

Text Books:

3. Vipin Kumar, Ananth Grama, Anshul Gupta and George Karypis, "Introduction to Parallel Computing", 2nd Ed, Pearson Education,2008.
4. George Coulouris, Jean Dollimore and Tim Kindberg," Distributed Systems Concepts and Design", 4th Ed., Pearson Education, 2009.

Reference Books:

5. S G Akl, "The Decision and Analysis of Parallel Algorithms", Prentice Hall, 1989.
6. Hwang, Kai, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", 2nd Ed., McGraw Hill, 2011.
7. J Jaja, "An Introduction to Parallel Algorithms", Addison Wesley, 1992.
8. T G Lewis and H El Rewini, "Introduction to Parallel Computing", Prentice-Hall 1992.

CS-14.405 **Digital Image Processing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.101 (Programming Language), MA-14.201(Applied Mathematics)

Objective(s):

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the image segmentation and representation techniques
- To study the image representation in form of features and descriptors

1.	**Digital Image Fundamentals:** Elements of digital image processing systems, elements of visual perception, brightness, contrast, hue, saturation, mach band effect, color image fundamentals - RGB, HSI models, image sampling, quantization, dither, two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD.	[7]
2.	**Image Enhancement and Restoration:** Histogram equalization and specification techniques, noise distributions, spatial averaging, directional smoothing, median, geometric mean, harmonic mean, contra harmonic mean filters, image restoration - degradation model, unconstrained restoration, inverse filtering, removal of blur caused by uniform linear motion.	[7]
3.	**Morphological Image Processing:** Basics, structuring element, erosion, dilation, opening, closing, hit-or-miss transform, boundary detection, hole filling, connected components, convex hull, thinning, thickening, skeletons, pruning, and reconstruction by dilation and erosion.	[7]
4.	**Image Segmentation:** Edge detection, edge linking via Hough transform, thresholding, region based segmentation, region growing, region splitting and merging, and segmentation by morphological watersheds, basic concepts, dam construction, and watershed segmentation algorithm.	[7]
5.	**Image Representation:** Boundary representation, chain code, polygonal approximation, signature, boundary segments, boundary description, shape number, Fourier descriptor, regional descriptors, and topological features.	[6]
6.	**Image Compression:**Need for data compression, Huffman, run length encoding, shift codes, arithmetic coding, vector quantization, transform coding, JPEG standard, MPEG.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Discuss digital image fundamentals.
- Apply image enhancement and restoration techniques.
- Use image compression and segmentation Techniques.
- Represent features of images.

Text Books:

10. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.
11. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011.
12. Bernd Jähne, Digital Image Processing, Springer Science & Business Media, 29-Jun-2013.

Reference Books:

13. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
14. William K Pratt, “Introduction to Digital Image Processing”, CRC Press, 13-Sep-2013.

CS 14.411 **Advanced Computer Architecture** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming languages), CS 14.208 (Computer Organization and Architecture)

Objective(s):

- To discuss the organization of computer-based systems and how a range of choices are influenced by application.
- To understand the organization and operation of current generation computer systems including multiprocessor and multicore systems.
- To understand the principles of I/O in computer systems including viable mechanism for I/O and secondary storage organization.

1.	**Introduction**: Overview of parallel processing and pipelining, study and comparison of uni-processors and parallel processors, architectural classification, applications of parallel processors, instruction level parallelism, performance matrices and measures, speedup.	[6]
2.	**Pipelining:** Principles and implementation of pipelining, classification of pipelining processors, pipeline architecture, general pipelining reservation table, design aspect of arithmetic and instructional pipeline, pipelining hazards and resolving techniques, advanced pipelining techniques, software pipelining, implementation issues.	[8]
3.	**Vector and Array Processors** : Vector and array processors, basic vector architecture, issues in vector processing, SIMD computer architecture, masking and data network mechanism, interconnection networks of SIMD, static vs dynamic networks, parallel algorithm for array processors, matrix multiplication, sorting, implementation issues.	[10]
4.	**Multiprocessor Architecture** : Multiprocessor architecture, loosely and tightly coupled multiprocessors, characteristics of multiprocessor, inter-processor communication network, memory contention and arbitration techniques, cache coherence, bus snooping, massively parallel processors, inter process communication and synchronization.	[10]
5.	**Parallel Algorithms:** Multithreading, synchronous and asynchronous message passing, shared memory, study of parallel programming concepts, parallel algorithm for multiprocessors, operating system for multiprocessors, message passing interfaces, parallel programming languages, Fortran 90, Occam, C-Linda, CCC.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Describe the operation of performance enhancements such as pipelines, dynamic scheduling, branch prediction, cache, and vector processors.
- Describe modern architectures such as RISC, super scalar, multiprocessor and multicore systems.
- Develop applications for high performance computing systems.

Text Books:

3. Kai Hwang, Naresh Jotwani, “Advanced Computer Architecture”, McGraw-Hill Education, 2011.
4. John L Hennessey, David A Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann, Elsevier Publishers, 5th edition, 2012.

Reference Books:

3. Kai Hwang, Zhi Wei Xu, “Scalable Parallel Computing”, McGraw Hill,1998.
4. Kai Hwang, Faye A Briggs, “Computer Architecture and Parallel Processing”, McGraw Hill, 1984.

CS 14.412 **Software Project Management** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS 14.302 (Software Engineering)

Objective(s):

- To introduce the concepts of Software Project Management to the students.
- To make the students understand the requirement for project evaluation.
- To make the students understand the requirement for Software quality assurance and project management along with its tools.

1.	**Introduction to Software Project Management (SPM) : S**oftware Engineering problem and software product, software product attributes, definition of a Software Project (SP), SP vs. other types of projects activities covered by SPM, categorizing SPs, Project Management cycle, SPM framework, types of project plan	**[6]**
2.	**Project Evaluation:** Strategic assessment, technical assessment, cost benefit analysis, cash flow forecasting, cost benefit evaluation techniques, risk evaluation	**[5]**
3.	**Activity Planning:** Objectives, project schedule, sequencing and scheduling activities, network planning models, forward pass, backward pass, activity float, shortening project duration, activity on arrow networks, risk management, nature of risk, types of risk, managing risk, hazard identification, hazard analysis, risk planning and control	**[8]**
4.	**Monitoring and Control:** Introduction, creating the frame work, collecting the data, visualizing progress, cost monitoring, earned value, prioritizing monitoring, getting the project back to target, change control	**[6]**
5.	**Managing people and Organizing teams:** Introduction, understanding behaviour, organizational behaviour: a background, selecting the right person for the job, instruction in the best methods, motivation, the Oldman, Hackman job characteristics model, working in groups, becoming a team, decision making leadership, organizational structures, stress, health and safety, case studies	**[8]**
6.	**Software Quality Assurance and Testing:** Testing principles and objectives, test plan, types and levels of testing, test strategies, program verification and validation, software quality, SEI-CMM,SQA activities, QA organization structure, SQA plan	**[7]**

Outcome(s):

Upon completion of the course the student should be able to:

- Examine the fundamentals of the software project and the factors involved in using a methodology in the context of project management.
- Explain the risks, issues, and critical success factors associated with technology projects and software projects in particular.
- Create a project plan, including scope definition, risk assessment, task breakdown, team selection, estimates, communication mechanisms and progress evaluation and reporting using an appropriate project lifecycle.
- Present and justify a fully documented project plan.
- Employ appropriate software for project planning, estimation, monitoring and control, communication and reporting.

Text Books:

3. Bob Hughes, Mikecotterell, “Software Project Management”, Fourth Edition, Tata McGraw Hill, 2009.
4. Ashfaque Ahmed,"Software Project Management: A Process-Driven Approach",CRC Press, 2016.

Reference Books:

4. **Ramesh, Gopalaswamy, "Managing Global Projects", Tata McGraw Hill**, 2nd ed. 2005.
5. Royce, “Software Project Management”, Pearson Education, 1999.
6. Walker Royce, Software Project Management, 1998, Addison Wesley.

CS 14.413 **Foundations and Applications of IoT** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming Language), CS 14.303 (Operating System), CS 14.306 (Computer Networks)

Objective(s):
- To introduce the vision and impact of IoT.
- To understand IoT Market perspective.
- To understand the challenges that must be overcome by IoT technology.

1.	**M2M to IoT:** The vision-introduction, from M2M to IoT, M2M towards IoT-the global context, a use case example, differing characteristics.	[5]
2.	**M2M to IoT – A Market Perspective:** Introduction, some definitions, M2M value chains, IoT value chains, an emerging industrial structure for IoT, the international driven global value chain and global information monopolies, M2M toIoT-an architectural overview, building an architecture, main design principles and needed capabilities, an IoT architecture outline, standards considerations.	[9]
3.	**M2M and IoT Technology Fundamentals:** Devices and gateways, local and wide area networking, data management, business processes in IoT, everything as a service (XaaS), M2M and IoT analytics, knowledge management.	[7]
4.	**IoT Architecture- Introduction, State of the art:** Architecture reference model-introduction, reference model and architecture, IoT reference model.	[6]
5.	**IoT Reference Architecture:**IoT reference architecture- introduction, functional view, information view, deployment and operational view, other relevant architectural views, real-world design constraints- introduction, technical design constraints-hardware is popular again, data representation and visualization, interaction and remote control.	[8]
6.	**Implementation Examples:** Industrial automation, the smart grid, smart cities.	[5]

Outcome(s): On successful completion of this course, students will be able to
- Understand the vision of IoT from a global context.
- Determine the Market perspective of IoT.
- Understand the use of Devices, Gateways and Data Management in IoT.
- Build architecture in IoT
- Analyze, design and develop parts of IoT solution

Text Books:
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
4. Malcolm Frank, Paul Roehrig, Ben Pring,"What To Do When Machines Do Everything" ,John Wiley & Sons, 13-Feb-2017

Reference Books:
4. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
5. Peter Waher, "Learning Internet of Things", Packt Publishing Ltd, 27-Jan-2015.
6. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013

CS 14.414 **Technologies of Big Data** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.415 (Data Science and Big Data and Analytics)

Objective(s): To understand and learn various technologies of Big Data Analytics and apply them to solve real world problems.

1.	**Hadoop and MapReduce**: Functional programming, MapReduce programming, running a MapReduce programs on Hadoop, word count, distributed sort, distributed grep.	[7]
2.	**Hive**: Hive, HiveQL vs SQL, Hive in Hadoop ecosystem, installation of Hive, query execution in Hive, data types and file formats, create table, alter table, drop table, loading data into tables, select-from clause, where clause ,group by clause, join statements, views and indexes.	[10]
3.	**Pig**: Pig , PigLatin, Pig on Hadoop, installing and running Pig, Grunt, Pig data models, load, store and dump, relational operations-foreach, filter, groupby, orderby, distinct, Join, user defined functions(UDFs),developing and testing PigLatin scripts.	[10]
4.	**Spark**: Spark, Hadoop versus Spark, Installation of spark, spark architecture, solving business problem with Spark, Spark streaming framework and processing models.	[7]
5.	**NoSQL Databases**: NoSQL, database scaling, CAP theorem, ACID versus BASE, key – value stores, column oriented databases, document databases, graph databases, NoSQL challenges.	[6]

Outcome(s): On successful completion of this course, students would be able to

- Apply learning and knowledge of Big Data technologies tosolve real world problems and acquire required skills set for industry.

Text Books:

3. Chuck Lam, “Hadoop in Action”, Manning Publications,2nd ed. 2015, ISBN: 9781935182191
4. Edward Capriolo, Dean Wampler, Jason Rutherglen,“Programming Hive”, O’Reilly Media,2016,ISBN: 978-1-449-31933-5

Reference Books:

3. Alan Gates, “Programming Pig”, O’Reilly Media,2011,ISBN: 978-1-449-30264-1
4. James A. Scott, “Getting Started with Apache Spark”, MapR Technologies,2015

CS 14.415 **Data Science and Big Data Analytics** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.204 (Database Management System)

Objective(s): To understand the fundamental concept of Data Science and Big Data Analytics and its application in various fields.

1.	**Data and its Classifications**: Data, information, knowledge and wisdom, digital and analog data, unstructured data, semi-structured data ,structured data, sources of data, dealing with unstructured data, data science and responsibilities of data scientist, database, data warehouse, data mining and big data.	[10]
2.	**Introduction to Big Data**: Big data, characteristics of big data-volume, velocity, variety, challenges with big data, applications of big data in healthcare, agriculture, education, scientific experiments, advertising, stock market etc., integrity and privacy of big data, big data and cloud computing, big data and IoT.	[10]
3.	**Classification of Analytics:** Descriptive, diagnostic, discovery, prescriptive and predictive analytics, big data analytics, semantic analytics, in-memory analytics, analytics and decision making, shared nothing architecture, CAP theorem, parallel and distributed system, massively parallel processing.	[10]
4.	**Hadoop and its Architecture**: RDBMS and Hadoop, master slave architecture, HDFS, name node, secondary name node, data node, HDFS client, replica placement strategy, MapReduce, job tracker, task tracker, map phase, reduce phase, shuffle phase, Hadoop 1.0 and Hadoop 2.0, YARN, Installation of Hadoop in pseudo distributed mode and full distributed mode.	[10]

Outcome(s): On successful completion of this course, students will be able to

- Apply learning and knowledge ofData Science and Big Data Analytics to solve real life problems in various areas of social importance.

Text Books:

4. Seema Acharya, SubhashiniChellapan, “Big Data and Analytics”, Wiley,,ISBN:978-81-265-5478-2, 2015
5. Tom White, “Hadoop: The Definitive Guide”, O’Reilly Media,2012,ISBN: 978-1-449-38973-4
6. Vincenzo Morabito, "Big Data and Analytics: Strategic and Organizational Impacts",Springer,2015

Reference Books:

3. Rick Smolan, Jennifer Erwitt,“The Human Face of Big Data”, Sterling, 2012, ISBN:9781454908272
4. EMC Education Services , “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, John Wiley & Sons, 05-Jan-2015, ,ISBN: 978-1-118-87613-8

CS 14.416 **Designing of IoT** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming Languages), CS 14.303 (Operating System), CS 14.306 (Computer Networks)

Objective(s):
- To understand IoT architecture and IoT design constraints
- To understand the vision and impact of IoT
- Understand IoT Market perspective.

1.	**Internet/Web and Networking Basics** : OSI Model, data transfer referred with OSI model, IP addressing, point to point data transfer, point to multi point data transfer & network topologies, sub-netting, network topologies referred with web, introduction to web servers, introduction to cloud computing	[5]
2.	**IoT Platform Overview:** Overview of IoT supported hardware platforms such as: raspberry pi, ARM cortex processors, arduino and intel galileo boards, network fundamentals: overview and working principle of wired networking equipment's – router, switches, overview and working principle of wireless networking equipment's – access points, hubs etc. linux network configuration concepts: networking configurations in linux accessing hardware & device files interactions.	[7]
3.	**IoT Architecture:** History of IoT, M2M – machine to machine, web of things, IoT protocols, remote monitoring & sensing, remote controlling, performance analysis, the layering concepts , IoT communication pattern, IoT protocol architecture, the 6LoWPAN, security aspects in IoT.	[8]
4.	**IoT Application Development**: MQTT, REST/HTTP, CoAP, MySQL, apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB object type database, HTML, CSS & jQuery for UI designing, JSON lib for data processing, security & privacy during development, application development for mobile platforms: overview of android / IOS app development tools.	[13]
5.	**Case Study & advanced IoT Applications:**IoT applications in home, infrastructures, buildings, security, Industries, home appliances, other IoT electronic equipments, use of big data and visualization in IoT, industry 4.0 concepts, sensors and sensor node and interfacing using any embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino)	[7]

Outcome(s): On successful completion of this course, students will be able to:
- Explain the current status and expected future directions of the internet of things.
- Identify and propose applications which advance the IoT.
- Develop applications which advance the IoT.

Text Books:

4. Dr.OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers,2013
5. Jean-Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet", Morgan Kuffmann, 2010.
6. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", Wiley, 2011.

Reference Books:

3. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing", 4th ed. Tata McGraw Hill, 2010.
4. F. Adelstein and S.K.S. Gupta, "Fundamentals of Mobile and Pervasive Computing", McGraw Hill, 2009.

CS 14.418 **Software Defined Networking** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.302 (Software Engineering), CS 14.306 (Computer Networks)

Objective(s):

- To explore the basics of SDN
- To discuss various types plane
- To list out various controllers
- To program a simple SDN

1.	**Control and Data Planes**: Introduction, evolution vs revolution, the control plane, data plane, moving information between planes, distributed control planes, convergence time, load balancing, creating the MPLS overlay, centralized control planes, logical vs literal, ATM.LANE, route servers.	[8]
2.	**SDN Controllers:** Wire protocol, replication, FAWG, hybrid approaches, SDN controllers, VMware, Nicira, OpenFlow, Mininet, NOX/POX, Trema, Ryu, L3VPN, RSPV-TE problem statement, bin-packing, deadlock, Plexxi, Cisco OnePK.	[8]
3.	**Network Programmability:** The management interface, the application-network divide, NETCONF and NETMOD, SNMP, modern programmatic interface, XMPP, JSON, I2RS, OpenStack, CloudStack, Puppet, virtual multitenant data center, SDN solution for data center networks.	[8]
4.	**Network Function Virtualization**: Virtualization and data plane I/O, services engineered path, service locations and chaining, NFV at ETSI, non-ETSI NFV work, network topology, LLDP, BGP-TE/LS, ALTO, I2RS topology.	[8]
5.	**Building an SDN framework:** Build code first, ask questions later, the Juniper SDN framework, IETF SDN framework, open daylight controller/framework, use cases for bandwidth scheduling, manipulation, data center overlays, big data, NFV, and traffic monitoring.	[8]

Outcome(s): On successful completion the students will be able to:

- Describe the key benefits of SDN
- Describe the data plane
- Configure an SDN friendly network emulator
- Program a simple SDN for a given task using a low level approach and high level approach
- Evaluate a sample SDNs performance and reliability

Text Books:

2. Ken Gray, Thomas D Nadeau, “SDN: Software Defined Networks”, O’Reilly, 2013.

Reference Books:

4. Paul Goransson, Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, First edition, 2014 .
5. Vishal Shukla, “Introduction to Software Defined Networking – OpenFlow&VxLAN”, Createspace, 2013.
6. Patricia A Morreale, James M. Anderson, “Software Defined Networking: Design and Deployment”, CRC Press, 2014.

CS 14.422 **Software Testing and Quality Assurance** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.302 (Software Engineering)

Objective(s):

- To explore the basics and goals of software testing
- To discuss various types of software testing and its techniques
- To list out various tools that can be used for automating the testing process
- To introduce various software quality standards for establishing quality environment
- To discuss various methods and evaluation procedures for improving the quality Models

1.	**Basics of Software Testing**: Definition, test cases, insights from a Venn diagram, identifying test cases, error and fault taxonomies, levels of testing, examples: generalized pseudo-code, the triangle problem, the NextDate problem, the commission problem	[6]
2.	**Decision Table Based Testing:** Decision tables, test cases for triangle problem, test cases for Next Date problem, test cases for commission problem, data flow testing, use testing, slice based testing, guidelines and observation, traditional view of testing levels, alternative life-cycle models, separating integration and system testing, decomposition based, call graph based, path based integration, case study	[10]
3.	**System and Interaction Testing:** Threads, basic concepts of requirements specification, finding threads, structural strategies and functional strategies for thread testing, SATM test threads, system testing guidelines, interaction testing, a taxonomy of interactions, composition, and determinism, client-server testing, issues in object-oriented testing, inheritance and polymorphism, levels of object-oriented testing, GUI testing, dataflow testing for object-oriented software, examples and case study	[10]
4.	**Object-Oriented Integration Testing**: UML support for integration testing, MM paths for object-oriented software, GUI testing, unit testing, object-oriented system testing, UML based system testing, statechart based system testing	[6]
5.	**Quality Assurance:** Software quality, level of measurement, reliability and validity, Ishikawa's seven basic tools, cause and effect diagram, reliability models, quality and quality management metrics, software process maturity assessment	[8]

Outcome(s): On successful completion the students will be able to:

- Compare and pick out the right type of software testing process for any given real world problem
- Carry out the software testing process in efficient way
- Automate the testing process by using several testing tools
- Establish a quality environment as specified in standards for developing quality software
- Analyze and improve the quality procedures based on the past experience

Text Books:

3. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications, 4th Edition, 2016.
4. Stephen H Khan, "Metrics and Models in Software Quality Engineering", Pearson, 2nd edition 2013.

Reference Books:

4. CemKaner, Rebecca L. Fiedler,"Foundations of Software Testing" , Context-Driven Press, 2013
5. Aditya P Mathur, " Foundations of Software Testing", Pearson, 2008.
6. Mauro Pezze, Michal Young,"Software Testing and Analysis – Process, Principles and Techniques", John Wiley & Sons, 2008.

CS 14.424 **Machine Learning with Big Data** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.322 (Data Mining)

Objective(s): To learn the fundamental concept of machine learning and apply the concept of recommendations, clustering and classifications on large scale data sets using mahout.

1. **Introduction**: learning problems, designing learning system, perspectives and issues, concept learning, version spaces and candidate elimination algorithm, inductive bias, decision tree learning, representation, heuristic space search [8]
2. **Data Mining, Machine Learning** : Data mining ,machine learning, statistical modeling, feature extraction, computational approaches to modeling, statistical limits on data mining, statistical limits on data mining, Bonferroni's principle, recommendation engines, clustering and classifications, mahout : Mahout, installation and setting up of Mahout, tackling large scale data with mahout and Hadoop [8]
3. **Recommendations:** Defining recommendation, Running a recommender engine, Evaluating a recommender, Evaluating precision and recall, evaluating the GroupLens data set, representing preference data, in-memory data models, coping without preference values, user-based recommendation, item-based recommendation, similarity metrics, slope-one recommender, distributing recommendation computations [8]
4. **Clustering**: Clustering basics, measuring the similarity of items, running a simple clustering example, distance measures, representing data, visualizing vectors, representing text documents as vectors, generating vectors from documents, clustering algorithms in Mahout, k-means clustering, different kinds of clustering problems, fuzzy k-means clustering, model-based clustering, evaluating and improving clustering quality, real-world applications of clustering [8]
5. **Classifications**: Introduction to classification, Mahout for classification, differences between classification, recommendation, and clustering, applications of classification, working of classification, training a classifier, extracting features to build a Mahout classifier, preprocessing raw data into classifiable data, converting classifiable data into vectors, evaluating and tuning a classifier, deploying a classifier [8]

Outcome(s): Students would be able to apply learning and knowledge of machine learning techniques in the area of Big Data Analytics using Mahout to solve real life problems.

Text Books:

4. Sean Owen, Robin Anil, Ted dunning, Ellen friedman, "Mahout in Action",Manning Publications,2012,ISBN 9781935182689
5. Jared Dean,"Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners", Wiley,2014, ISBN: 978-1-118-61804-2
6. Tom M. Mitchell, "Machine Learning", McGraw Hill , 2013

Reference Books:

3. Suthaharan, Shan, "Machine Learning Models and Algorithms for Big Data Classification ", Springer,2016,ISBN 978-1-4899-7641-3
4. AnandRajaraman, Jure Leskovec, Jeffrey D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2015,ISBN:978-1-107-07723-2

CS 14.426 **Wireless and Sensor Networks** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.306 (Computer Networks)

Objective(s):

- To provide an overview about wireless and sensor networks and emerging technologies
- To study about the network architecture of sensor nodes and its execution environment
- To understand the concepts of communication, MAC and routing protocols in WSN
- To learn about topology control and clustering for localization services with sensor tasking and control
- To study about sensor node hardware and software platforms and understand the simulation and programming techniques

1.	**Overview of Wireless Sensor Networks**: Introduction, characteristics, challenges for WSN, emerging technologies for WSN, advantages of sensor networks, applications.	[8]
2.	**Architecture:** Single-node architecture, hardware components, energy consumption of sensor nodes, operating system and execution environment, network architecture, single hop vs multi hop, multiple sources and sinks, optimization goals and figures of merit, WSN gateway and tunneling.	[8]
3.	**Networking Sensors:** Physical layer, MAC protocols for WSN, low duty cycle and wakeup concept S-MAC, address and name management, assignment of MAC addresses, routing protocols, multipath unicast routing, energy efficient routing, geographic routing.	[8]
4.	**Infrastructure**: Topology control, clustering, multilayer clustering, time synchronization, localization and positioning, positioning in multihop environment, ranging techniques, range based localization, sensor tasking and control, information based sensor tasking, joint routing and information aggregation	[8]
5.	**Platforms and Tools:** Sensor node hardware, Berkeley motes, programming challenges, node level software platforms, TinyOS, nesC, TinyGALS, simulators, ns2, TOSSIM, state centric programming	[8]

Outcome(s): On successful completion the students will be able to:

- Compare and pick out the right type of software testing process for any given real world problem
- Carry out the software testing process in efficient way
- Automate the testing process by using several testing tools
- Establish a quality environment as specified in standards for developing quality software
- Analyze and improve the quality procedures based on the past experience

Text Books:

3. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2007.
4. Feng Zhao, Leonidas Guibas, Jie Liu, , “Wireless Sensor Networks- An Information Processing Approach", 2nd ed. Elsevier, 2016.

Reference Books:

3. KazemSohraby, Daniel Minoli, &TaiebZnati, “Wireless Sensor Networks- Technology, Protocols, And Applications”, John Wiley, 2007.
4. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

CY-14.101 **Engineering Chemistry** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- To purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers their preparation, properties and uses.
- To develop the basics of protecting engineering materials from the natural forces.
- To understand the present-day up-to-date knowledge of the contemporary energy sources.
- To build up the basis of the future Engineering materials like superconductors, conducting organic polymers, Nanomaterials etc.

1. **Water treatment**: Hardness, types of hardness, determination of hardness by complex metric (EDTA) method, degree of hardness, boiler troubles: corrosion, sludge and scale formation, prevention of sludge and scale formation in boilers, methods of boiler water treatment: lime-soda process, permutit (zeolite) process, ion exchange methods, numerical problems based on water treatment (lime-soda process). [10]

2. **Organic and Inorganic Polymers:** Classification, functionality, types of polymerization, mechanism of addition polymerization, plastics: thermoplastic and thermosetting resins, preparation, properties and uses of Polyamides, Bakelite, Polyesters, Rubber, vulcanization of rubber, synthetic rubber viz. Buna-S, Buna-N, Butyl and Neoprene rubbers, Silicones-polysiloxanes and Sulphur based polymers. [8]

3. **Electrochemistry and Corrosion**: Classifications (Galvanic cell, electrolytic cell), types of electrodes (reference electrodes-standard hydrogen electrode, indicator electrodes- glass electrode), theorigin of electrode potential, Nernst equation of electrode potential. electromotive force, electrochemical series. corrosion: definition and its significance, theories of corrosion, mechanism of corrosion, types of corrosion, Galvanic cell, and concentration cell, water line corrosion, pitting & stress corrosion (caustic embrittlement), protection against corrosion, corrosion control (corrosion inhibitors, cathodic protection - sacrificial anodic and impressed current cathodic protection),protective metallic coatings. [10]

4. **Fuels:** Classifications of fuels, Comparison of solid, liquid & solid fuels, Calorific value of a fuel, Bomb calorimeter, determination of LCV & HCV, petroleum: origin, composition, processing, cracking, synthetic petrol, refining, reforming, knocking, unleaded petrol, LPG as a gaseous fuel, numerical problems based on combustion. [6]

5. **New Engineering Materials**: Introduction: superconductors, high and low-temperature superconductors, organic electronic materials, fullerenes and nanomaterials, industrial applications of fullerenes and nanomaterials. [6]

Outcomes: The student will be able to understand the basis of the future Engineering materials like of superconductors, conducting polymers, Nano materials etc and purification of the most valuable natural resource of the future-water

Text Books:

1. O.G. Pananna, “Engineering Chemistry” 2nd Edition, McGraw Hill Education, 2017
2. Jain and Jain, “Engineering Chemistry,” 16th Edition, DhanpatRai Publishing Company, 2013.

Reference Books:

1. C. Housecroft, A.G. Sharpe, Inorganic Chemistry, 4th Edition, , Pearson Education Limited, England, 2012.
2. Atkins, “Physical Chemistry,” 8th edition,W. H. Freeman and Company New York, 2006.
3. William D. Callister, “Materials Science and Engineering: An Introduction, Eighth Edition,.John Wiley & Sons, Inc, 2010.
4. Bokris and Reddy, “Modern Electrochemistry,” 2nd Edition, Kluwer Academic Publishers New York, 2004.

CY-14.111 **Chemistry Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

1. To determine the Total, Temporary and permanent hardness of water by EDTA method.
2. To determine the % of available chlorine in a sample bleaching powder.
3. To determine the alkalinity of given water sample.
4. To prepare urea formaldehyde resin.
5. To determine the Calorific value of a fuel by bomb calorimeter.
6. Determination of the strength of HCl by titrating it against NaOH pH metrically.

7.Determination of the strength of HCl by titrating it against NaOHconductometrically.

Outcome(s): On completion of this course, students will have the knowledge in

- Handling different types of instruments for analysis of materials using small quantities of materials involved for quick and accurate results.
- Carrying out different types of titrations for estimation of concerned in materials using comparatively more quantities of materials involved for good results.

EC-14.101 **Basics of Electronics Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course would facilitate the learner to acquire good exposure to electronics and communication engineering.

1. **Introduction:** Brief history of major inventions, scope, significance and job opportunities in electronics and communication engineering, Overview of various specializations in ECE, Electronic testand measurement equipment's, Specifications for electronic components. [3]

2. **Semiconductors:** Material and its properties, Formation of energy band diagram, Currents in semiconductors, Fermi-Dirac energy distribution, Types of semiconductors – Intrinsic and Extrinsic, Mass action law, Hall effect. [5]

3. **Diodes:** Introduction, Characteristic of ideal and real diode, Current components in thediode, load characteristics, Breakdown in thediode, Zener diode, Varactor diode, Tunnel diode, Clippers and Clampers, Rectifiers – Half and Full-wave rectifiers. [8]

4. **Transistors:** Introduction to PNP and NPN transistors, current components, active, cutoff and saturation regions, CC, CB and CE configuration, Operating point, Biasing circuits, Bias Stability, Thermal runway and thermal stability. [8]

5. **Signals:** Definition, Classification of signals – Analog and Digital, Deterministic and Random signals, Power and Energy of signals, Bandwidth, Bit and Baud rate. [4]

6. **Basics of Communication**: Definition, Block representation of communication system, Modulation – Definition, Need for modulation, Frequency translation, Types of modulation - Analog and Digital, Multiplexing – TDM and FDM. [6]

7. **Applications of Communication**: Introduction to - Optical Fiber, Transmission line, Waveguides, Satellite communication, and RADAR. [6]

Outcome(s):

- The learners are expected to have an overview of electronics and communicationengineering and learn the introductory concepts in each of the specializations in ECE.

Text Books:

1. George Kennedy, Bernard Davis, Electronics Communication Systems, 4th Edition, Tata McGraw-Hill, 2009.
2. Behrouz Forouzan, Data Communication, and Networking, 5th Edition, McGraw-Hill, 2012.
3. Robert L. Boylestad, Louis Nashelsky, Electronics Devices and Circuits Theory, 11th Edition, Prentice Hall,2013.

Reference Books:

1. David A. Bell, Electronics Devices, and Circuits, PHI, 4th edition, 2008.
2. Wayne, Tomasi, Advanced Electronic Communication Systems, 6th edition, PHI, 2013.

EE-14.101 **Elements of Electrical Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

1. **Introduction:** Background, major inventions, scope, significance and job opportunities in electrical engineering,brief overview of various energy resources. Apparatus used in generation, transmission, and distribution of electrical power and various industries. [3]

2. **D.C. circuits:** Review of circuit elements, voltage sources, current sources, ohms law,KVL, KCL, source transformation, mesh current and node voltage analysis of circuits. [5]

3. **Network Theorems**: Superposition theorem, Thevenin's theorem, Norton's theorem. Maximum Power Transfer theorem, star-delta transformation. [6]

4. **Single phase A.C. circuits:** Basic terminologies, average &RMS values of a.c. quantities, phasor representation, theresponse of R, L, C and their combination to a.c. excitation, theconcept of power and power factor in a.c. circuits. [6]

5. **Three phase A.C. circuits:** Three phase supply, phase sequence, star connection, delta connection, therelationship betweenphase andline quantities in 3-phase circuits, measurements of three-phase power underbalanced condition. [6]

6. **Magnetic Circuits & Transformer**: Magnetic circuit, mutually coupled circuit, Transformer: working principle, emf equation, ideal & practical transformer, equivalent circuits, transformer testing: open circuit and short circuit test, losses, voltage regulation and efficiency. [8]

7. **Rotating Machines:** Electro-mechanical energy conversion, introduction to rotating machines and applications [6]

Outcome(s):

- The students shall develop an insightful knowledge on various fundamental elements and devices of electrical engineering.

Text Books:

1.Nagrath& Kothari, Theory and Problems of Basic Electrical Engineering, 2nd edition PHI Publication,2017.
2. Fitzgerald & Kingsley, Basic Electrical Engineering, 6th edition TMH publication,2002.

Reference Books:

1. H.Cotton, Advanced Electrical Technology, CBS Publication,2005.

EE-14.111 **EEE Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- The objective of this course is to introduce the students to the basic concepts of Electronics Engineering.
- The aim of this course is to study the fundamental aspects of Electronics Engineering.
- To acquire the knowledge of hardware and verify the results on Multisim software.
- This lab facilitates the students to get a comprehensive exposure to operations of AC and DC machines, measurements of various parameters and applications of electrical machines.

Practical to be performed on Hardware:

1. Introduction to basic electronics components and study of breadboard, CRO, function generator, multimeter, and D.C. power supply.
2. To plot VI characteristics of p-n junction diode and Zener diode.
3. To design a half wave rectifier with and without filter circuit and find the ripple factor.
4. To design a full wave rectifier with and without filter circuitand find the ripple factor.
5. Study of clipper and clamper circuits and implement on abreadboard.
6. To perform soldering and de-soldering to make abanana probe, BNC probe, and connection on PCB.
7. To conduct open circuit test and short circuit test on single phase transformer and to determine equivalent circuit parameters.
8. Measurement of three-phase power by using two wattmeter methods.
9. Speed control of DC machine by field current control method.
10. To construct a fluorescent tube wiring and to measure thevoltage across tube rod, thevoltage across choke and current.

Practical to be performed using Multi-Sim Software:

1. An Introduction to Electronic Circuit Simulation using **Multi-Sim Software**.
2. To verify Ohm's law and Kirchhoff's law.
3. Simulate half wave and full wave bridge rectifier.
4. To plot VI characteristics of p-junction diode

Outcome(s): After completion of the course, students would be able to:

- To use the technique, skills, and modern engineering tools necessary for engineering practice.
- Able to explain the basic concepts of basic electronics components.
- Able to describe& explain Clipper and Clamper circuits, V-I Characterization of p- n junction & Zener diode.
- The students shall develop an insightful knowledge on various ac and dc machines with their industrial applications.

ET-362 **Mobile Apps Development** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS 14.202(Java Programming)

Objective(s):

- To learn how mobile apps are different from others traditional apps by learning those aspects of mobile programming that make it unique from other platforms
- Program mobile applications for the Android operating system that use basic and advanced phone features
- Deploy applications to the Android marketplace for distribution.

1.	**Getting started with Mobility:** Mobility landscape, mobile platform, mobile apps development, overview of android platform, setting up the mobile app development environment along with an emulator, a case study on mobile app development.	[8]
2.	**Building blocks of mobile apps: Apps user:** Interface designing-mobile UI resources (Layout,UI elements, Draw-able,Menu), activity-states and life-cycle, interaction amongst activities. app-functionality beyond user interface- threads, async task, service –state and life cycle, notification, broad cast receivers, telephony and smsapis native data handling-on device file I/O, shared preferences, mobile database such as SQLite, and enterprise data access(via Internet/Intranet)	[15]
3.	**Sprucing up mobile apps:** Graphics and animation- custom views, canvas, animation APIs, multimedia-audio/video playback and record, location awareness, and native hardware access (sensor such as accelerometer and gyroscope).	[8]
4.	**Testing mobile apps:** Debugging mobile apps, white box testing, black box testing, and test automation of mobile app, JUnit for Android, Robotium, Monkey Talk.	[6]
5.	**Taking apps to market:** Versioning signing and packaging mobile apps, distributing apps on mobile market place.	[3]

Outcome(s): On successful completion of this course, students will be able to

- Understand the android operating system in details
- Create mobile application for various screens
- Deploy on play store market
- Use various sensors available in mobile

Text Books:

1. Barry Burd, Android Application Development All in One for Dummies, Johen Wiley & Sons Inc., Edition I , 2011.

2. Anubhav Pradhan ,Anil V Deshpandy, Mobile App Development, Edition I

Reference Books:

1. Lauren Darcey, Shane Conder, "Teach Yourself Android Application Development in 24 Hours",Sams Publishing, 2012, 2nd Edition , 2012.

ET 463 **Enterprise Computing – I** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS14.101 (Programming Language), CS 14.204 (Database Management System)

Objective(s):

- To define enterprise computing
- To provide an in-depth and comprehensive knowledge of the hardware and software architecture of enterprise system
- To introduce about the enterprise standards

1.	**Characteristics of Enterprise Computing:** Reliability, availability, scalability, capacity, access to large amount of data, integrity and security, system management, autonomic capabilities.	[5]
2.	**Introduction to TSO & ISPF:** Logging in a mainframe, understanding ISPF menus, understanding datasets & record length, sequential, partitioned VSAM, creation of a PDS for programs, JCL etc. vs Loadlib, creation of a sequential DS for application data, understanding catalog, using ISPF editor.	[10]
3.	**JCL & SDSF Basics:** Basic JCL programming, modifying an existing compile, link and execute JCL for specific use, JOBCARD, DD statements, understanding JOB-STEP, understanding JOBLIB and STEPLIB, understanding PARM to move data from JCL to program, understanding SDSF outputs.	[10]
4.	**Basic Application Programming:** Understanding logical file name (used in program) and physical file name (used in JCL) and how they are mapped, writing a simple COBOL program with data stored in a VSAM file or a flat file (intent is not to teach COBOL language, the student should be able to apply the language in the environment, student will be provided with sample JCLs & VSAM file that will be used in program).	[10]
5.	**Introduction to SPUFI:** Understanding how to use SPUFI environment to write and execute SQL statements.	[5]

Outcome(s): On successful completion of this course, students will be able to

- Describe the hardware and software architecture of an actual enterprise platform and explain the main functionality of the physical and virtual components.
- Perform basic administrative tasks in an enterprise computer system such as: the creation of new users, job monitoring and management, and back-ups and re- store operations.
- Possess basic practical knowledge regarding the process of installing, configuring and operating applications in an enterprise computer system as well as applying updates to the operating system

Text Book:

5. Alex Leon , IBM Mainframe Handbook, 1/e PB 1st Edition.
6. Alan Simon, "Network Re-engineering: Foundations of Enterprise Computing", Academic Press, 2012.
7. Mike Ebbers, John Kettner, Wayne O'Brien, Bill Ogden, IBM Redbooks, "Introduction to the New Mainframe: z/OS Basics", IBM Redbooks, 2012.

ET 465 **Agile Software Development** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS14.332 (Software Engineering)

Objective(s):

- To learn the fundamental principles and practices associated with each of the agile development methods.
- To learn how agile methods scale to large and distributed projects.
- To learn the essentials of collaboration as they apply to agile methods.
- To perform in-depth explorations into aspects of agile development that are particularly relevant to each student through detailed discussion sessions.

1. **Fundamentals of Agile:** The genesis of Agile, introduction and background, Agile manifesto and principles, overview of Scrum, extreme programming, feature driven development, lean software development, Agile project management, design and development practices in Agile projects, test driven development, continuous integration, refactoring, pair programming, simple design, user stories, Agile testing, Agile tools. [7]
2. **Agile Scrum Framework:** Introduction to Scrum, project phases, Agile estimation, planning game, product backlog, sprint backlog, iteration planning, user story definition, characteristics and content of user stories, acceptance tests and verifying stories, project velocity, burn down chart, sprint planning and retrospective, daily scrum, Scrum roles – product owner, Scrum master, Scrum team, Scrum case study, tools for Agile project management. [9]
3. **Agile Testing:** The Agile lifecycle and its impact on testing, test driven development (TDD), unit framework and tools for TDD, testing user stories – acceptance tests and scenarios, planning and managing testing cycle, exploratory testing, risk based testing, regression tests, test automation, tools to support the Agile tester, securing Agile software. [10]
4. **Agile Software Design and Development:** Agile design practices, role of design principles including single responsibility principle, open closed principle, Liskov substitution principle, interface segregation principles, dependency inversion principle, Agile design, need and significance of refactoring, refactoring techniques, continuous integration, automated build tools, version control. [10]
5. **Industry Trends:** Market scenario and adoption of Agile, Agile ALM, roles in an Agile project, Agile applicability, Agile in distributed teams, business benefits, challenges in Agile, risks and mitigation, Agile project on cloud, balancing Agility with discipline, Agile rapid development technologies. [4]

Outcome(s):

On successful completion of this course, students will be able to

- Understand concept of agile software engineering and its advantages in software development. Recognize various agile methods.
- Design and manage a project using Scrum.
- Write user stories for project requirements.
- Write test cases for developing features.

Text Books:

4. Ken Schawber, Mike Beedle, Agile Software Development with Scrum, Pearson, 2008.
5. Robert C. Martin, Agile Software Development Principles, Patterns and Practices, Prentice Hall
6. Lisa Crispin, Janet Gregory, Agile Testing: A Practical Guide for Testers and Agile Teams, Addison Wesley.

Reference Books:

3. Alistair Cockburn, Agile Software Development: The Cooperative Game, Addition Wesley, 2006
4. Mike Cohn, User Stories Applied for Agile Software, Addison Wesley, 2004

ET 471 **Cloud Computing (Infosys)** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s):
Objective(s):

1.	**Overview of Cloud Computing:** Brief history and evolution - History of Cloud Computing, Evolution of Cloud Computing, Traditional vs. Cloud Computing. Why Cloud Computing, Cloud service models (IaaS, PaaS & SaaS). Cloud deployment models (Public, Private, Hybrid and Community Cloud), Benefits and Challenges of Cloud Computing. Introduction to AWS Public Cloud Vendor. Cost optimization in AWS.	[10]
2.	**Virtualization**: Basics of virtualization, Virtualization technologies, Server virtualization, VM migration techniques, Role of virtualization in Cloud Computing. Introduction to EC2 service of AWS.	[8]
3.	**Working with Private Cloud:** Private Cloud Definition, Characteristics of Private Cloud, Private Cloud deployment models, Private Cloud Vendors - CloudStack, OpenStack, Eucalyptus Microsoft, Private Cloud – Benefits and Challenges. Private Cloud implementation in Amazon EC2 service.	[8]
4.	**Working with Public Clouds:** What is Public Cloud, Why Public Cloud, When to opt for Public Cloud, Public Cloud Service Models, and Public Cloud Players. Infrastructure as a Service Offerings, IaaS Vendors, PaaS offerings, PaaS vendors, Software as a Service. Demonstrating public cloud with AWS – Storage and Database services. Private vs. Public Cloud – When to choose.	[12]
5.	**Overview of Cloud Security:** Explain the security concerns in Traditional IT, Introduce challenges in Cloud Computing in terms of Application Security, Server Security, and Network Security. Security reference model, Abuse and Nefarious Use of Cloud Computing, Insecure Interfaces and APIs, Malicious Insiders, Shared Technology Issues, Data Loss or Leakage, Account or Service Hijacking, Unknown Risk Profile, Shared security model between vendor and customer in IAAS/PAAS/SAAS, Implementing security in AWS.	[8]
6.	**Future directions in Cloud Computing:** When and not to migrate to Cloud, Migration paths for cloud, Selection criteria for cloud deployment, Issues/risks in cloud computing, Future technology trends in Cloud Computing.	[4]

Text Books:

1. Cloud Computing: Principles and paradigms By Raj Kumar Buyya, James Broberg, AndrezeiM.Goscinski, 2011
2. Cloud Computing, By Michael Miller, 2008.
3. Cloud Computing for dummies, By Judith Hurwitz, Robin Bllor, Marcia Kaufman, Fern Halper, 2009.
4. Cloud Computing: A Practical Approach, By Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, McGraw Hill, 2010.
5.Handbook of Cloud Computing, By BorkoFurht, Armando Escalante (Editors), Springer, 2010.

Reference Books:

1.Cloud computing: Implementation, management and security By Rittinghouse, John, W.
2.Cloud Computing Bible, By Barrie Sosinsky, Wiley, 2011.
3.Cloud Computing Architected: Solution Design Handbook by Rhoton, John.
4.Cloud Security, A comprehensive Guide to Secure Cloud Computing by Krutz, Ronald L.; Vines, Russell Dean

ET 474 **Enterprise Computing – II** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 463 (Enterprise Computing – I)

Objective(s):

- To define advance JCL.
- To provide an in-depth and comprehensive knowledge of the hardware and software architecture of enterprise system.
- To introduce about the enterprise standards.

1. **Advanced JCL:** Coding a JCL, using PROCS (Catalog and In-Stream), using DFSORT, ICETOOL. [8]
2. **Advanced Datasets:** Understanding record length, allocation of SPACE, fixed and variable record length, VSAM, defining VSAM, understanding CI and CA, GDG, understanding usage of GDG, defining GDG. [12]
3. **Understanding CICS:** CICS fundamentals, understanding transactions, pseudo conversational programming, understanding CICS tables, coding BMS maps, compiling of a CICS program & NEWCOPY + CEMT entry for programs, writing simple CICS program to read key data (say StudentID) from user & display details obtained from a VSAM, CICS tables for VSAM/DB2 will be provided. [20]

Outcome(s): On successful completion of this course, students will be able to

- Describe the hardware and software architecture of an actual enterprise platform and explain the main functionality of the physical and virtual components.
- Perform basic administrative tasks in an enterprise computer system such as: the creation of new users, job monitoring and management, and back-ups and re- store operations.
- Possess basic practical knowledge regarding the process of installing, configuring and operating applications in an enterprise computer system as well as applying updates to the operating system

Text Book:

3. IBM Mainframe Handbook by Alex Leon.
8. Alan Simon, "Network Re-engineering: Foundations of Enterprise Computing", Academic Press, 2012.
4. Mike Ebbers, John Kettner, Wayne O'Brien, Bill Ogden, IBM Redbooks, "Introduction to the New Mainframe: z/OS Basics", IBM Redbooks, 2012.

CS-18.307	Big Data Programming	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	Basic knowledge of Linux • Basic SQL knowledge • Working knowledge with big data and Hadoop technologies • Have a basic understanding of notebook technologies for data science • Students can attend free courses at www.bigdatauniversity.com to acquire the necessary requirements • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	• To Understand what Big Data is • To understand how the growth of interconnected devices helps big data. • To Learning the tools that will enable to continue big data education after the course	
1.	**BIG DATA OVERVIEW**: Introduction to Big Data, Introduction to the Big Data Ecosystem, Introduction to Hortonworks Data Platform (HDP), Apache Ambari, Hadoop and HDFS, MapReduce and YARN, Apache Spark, Storing and quering data, ZooKeeper, Slider, and Knox, Loading data with Sqoop, Security and Governance, Stream Computing, Exercise: Exploration of the lab environment, Managing Hadoop clusters with Apache Ambar, File access and basic commands with HDFS, Running MapReduce and YARN jobs, Creating and coding a simple MapReduce job, Working with a Spark RDD with Scala, Using Hive to access Hadoop/HBase data, Explore Zookeeper, Moving data into HDFS with Sqoop,	[20]
2.	**Introduction to Data Science**: Data Science and Data Science Notebooks, Data Science with Open Source Tools, Exercise: Moving data into HDFS with Sqoop	[5]
3.	**Big SQL**: Using Big SQL to access data residing in the HDFS, Creating Big SQL schemas and tables, File formats and querying Big SQL tables, Managing the Big SQL Server, Configuring Big SQL security, Data federation with Big SQL, Exercise: Connecting to the IBM Big SQL Server, Creating and managing Big SQL schemas and tables, Querying Big SQL tables, Managing the Big SQL Server, Configuring Big SQL security, Configuring impersonation in Big SQL, Using Fluid Query with Big SQL.	[9]
4.	**IBM Watson Studio:** Introduction to IBM Watson Studio, Analyzing data with Watson Studio,Exersice: Getting started with Watson Studio, Analyzing data with Watson Studio.	[6]
Outcome(s):	On the successful completion of the course, the student will be able to: • Hadoop and the Hadoop Distributed File System•Analyze the time and space complexity of algorithms. • Apache Spark. • ZooKeeper, Slider, and Knox	
Text Books:	1. IBM Study Material	
Reference Books:		

CS-18.205	Application Development for Cloud	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	Basic knowledge of JavaScript. • Basic knowledge of Eclipse-based development tools • Basic understanding of HTML • Basic understanding of the IBM Skills Academy learning environment • Basic understanding of the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	To Define cloud computing • To Describe the choices that are available to developers when creating cloud applications • To Describe infrastructure as a service, platform as a service, and software as a service • To Describe IBM Cloud • To Describe the architecture of IBM Cloud	
1.	**CLOUD APPLICATION FOUNDATIONS**: Introduction to HTML5 and JavaScript Programming, JavaScript programming for web applications, HTML5 features,Exersices: Working with JavaScript in HTML documents, Working with HTML5 features	[8]
2.	**CLOUD APPLICATION DEVELOPER**: Essentials of Cloud Application Development, Introduction to cloud computing and IBM Cloud, Getting started with IBM Cloud, Developing IBM Cloud applications on a local workstation, Adopt a DevOps approach by using IBM Cloud Continuous Delivery, REST architecture and Watson APIs, Introduction to data services in IBM Cloud, IBM Cloud mobile backend as a service, Exercise: IBM Cloud command line interface (CLI), Develop IBM Cloud applications with Eclipse, Developing IBM Cloud applications with IBM Cloud Continuous Delivery, IBM Cloud with Cloudant,Build a mobile application by using Kinetise,	[20]
3.	**Developing Cloud Applications with SDK for Node.js**: Introduction to server-side JavaScript, Asynchronous I/O with callback programming, Express web application framework, Exercise :Developing a Hello World Node.js app on IBM Cloud, Understanding asynchronous callback, Creating your first express application, Understanding asynchronous callback Building a rich UI application by using AngularJS with Node.js	[12]
Outcome(s):	On the successful completion of the course, the student will be able to: •Understand asynchronous callbacks and be able to write the code in a Node.js application •Understand Express routing •Understand IBM Watson Natural Language Understanding service •Use the Fetch API to interact with back-end web services	
Text Books:	IBM Study Material.	
Reference Books:		

CS-18.338	Predictive Modeling Analytics	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	• English Proficiency • Basic Internet and web browser usage experience • Basic analytics experience	
Objective(s):	□ To understand how analytics provided a solution to industries using real case studies □ To Explain what is analytics, the various types of analytics, and how to apply it □ To Improve efficiency, sample records, and work with sequence data □ To Integrate and collect data □ To Understand the principles of data mining	
1.	**Business Analytics Overview**: Analytics overview, Analytics trends, Towards a predictive enterprise, Analytics: Industry domains , Case studies and solutions. Business Intelligence and Analytics	[5]
2.	**Introduction to A Predictive Analytics Platform & Data Mining**: Introduction to data mining, Working with modeler, A Data-mining tour ,Collecting initial data , Understanding your data ,Setting the unit of analysis ,Integrating data ,Deriving and reclassifying fields, Looking for relationships ,Introduction to modeling , Exercise: On the basis of all above topics.	[10]
3.	**Advanced data preparation**: Using functions, Data transformations, Working with sequence data, Sampling records, Improving efficiency. Exercise on the basis of all above topics.	[10]
4.	**Automated Data Mining**: Introduction to data mining ,The basics of using a modeler ,Reading data files , Data exploration , Automated data preparation ,Data partitioning, Predictor selection for modeling ,Automated models for categorical targets , Model evaluation , Automated models for continuous targets ,Deploying models Exercise :Adding nodes and creating streams in the modeler ,Reading a data file and typing the data in the source node , Review missing values in modeler and use the data audit node on the charity data , Practice using the ADP node to prepare data for modeling ,Use a partition node to split the charity data for modeling ,Use the feature selection node to select fields and predict a response ,Using the auto classifier node to construct a model in order to predict a response, Evaluate the model created to predict the field response ,Develop a model to predict the total spending , Use a scoring stream to make predictions	[15]
Outcome(s):	On the successful completion of the course, the student will be able to: • Understand the principles of data mining • Use the user interface of modeler to create basic program streams • User a partition node to create training and testing data subsets • Use a model to score new data	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.409	Block Chain	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• Basic knowledge of JavaScript, Node.js, Angular.js, Golang, Docker, and Kubernetes • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	To Explain block chain and how it is applied across industries To Understand the benefits of a blockchain platform To Explain what is Hyperledger Composer, how it fits into blockchain, and its applications To Explain the elements of a business network, the role of channels, and how the world state is maintained To Understand block chain deployment, security and integration capabilities	
1.	**Blockchain overview**: What is Blockchain? The business backdrop, The problem area, Relation to Bitcoin, Difference between Bitcoin and Blockchain, Requirements for a blockchain in a business environment, Requirements deep dive, Apply blockchain to business, Why blockchain is relevant for business, Consensus: Shared Reference Data Example, Provenance: Supply Chain Example, Immutability: Audit and Compliance Example, Finality: Letter of Credit Example, Industry Use Cases, Hyperledger Composer, Hyperledger Fabric, Blockchain for Financial Services	[10]
2.	**Blockchain Foundations**: HTML5 overview, JavaScript programming for web applications, HTML5 features, Working with HTML 5 features, Node.js, Server-Side JavaScript, Creating a Node.js Web Application, Asynchronous I/O with callback programming, Refactor weather project, , Working with JavaScript in HTML documents.	[10]
3.	**Docker Essentials** : Introduction to Docker, Add value CI/CD with Docker Images, Introduction to Orchestration, Get started with Kubernetes, Virtual machines, containers, and Kubernetes, Relationship between Kubernetes and containers, Deploy an application with IBM Watson services.	[10]
4.	**Blockchain Developer:** Blockchain Overview, Introducing Hyperledger Composer, Understanding Blockchain Solution Architecture, Blockchain in-depth, Hyperledger Fabric Application Development, Understanding Blockchain Deployment Options, Understanding Blockchain Security, Blockchain Integrated, Applying blockchain concepts to the vehicle manufacture lifecycle use case, Developing a blockchain user application with Hyperledger Composer SDK, Developing a client application for Hyperledger Fabric, Integrating blockchain with other systems,	[10]
Outcome(s):	On the successful completion of the course, the student will be able to: • Understand blockchain and how it is applied across industries • Understand the role of a shared ledger • Understand the benefits of a blockchain platform • Understand what is Hyperledger Composer, how it fits into blockchain, and its applications • Understand the blockchain solution architecture	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.216	Application Security	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• Basic web development knowledge • Basic knowledge on HTML and HTTP • Basic knowledge of application security • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform
Objective(s):	• To Describe the emerging threats and leaks as the world is becoming digitalized • To Understand the security dynamics of securing the enterprise • To Understand relational database concepts and how to work with database objects • To Describe how to work with select statements, DML statements, and multiple tables • To Understand how to use JOINs in SQL • To Understand the basics of HTML5 (objectives, document types that are supported, browser support etc.) • To Understand glass box scanning, content based scanning, and troubleshooting

1.	**Cyber Security Overview**: Emerging threats and leaks as the world is becoming digitalized, The changing dynamics of securing the enterprise, A new approach to security, The foundation of approach to security the enterprise, IT Security Frameworks, Security Intelligence as a foundation of all security programs, IBM Security.	[5]
2.	**Application Security Foundations**: SQL Fundamentals, Relational database concepts, Working with database objects, Reading data, Inserting, updating, and deleting data, Working with multiple tables, exercises on Relational database exercise, Creating, modifying and deleting database objects ,Inserting, updating, and deleting data.	[9]
3.	**Introduction to HTML5 and JavaScript Programming:** HTML5 overview, JavaScript programming for web applications, HTML5 features, Working with JavaScript in HTML documents, Working with HTML5 features.	[9]
4.	**Web Application Security Fundamentals:** The web application security problem, Web application basics, Injection flaws, Broken authentication and session management, Cross-Site scripting, Insecure direct object reference, Security misconfiguration, Sensitive data exposure, Missing function level access control, Cross-site request forgery (CSRF), Using components with known vulnerabilities, Unvalidate redirects and forwards, Integrating security in the software development lifecycle	[9]
5.	**Web Application Security Solution Fundamentals:** Web application security overview, Installation and setup, Preparing for scan, Configuring first scan, Reviewing the results, Reporting, Logging in and managing sessions, Configuring explore options, Optimizing your scan, Glass box scanning, Content-based scanning, Reviewing scan coverage, Scanning web services, Extending the security web application solution, Troubleshooting,	[8]

Outcome(s):	• Understand relational database concepts and how to work with database objects • Describe how to work with select statements, DML statements, and multiple tables • Understand how to use JOINs in SQL • Understand the basics of HTML5 (objectives, document types that are supported, browser support etc.) • Understand the basics of JavaScript • Describe the web application security problem and web application basics
Text Books:	IBM Study Material.
Reference Books:	

CS 18.407	Advanced Artificial Intelligence	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• English Proficiency • Exposure to the IBM Skills Academy Portal learning environment
Objective(s):	• To Describe the field of AI and its subfields machine learning, NLP and computer vision • To Describe the types of AI • To Describe the types of machine learning: Supervise learning, unsupervised learning, and deep learning • To Describe the purpose of training the various Watson services to adapt them to a closed-domain • To Use Watson API Explorer to interact with the Watson services REST API, to rest your calls to the • To Define chatbots • To Explain the factors that lead to the growing popularity of chatbots • To Identify applications that are good candidates to integrate with chatbots • To Describe the main components that are involved when building a chatbot and explain their purpose • To Describe how to build a chatbot by using the IBM Watson Conversation service

1.	**Artificial intelligence overview**: Introduction to Artificial Intelligence, Machine Learning, Natural Language Processing, Computer vision, Cognitive Computing.	[5]
2.	**Artificial intelligence foundations**: Introduction to IBM Watson, Evolution from DeepQA to Watson services on IBM Cloud, Build with Watson, Exploring Watson services with Watson API Explorer.	[10]
3.	**Artificial intelligence analyst:** Introduction to Natural Language Processing, Pipeline and concepts, NLP and IBM Watson, Exercises on Ingest, Convert, Enrich, and Query with Watson Discovery Service.	[10]
4.	**Chatbots:** Introduction to Chatbots, Chatbot fundamentals, IBM Watson conversation service.	[8]
5.	**Computer Vision:** Introduction to Computer Vision, Computer Vision fundamentals, IBM Watson Visual Recognition service, Exercise on Classifying images with Watson Visual Recognition.	[7]

Outcome(s):	Understand the relationship between AI and NLP Know the history and advancement of Computer Vision Understand Computer Vision components Learn about the Vision services that are available from IBM Watson.
Text Books:	IBM Study Material.
Reference Books:	

CS 18.210	Business Intelligence	Total Lectures: 40
		Credit: 3-0-0-3
Prerequisite(s):	• English proficiency • Microsoft Windows operating system basic experience • Basic Internet and web browser usage experience • Knowledge of an organization's business intelligence and reporting needs • Basic database background is preferred • Basic knowledge of XML is preferred • Exposure to the IBM Skills Academy portal learning environment • Exposure to the IBM Skills Academy cloud hands-on labs platform	
Objective(s):	• To Understand how analytics provided a solution to industries using real case studies • To Explain what is analytics, the various types of analytics, and how to apply it • To Understand how a business analysis software works, and its architecture • To Describe a reporting application, its interface, and the different report types • To Create different types of advanced reports • To Understand Active Reports and how to create them	
1.	**Business Analytics Overview**: Analytics overview, Analytics trends: past, present & future, Towards a predictive enterprise, Analytics: Industry domains, Case studies and solutions.	[5]
2.	**Business Intelligence and Analytics 101 and Business analytics foundations**: Business Intelligence and Analytics 101, IBM Cognos Analytics for Consumers, Business analysis solution for consumers.	[7]
4.	**Business intelligence analyst:** IBM Cognos Analytics: Author Reports Fundamentals, Introduction to IBM Cognos Analytics, Create list reports, Focus reports using filters, Create crosstab reports, Present data graphically, Focus reports using prompts, Extend reports using calculations, Use additional report building techniques, Customize reports with conditional formatting, Drill-through definitions, Enhance report layout, Overview of IBM Cognos Analytics	[12]
5.	**IBM Cognos Analytics: Author Reports Advanced:** Create query models, Create reports based on query relationships, Create advanced dynamic reports, Design effective prompts, Create additional advanced reports, Examine the report specification, Distribute reports through bursting, Enhance user interaction with HTML.	[11]
6.	**IBM Cognos Analytics: Author Active Reports:** Introduction to IBM Cognos Active Reports, Use Active Report connections, Active Report charts, visualizations, and decks.	[5]
Outcome(s):	• Describe a reporting application, its interface, and the different report types • Create different types of advanced reports • Understand Active Reports and how to create them	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.309	Security Intelligence	Total Lectures: 40
		Credit: 3-0-0-3
Prerequisite(s):	• Basic understanding of the security fundamentals • Basic understanding of the IT infrastructure and IT security fundamentals • Basic understanding of Linux, Windows, TCP/IP networking and Syslog • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	Identify enterprise business and IT drivers that influence the overall IT Security Architecture Define the role of a centralized Security Intelligence solution and how it integrates with other IT enterprise security components Explain how a Security Intelligence solution can be used to investigate and stop advanced threats and address IT governance and regulatory compliance Describe how QRadar SIEM collects data to detect suspicious activities Navigate and customize the QRadar SIEM dashboard Investigate suspected attacks and policy breaches Search, filter, group, and analyze security data Investigate the vulnerabilities and services of assets Locate custom rules and inspect actions and responses of rules Use QRadar SIEM to create customized reports Use charts and apply advanced filters to examine specific activities in your environment	
1.	**Cyber Security Overview**: The status quo of IT Security, Security intelligence and operations,	[5]
2.	**Cyber Security Foundations**: Security Intelligence Fundamentals, Designing a security intelligence solution, Security intelligence functional components,	[10]
3.	**SECURITY INTELLIGENCE ENGINEER:** Security Intelligence Solution Foundations, Introduction to Security Intelligence Solution SIEM, How Security Intelligence Solution SIEM collects security data, Using the Security Intelligence Solution SIEM dashboard, Investigating an offense that is triggered by events, Investigating the events of an offense, Using asset profiles to investigate offenses, Investigating an offense that is triggered by flows, Using rules and building blocks, Creating Security Intelligence Solution SIEM reports, Perform advanced filtering	[10]
Outcome(s):	Understand the relationship between AI and NLP Know the history and advancement of Computer Vision Understand Computer Vision components Learn about the Vision services that are available from IBM Watson.	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.214	Developing IoT based Applications	Total Lectures: 40
		Credit: 3-1-0-4
Prerequisite(s):		
Objective(s):	An introduction the idea of collaborative devices working together to achieve a larger goal is not new. Beginning from the simple operational definition, the session will outline the historical perspective right from pre-internet era, specific machine-to-machine communication context aware computing to wearables. It will conclude architecture of Internet of Things (IoT).	
1.	**Unpacking Internet of Things**: What is IoT,Why IoT,Journey of IoT, Business Use cases of IoT, Brainstorming on various IoT use cases on any two Domains like- (Manufacturing , Buildings , Agriculture , Energy & Utilities , Worker Safety),Available programming languages for IoT enabled applications,Basic commands and board configurations,Integration IoT on Arduino.	[5]
2.	**Introduction to basic hardware interfaces and proteus simulation:** Describe a development platform, Describe the architecture of a development platform, Introduction to sensor and hardware (LED, ultrasonic Sensor, Flame sensor, DHT sensor, LCD etc.), Introduction and installation of proteus, Introduction to LED, Writing of LED blinking program on Arduino IDE with hardware implementation,Introduction to seven segment display and its working,Introduction to LCD and describing how digital display works, Writing code for LCD to display sensors results,Descriptive explanation of analog and digital conversion in electronics,Descriptive explanation of Pulse Width Modulation in electronics	[9]
3.	**Introduction to various sensors and their interface with Arduino:** Introduction to ultrasonic sensor and describing how ultrasonic sensors works, Writing code for ultrasonic sensor and display result in Serial Monitor,Introduction to Flame sensor and describing how Flame works, Writing code for Flame sensor to calculate ppm value and display result in Serial Monitor,Introduction to DHT sensor and describing how DHT sensors works, Writing code for DHT and display result in Serial Monitor,Introduction to LDR and describing how it works, writing code it,Introduction, to IR and describing how it works, Writing code for it,Introduction to LM35 and its application	[9]
4.	**Advanced Modules Interfacing And Assignments:** Introduction to Bluetooth and describing how Bluetooth works, Writing code for HOME AUTOMATION,Introduction to GSM and introduction to AT commands, write a code to call/message other phone using AT commands through arduino,write code to upload temperature sensor value on Cloud ,Introduction to Wi-Fi and new modules avail in the market, Write some code on ARDUINO for ESP8266 to upload sensors value on web,Introduction to Acc. describing how it works, Writing code for it	[9]
5.	**ASSIGNMENTS:** Displaying text on LCD ,Scrolling text on LCD,Displaying numbers on LCD ,IOT based agricultural field monitoring and controlling,IOT Based office home security with auto capture on intruder and sending alert,IOT based digital notice board for college ,IOT based contactless liquid level monitoring with empty and full alert ,IoT based home automation with fault switch,IoT based agricultural field monitoring and controlling, Project discussion.	[8]
Outcome(s):	• Unpacking Internet of Things • Getting introduced to IoT • Business Use cases of IoT • Embed various sensors with iot platform and simulate them on virtual simulation software proteus • Creating account on iot cloud platform and setting up communication between arduino and cloud platform.	
Text Books:	IBM Study Material.	
Reference Books:		

CS 17.302 **Advanced RDBMS** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): Database Management System

Objective(s): To acquire fundamental knowledge of Software designing using UML.

1.	Overview of DB2 9 on Linux, UNIX and Windows, Command Line Processor (CLP) and GUI usage, The DB2 environment.	[12]
2.	Creating databases and data placement, Creating database objects, Moving data.	[10]
3.	Backup and recovery, Locking and concurrency, Investigating DB2 locking.	[10]
4.	Problem determination, Application issues and performance, Application performance tools, Security.	[8]

Outcome(s): After completion of this course student get the understandings of advance concepts of Database design and security.

Text Books:

1. RamezElmasri, Shamkant B. Navathe, "Fundamentals of Database Systems",Pearson Education, 7th Edition, 2015.

Reference Books:

2. AviSilberschatz , Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2011.

1. Jeffrey A. Hoffer, Mary B. Prescott and Fred R. McFadden, "Modern DatabaseManagement", Prentice Hall, 8th Edition, 2006.

CS 17.208 **Essentials of Software Engineering (OOAD & SW Lifecycle)** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): Object Oriented Technologies

Objective(s):

- To acquire fundamental knowledge of Software designing using UML.

1. **Software Engineering Overview:** Best Practices of Software Engineering Concepts of Object Orientation Essentials of Visual Modeling Requirements Overview [12]
2. **Requirement analysis**: Analysis and Design Overview Architectural Analysis Use-Case Analysis Identify Design Elements [10]
3. **Design analysis**: Identify Design Mechanisms Describe the Run-time Architecture Describe Distribution Use-Case Design Objectstore Mechanism Security Mechanism. [10]
4. **UML and mapping**: UML to C++ Mapping UML to Java Mapping UML to Visual Basic Map UML to Visual Basic Map [8]

Outcome(s):

- After completion of this course student get the understandings of object-oriented analysis and design concepts, as well as hands-on practical experience applying the techniques within a use-case-driven, architecture-centric, and iterative development process.

Text Books:

1. Pressman R.S., "Software Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Sommerville, Ian "Software Engineering", Pearson Education

Reference Books:

1. Jalote Pankaj, "An Integrated Approach to Software Engineering", NAROSA.
2. Fairely, R.E., "Software Engineering Concepts", McGraw-Hill

CS 17. 204 **R Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language(CS 14.101)

Objective(s):

- To understand and learn programming concepts of R
- To Apply R programming to solve various statistical, graphics and modeling problems

1. **Fundamentals of R** : Evolution of R, Features of R, R environmental Setup, R Script file, Data types- Vectors, Lists, Matrices, Arrays, Factors, Data Frames, Variables, finding and deleting variables, Operators in R. [6]
2. **Control Statements in R**: if-else statement, switch statement, Repeat loop, while loop, for loop, break statement, next statement [8]
3. **Functions, Strings and Vectors :** Function Definition , Function Components Built-in Function, User-defined Function, Calling a Function, Lazy Evaluation of Function, Strings and Strings Manipulation, Vector creation, accessing vector elements, vector manipulation, [10]
4. **Lists, Matrices and Arrays :** List Creation, Naming list elements, Accessing list elements, Manipulating list elements, Merging list, Converting list to Vector, Accessing elements of matrix, matrix computations, Naming row and column of array, accessing array elements, manipulating array elements, calculation across array elements [10]
5. **Data frames, factors and packages:** Extract data from data frame, expand data frames, factors in data frames, changing the order of levels, generating factor levels, packages [6]

Outcome(s): After completing the course the student is expected to

- be able to use and program in the R programming language
- be able to use R programming to solve statistical problems
- be able to apply R Programming concept to solve real world problems

Text Books:

1. Hadley Wickham, Garrett Grolemund, R for Data Science, O'Reilly, January 2017.
2. John Maindonald and John Braun, Data Analysis and Graphics Using R, Cambridge University Press, Cambridge, 2007.

Reference Books:

1. Peter Dalgaard, Introductory Statistics with R, Springer Verlag, 2008.
2. Phil Spector. Data Manipulation with R. Springer, New York, 2008.

CS 17. 254 **R Programming Laboratory** **Credit: 0-0-2-1**

Prerequisite(s): CS14.111(Programming Language Laboratory)

Objective(s):

- To learn R programming constructs
- To learn use R for statistical analysis
- To learn R for modeling.

Contents: Lab manual based upon the theory course CS 17.204 and to achieve the listed course objectives and outcomes.

Outcome(s): On successful completion of this course, the students will be able to

- Write programs using R programming
- Use R programming for statistical analysis of data
- Use R programming for data visualization
- Use r programming for problem modeling

MA-14.101 **Mathematics-I** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

1. **Calculus:** Review of basic concepts, partial differentiation, Euler's theorem on homogeneous functions, Taylor's series and Jacobian, maxima and minima of functions of two variables, asymptotes, tracing of simple Cartesian curves, length of plane curves, area bounded by the curves, multiple integrals (double and triple integrals, change of order of integration), physical interpretations and applications. [16]

2. **Three-dimensional Geometry**: Direction cosines and direction ratios of a straight line, equation of a plane,plane passing through intersections of two planes, equations of astraight line, theshortest distance between two skew lines, theequation of a sphere, intersection of plane and sphere. [10]

3. **Matrix Theory**: Rank of matrix, linear dependence and independence of vectors, solution of system of simultaneous linear equations, Eigen values, Eigenvectors of a matrix, statement of Cayley-Hamilton theorem (without proof) , reduction of a matrix to diagonal form, quadratic forms, linear transformation of a quadratic form, and applications. [10]

4. **Theory of Equations**: Introduction of polynomials, therelation between roots and coefficients, Cardon's method. [4]

Outcome(s):

- After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj, New Delhi, 43rd Edition, 2013.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 3rd Edition 2008.

Reference Books:

1. Kreyszig Erwin, Engineering Mathematics, John Wiley and Sons, New York, ISBN: 04717289777/0471726478, 9th Edition, 2005.
2. Veerarajan T., Engineering Mathematics (for first year), TMH Publishing Company Limited, New Delhi, 2nd Edition 2006.

MA-14.102 **Mathematics-II** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): MA-14.101

Objective(s):

- To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

1. **Computational Methods**: Introduction and importance of numerical analysis, calculus of finite differences, interpolation schemes for equal and unequal intervals (Newton's forward and backward interpolation formulae), divided difference, interpolation for unequal intervals (Newton's divided difference and Lagrange interpolation formulae), solution of algebraic and transcendental equations by Newton-Raphson method, applications to Engineering. [13]

2. **Ordinary Differential Equations:** First order and first-degree differential equations (variable separable, homogeneous, linear, exact equations, linear differential equations of second order with constant and variable coefficients (complementary functions and particular integrals) and applications. [12]

3. **Partial Differential Equations**: Formation of partialdifferential equations, Lagrange's multipliers method for thesolution of first order differential equations, separation of variables for nonlinear differential equations and applications. [5]

4. **Vector calculus**: Vector and scalar point functions, conservative fields, gradient of scalar point functions, divergence and curl of vector point functions (Solenoidal and irrotational vectors), directional derivative of scalar point functions, work done along a curve, integration of vectors, line integral (work done), surface integral, volume integral, physical interpretations and applications. [10]

Outcome(s):

- After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj,New Delhi, 40th Edition, 2007.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited,New Delhi, 2nd Edition 2007.

Reference Books:

1. Kreyszig Erwin, Engineering Mathematics, John Wiley and Sons, New York, , 10th Edition, 2010.
2. Veerarajan T., Engineering Mathematics (for first year), TMH Publishing Company Limited, New Delhi, 5th Edition 2015.

MA 14.201 **Applied Mathematics** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): None

Objective(s):

- To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1. **Linear Programming:** Introduction, graphical method (bounded & unbounded solutions), Simplex method, artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). [12]
2. **Numerical Methods:** Solution of system of equations (Gauss elimination and Gauss – Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods), solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector Runge-Kutta methods) [10]
3. **Complex Analysis:** Function of complex variable, analytic function, Cauchy- Riemann equations (without proof), integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula (without proof), zeros and singularities of complex functions, residues. [6]
4. **Integral Transform**: Laplace transform and inverse Laplace transform, first and second shifting theorems, convolution theorem (without proof), solution of ordinary differential equations with initial conditions by Laplace transforms, Fourier series of periodic functions, even and odd functions, Fourier half-range series, basics of Fourier transform. [12]

Outcome(s):

- After completion of the course, students would be able to apply the knowledge of linear programming, numerical methods, complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH,2nd 2007.
2. Grewal B.S. & Grewal J.S., Higher Engineering Mathematics, Khanna publishers, 40th Edition: 2007.
3. Taha H.A., Operation Research: An Introduction, Pearson,8th edition 2006.
4. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.

Reference Books:

1. Jain R.K. & S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 5th Edition 2016.
2. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
3. James B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Babu Ram, Engineering Mathematics, Pearson, Year 2010.

MA 14.202 **Statistics and Probability Theory** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): Nil.

Objective(s):

- To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

1.	**Introductory Ideas:** Recapitulation of Basic Probability theory; Law of addition and law of multiplication ;conditional probability; total probability; Bayes' theorem and it's applications.	[6]
2.	**Random Variables and Distribution:** Discrete and continuous random variables; types of distribution; probability mass and density functions; mean, variance and standard deviation of distribution.	[4]
3.	**Theoretical Probability Distribution:** Discrete types (Binomial) and Continuous type (Normal, Student's't'); applications of basic ideas to these distributions	[8]
4.	**Sampling Theory:** Sampling distribution of mean and variance; central limit Theorem.	[4]
5.	**Testing of Hypothesis:** Simple and Composite hypothesis; Type I and Type II errors; tests of significance and level of significance.	[4]
6.	**Correlation and Regression:** Simple, partial and multiple correlations; linear regression.	[6]
7.	**Queuing Theory and Queuing Models:** Birth and death process; pure birth and pure death process; Classification of queuing models: M/M/1, M/M/1/N, M/M/S and M/M/S/N.	[8]

Outcome(s):

- After completion of the course, students would be able to apply the knowledge of Statistics and Probability in engineering and solve curriculum problems.

Text Books:

1. A.P.Baisnab and Manoranjan Jas, Elements of Probability and Statistics, TMH, 2003.
2. Pugalararasu, Probability and Queuing Theory, TMH, 2011.
3. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, 2002.
4. Gupta & Kapoor, Fundamental of Applied statistics, SCS Publisher, 2001.
5. B.V. Ramana, Higher Engineering Mathematics, TMH, 2006.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH, 2002.
2. Palaniammal, Probability and Random Processes, PHI, 2012.
3. Spiegel, Probability and Statistics (Schaum's outline Series), TMH, 2004.
4. Miller and Freund's, Mathematical Statistics with Applications, 7th Edition, Pearson, 2003.
5. Richard A. Jonson, Probability and Statistics for Engineers, Pearson, 2005**.**

ME-14.101 **Applied Mechanics** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course will help the student to acquire knowledge of basic engineering mechanics concepts and enhance their ability to solve open-ended engineering problems.
- To provide the student with a clear and thorough understanding of the theory and applications of engineering mechanics, covering both statics and dynamics.
- To provide the student with a thorough understanding of the concept, drawing, and the use of free-body diagrams.
- To be able to determine the Centre of Gravity and Moments of Inertia of simple geometric shapes and understand the physical applications of these properties.
- To understand the use and be able to perform calculations related to friction forces in engineering applications.

1. **Introduction:** Idealization of Mechanics, theconcept of Rigid Body, External Forces (Body forces & surface forces), Laws of Mechanics. [3]

2. **Force Systems and Equilibrium**: Introduction to vector, Statically Equivalent Force systems,Free Body Diagram, Equations of equilibrium and their applications to thevarious system of forces. [8]

3. **Distributed Forces and Moment Of Inertia**: Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, Principle axes and Principle Moment of Inertia. [5]

4. **Friction:** Introduction of friction, Laws of friction, wedge, screw, belt, rolling friction. [5]

5. **Tension,Compression, and Shear:** Normal stress and strain, Linear elasticity, Hooke's Law and Poisson's Ratio, Shear stress and shear strain, Relationship between modulus. [4]

6. **Beams:** Different support & load conditions, SFD, BMD [5]

7. **Kinematics of Particles**: Introduction, Rectilinear motion, Plane curvilinear motion, Rectangular coordinates, Tangential and normal coordinates, polar coordinates, Relative motion (Translating Axes), constrained motion of connected particles. [5]

8. **Kinetics of Particles:** Introduction, Force, Mass and acceleration, Newton's second law of motion, Equation of motion and solution of problems, Work and Energy, Impulse and Momentum. [5]

Outcome(s):

- The students shall develop the ability to identify, formulate, and solve engineeringproblems related to forces and motion.

Text Books:

1. Timoshenko, S, Young, D.H, Rao, J.V, Engineering Mechanics, 4th edition TMH, 2010.
2. Merian, J.L, Kraige, L.G., Engineering Mechanics Vol I & II, 7th edition Wiley India 2015.

Reference Books:

1. Hibbeler, Gupta R. C., Engineering Mechanics, 11th ed.,Pearson India, 2010.

ME-14.111 **Computer Aided Engineering Drawing** **Total Lectures: 40**

Credit: 0-0-4-2

Prerequisite(s): NIL

Objective(s):

- To improve the visualization skills.
- To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
- To impart the knowledge of understanding and drawing of simple engineering products.

1. **Introduction to Computer Aided Sketching**: Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and freehand practice. Board Drawing vs. Computer- Aided Drawing. Introduction to Solid works Environments. Computer screen, thelayout of the software, standard toolbar/menus and description of most commonly used toolbars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP &LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, dimensioning, line conventions, material conventions and lettering. [8]

2. **Orthographic Projections**: Horizontal planes, Vertical planes, Front view, Top view, Side view, Projections, theFirst and Third angle of projection, Projections of points, Principles of orthographic projections, Sketching of different views of given objects. Introduction to sketching in Solid works : 2-Dimensional Sketching, Sketching in Solid works, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination, and perpendicularity. [12]

3. **Projections of Lines, Planes, and Solids**: Lines inclined to both the principal planes, theprojection of Lamina inclined to both principal planes, Projections of solids: Axis inclined to both the reference planes and Intersection of solids. Introduction to thepart module in Solid works: Extrude, Revolve, Sweep, Hole, Filleting, and Chamfering features. [12]

4. **Sections of solids and sectional orthographic views:** Sectional orthographic projections - Full,Half, Partial, revolved and removed surfaces. Introduction to drawing module in Solid works:Standard 3 views, Auxiliary view, Section View, Projected view. [12]

5. **Isometric Projection:** Terminology, Isometric scale, Box method, Coordinate or offset method, Four-center method, theisometric projection of arcs. Solid models practice using Solid works partmodule. [8]

Outcome(s):

- Students will be able to improve their visualization skills so that they can apply these skills in developing new products.
- Students will be able to know and understand the conventions and the methods of engineering drawing using Solid works.
- Students will be able to prepare simple drawings of engineering products.

Text Books:

1. N.D. Bhatt, "Engineering Drawing",Charotar Publishing House, 2017.
2. Prof. Sham Tickoo, Sandeep PremDass Solid works 2013 for Engineers and Designers Wiley Publication, 2017.

Reference Books:

1. Randy H. Shih, Solid works 2017 and Engineering Graphics: An Integrated Approach, SDC Books: Publications. 2017
2. David Planchard, "Engineering Graphics with Solid Works 2014 and Video Instruction", SDC Publications, 2013.

ME-14.112 **Mechanical Workshop** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To learn various hand tools used in fitting, carpentry and sheet metal shop.
- To learn about lathe and drilling machine and their operations.
- To learn how various joints are made using wood and other metal pieces.

1. Fitting Shop: Prepare job that contains various fitting operation like filing, marking, measuring, cutting, drilling etc.

2. Carpentry Shop: Making of carpentry joint (T, L joint etc).

3. Sheet Metal Shop: Making job from thesheet (funnel, tray etc).

4. Machine Shop: Perform various operations like turning, step turning, facing, chamfering, knurling etc. on Lathe.

Outcome(s): Students will able to:

- Understand use of tools of Fitting, Carpentry & Sheet Metalworking operations
- Study and practice on lathe and drilling machine and their operations
- Acquire engineering skills in Fitting, Carpentry & Sheet Metalworking operations

MT 201 **Engineering Economics** **Total Lectures: 24Credit: 2-0-0-2**

Prerequisite(s): NIL

Objective(s):

- To know about the basic concepts of Engineering Economics and its role in Indian economy.
- To understand about the elements of economics with application to the industrial sector and its impact on Economy.
- To discuss about the market demand analysis, production analysis and pricing mechanism for decision making.
- To find the role of consumer perception in market demand and its features and infrastructure development in India.
- To discuss about cost analysis and optimization techniques with multiple objectives.

1.	**Introduction to Engineering Economics:** Origin, principles, engineering economics and design process, engineering for economic competitiveness, engineering economy and the engineer.	[3]
2.	**Elements of Economics:** Definition, demand and supply, income, equilibrium, utility.	[3]
3.	**Economics applied to Industries:** Market demand analysis, production analysis for decision Making, cost analysis, pricing techniques in regards of goods and services, break even analysis, interest, annuities and profits.	[12]
4.	**Replacement Analysis:** Capital recovery, depreciation methods for replacement studies.	[2]
5.	**Optimization Techniques:** Economics and optimization, price mechanism and optimal resource allocation, optimization under constraints, optimization under risk and uncertainty,	[4]

Outcome(s): Students would

- Be able to perform and evaluate payback period and capitalized cost on one or more than one economic alternatives.
- Be able to carry out and evaluate the benefit/cost, break even analysis on one or more alternatives.
- Have the knowledge of fundamentals of Engineering Economics for the purpose of economic condition of the country.

Text Books:

3. **Salvetore Dominick, Managerial Economics, Prentice Hall of India,6th Edition, 2008.**
4. **Christopher Thomas, S Charles Maurice, Managerial Economics, Mc-Graw Hill,11th Edition, 2012.**

Reference Book:

2. **Van Horne,James C., Fundamentals of Financial Management, Pearson Education,13thEdition, 2009.**

PY-14.101 **Engineering Physics** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To make a bridge between the physics in school and engineering courses.

1. **Modern Physics**: Introduction to black body radiation spectrum, photoelectric effect, Compton effect. Wave-particle Dualism, deBroglie hypothesis, de Broglie wavelength, extension to electron particle, Davisson and Germerexperiment,matter waves and their characteristic properties, phase velocity, group velocity and particle velocity, relation between phase velocity and group velocity, relation between group velocity and particle velocity,expression for deBr;oglie wavelength using group velocity. [8]

2. **Quantum Mechanics:** Heisenberg's uncertainty principle and its physical significance, application of uncertainty principle (non-existence of electron in the nucleus, explanation for decay and kinetic energy of electron in an atom), wave function, properties and physical significance of wave function, probability density and normalization of wave function,setting up of one dimensional time independent Schrodinger wave equation, eigenvalues and eigenfunctions, application of Schrodinger wave equation, energy eigenvalues for a free particle,energy eigenvalues and eigenfunctions for a particle in a potential well of infinite depth. [7]

3. **Electrical Conductivity in Metals**: Free–electron concept, classical free electron theoryAssumptions, drift velocity, mean collision time and mean free path, relaxation time,expression for drift velocity, expression for electrical conductivity in metals,effect of impurityand temperature on electrical resistivity of metals,Quantum free electron theory assumptions, Fermi – Dirac statistics, Fermi-energy, Fermifactor, density of states (No Derivation),expression for electrical resistivity / conductivity,temperature dependence of resistivity of metals, electron in a periodic potential, origin of theenergy gap, band theory of solids, distinction of solids into metals, semiconductors andinsulators. [8]

4. **Dielectric & Magnetic Properties of Materials**: Dielectric constant and polarization of dielectric materials, types of polarization, equation for internal field in liquids and solids (one dimensional), Ferro and Piezoelectricity,frequency dependence of dielectric constant, important applications of dielectric materials,classification of dia, para and ferro-magnetic materials, hysteris in ferromagnetic materials, soft and hard magnetic materials,applications. [7]

5. **Lasers and Optical Fibers**: Einstein's coefficients (expression for energy density), requisites of a Laser system, condition for laser action, principle, construction and working of CO_2 laser and semiconductor laser, applications of laser – Laser welding, cutting and drilling, measurement of atmospheric pollutants, holography–principle of recording and reconstruction of images, applications of holography, propagation mechanism in optical fibers, angle of acceptance, numerical aperture, types of optical fibers and modes of propagation, attenuation, application, block diagram discussion of point to point communication. [10]

Outcome(s):

- The student will be able to understand many modern devices and technologies based on lasers and optical fibers. A student can also appreciate various material properties which are used in engineering applications and devices.

Text Books:

1. S. O. Pillai, Solid State Physics, 8th Edition, New Age International, 2018.
2. V. Rajendran, Engineering Physics, TMH,2nd edition 2010.

Reference Book:

1. G. K. Shivkumar, Engineering Physics, Prism Book Pvt. Ltd,2011.

PY-14.111 **Physics Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To make the students gain practical knowledge to co-relate with the theoretical studies.

1. To study the material constant, temperature coefficient of current and Planck's constant.
2. To determine the specific resistance of a given wire by using the Carey Foster's bridge.
3. To determine the ballistic constant, K of a moving coil ballistic galvanometer with a standard capacitor of known capacity.
4. To determine the high resistance by the method of leakage of a condenser with the help of ballistic galvanometer.
5. To study the variations of resistivity with temperature and hence determines the energy band gap of the given semiconductor with help of four probe method.
6. To convert a galvanometer into a voltmeter of a given range.
7. To convert a galvanometer into an ammeter of a given ranges.
8. To plot graph showing the variation of magnetic field with distance along the axis of a circular coil carrying current and to estimate from it the radius of the coil.

Outcome(s):

- After completion of the course, students would be able to develop the skills necessary to perform experiments in physics and acquire an experience of the methods used and analysis needed in experimental physics.

RM 17.101 **Research Methodology** **2-0-0-2**

1. **Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research. [2]

2.**Problem Formulation:** Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature, Research Gaps. [4]

3. **Research Design:** Research Framework, Meaning & Significance of Research Designs, Features of a good Research Design, Types of Research Design. [4]

4. **Data for research:** Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis. [4]

5. **Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [8]

6. **Report Writing:** Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [4]

TextBooks:

1. R.Pannershelvam, "Research Methodology" Prentice Hall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"Research Methodology: Methods and Techniques", New Age International (p) Limited, Publishers New Delhi, 4ndedition, 2018.

References –

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013.
4. Dr. A.K. Phophalia, “Modern Research Methodology: New Trends and Techniques” Paradise Publishers Jaipur, 1st edition, 2012.
5. Pankaj Madan, “Research Methodology”, Global Vision Publishing House, New Delhi, 2nd edition, 2016.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of ECE

Course structure for

B.Tech ECE

BS-15.411 Business Support System – Intelligent Network (BSS-IN) 3-0-0-3

Total Lecture: 42

Prerequisites: Linux Basic, Database Basic, TCP/IP Basic.

1	**Introduction to Telecom Market** Customer and Vendors, How Adds and promotion benefits, Statistics (Postpaid/Prepaid).	**[2]**
2	**Unit 2: GSM Basic and Evolution** Architecture, Call Flows (Cover RAN/CORE/IN), OSI/SS7 Basic, Evolution (2G to 5G)	**[4]**
3	**Unit 3: Intelligent Network Overview** Common Charging Architecture - High Level Common Architecture, Charging Mechanisms, Charging Functions- Offline Charging Funtions; Offline Charging Funtions; Architecture Mapping ,Charging Principles; Charging data generation and quota supervision; Charging information utilization, OCS - Required Functionality, OCS - Reference Model/Architecture, OCS Rating Function, OCS Functionality Message Flows, OCS CDRs, Policy Control And Charging; Reference Architecture;Policy Control Requirements; Reference Points; Functional Entities; PCC Rules; QoS Rules; PCC Procedure and Flows, Refill And voucher management, Subscriber/Customer management - Customer Care	**[11]**
4	**Unit 4**: **Billing Mediation and Provisioning Basic** CDR, UDR, TAP files, RAP files, NRTRDE, Billing System architecture (Mediation, usage and tariff database, formatting and rating processes, invoice generation),Types of usage (duration, volume, QoS, day and time, number of events, type of service),Types of rating (batch rating, pre-event rating, post-event rating, backwards rating, prepaid balance management, spending control/unbilled limit), Standard rating functions (staircase, offset, linear), Parameters of billing (usage & recurring &onetime charges, discounts & fees & taxes),Types of billing (regular, on-demand, immediate, simulation, information), Different product features (supports MVNO, real-time discounts, cross discounts, shared balances, multiple balances), Different marketing tools (business partners, bundles and counters, F&F, free units, discounts), Typical Telecom Environment: Multivendor environment, Std Protocols & proprietary Interfaces, Integration challenges, File Mediation fundamentals: ASN.1, Need, Typical Use Cases, Architecture, Event Mediation fundamentals: Diameter, 3GPP, Need, Typical Use Cases, Architecture Provisioning fundamentals: MML, CAI, CAI-3G etc, Need, Typical Use Cases, Architecture	**[14]**
5	**Protocols/Tools** TCP/IP/SCTP; Stack Description ; Connection Flow; Messages Flow; Use Cases ,SIGTRAN/SS7; Stack Description; Connection Flow; Messages Flow; Use Cases, DIAMETER; Stack Description; Connection Flow ;Messages Flow; Use Cases, CAMEL ; Stack Description; Connection Flow ;Messages Flow ;Use Cases	**[9]**
6	**3PP Services integration with BSS** Integration With CRBT/MoMo, IVR Services, Practical Example/Use Cases.	[2]
	Assessment	[2]

Comment [D88]: Skills Development

CS -14.203 **Data Structures** **Total Lectures: 40**

Credit : 3-0-0-3

Prerequisite(s): CS-14.101, CS-14.111

Objective(s): To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures.

1. **Introduction:** Basic Terminology, Elementary Data Organization, Algorithm, Efficiency of an Algorithm, Time and Space Complexity, Asymptotic Notations, Time-Space Trade- Off, Abstract Data Types. **[4]**
2. **Array:** Definition, Single and Multidimensional Arrays, Representation of Arrays: Row Major Order, and Column Major Order, Application of Arrays, Sparse Matrices and Their Representations. **[4]**
3. **Searching & Sorting:** Sequential Search, Binary Search, Comparison and Analysis, Hash Function, Collision Resolution Strategies, Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort. **[6]**
4. **Linked list:** Singly Linked Lists, Doubly Linked List, Circular Linked List, Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List. **[6]**
5. **Stack:** Primitive Stack Operations: Push and Pop Array and Linked List Implementation of Stack, Application of Stack: Prefix and Postfix Expressions, Evaluation of Postfix Expression, Recursion, Tower of Hanoi Problem. **[4]**
6. **Queue:** Queue Operations, Circular Queues, Array and Linked List Implementation of Queues, Dequeue and Priority Queue. **[4]**
7. **Tree:** Binary Trees, Binary Tree Representation, Tree Traversal Algorithms: Inorder, Preorder and Postorder, Threaded Binary Trees, Huffman Algorithm, Binary Search Trees AVL Trees. **[6]**
8. **Graph:** Terminology, Sequential and Linked Representations of Graphs: Adjacency Matrices, Adjacency List, Adjacency Multi List, Graph Traversal: Depth First Search and Breadth First Search, Spanning Trees. **[6]**

Comment [D1]: Skills Development

Comment [D2]: Skills Development

Comment [D3]: Skills Development

Comment [D4]: Skills Development

Comment [D5]: Skills Development

Outcome(s): Upon completion of the course the student should

- be knowledgeable of certain abstract data types (ADT).
- be able to make a critical assessment of different implementations of an ADT.
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems.

Text Books:

1. Lipschutz, "Data Structures" Schaum's Outline Series, TMH, 2006.

Reference Books:

1. Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI, 2nd Edition, 2009.
2. Horowitz and Sahani, Fundamentals of Data Structures, Galgotia Publication, 1999.
3. Jean Paul Trembley and Paul G. Sorenson, An Introduction to Data Structures with applications, McGraw Hill, 2nd Edition, 2003.
4. G. A. V. Pai, Data Structures and Algorithms, TMH, 2008.

CS-14.202 **Java Programming** **Total Lectures: 40**

Credit : 3-0-0-3

Prerequisites: CS14.101, CS-14.205.

Objectives: The objective of this Course is to:

- Cover issues related to the definition, creation and usage of classes, objects and methods. Become comfortable with object-oriented programming and learn to think in terms of objects.
- Discuss the principles of inheritance and polymorphism. The concepts would be demonstrated through problem analysis assignments.
- Provide the foundation of good programming skills by discussing key issues of the design of object-oriented software, including programming design patterns and documentation.
- Cover the basics of APIs as well as allow students to explore the Java Abstract Programming Interface.

5. **Overview:** Introductionto java, importance of Java, interactive development environments: Eclipse/Net Beans, basics of OOP. **[4]**
6. **Data Types, Variable, and Arrays:** primitive data types, type casting,arrays, operators and control structures. Identifiers, constants and literals. **[6]**
7. **Classes and Objects:** Class fundamentals, declaring objects, assigning object referencevariables, introducing methods, constructors, the this keyword, garbage collection, the finalize() method, overloading methods, using objects as parameters and return type, introducing access control, understanding static, introducing final, introducing nested and inner classes, exploring the string class, using command-line arguments. **[9]**
8. **Inheritance:** Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final in inheritance, the object class. **[4]**
9. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, user defined exception. **[6]**
10. **Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, thread priorities, managing threads, Thread class built-in functions **[4]**
11. **I/O and String Handling:** I/O basics, reading console input, writingconsole output, the Print Writer class, reading and writing files, string constructors, operations on String, String tokenizing, String Buffer **[7]**

Comment [D37]: Employability

Comment [D38]: Employability

Comment [D39]: Employability

Outcomes: Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP

EC 15.311 **Telecommunication Switching Systems** **Total Lectures: 40**

3-0-0-3

Objectives:

1. To acquire knowledge on simple telephone communication and basics of switching system.
2. To get acquainted with electromechanical switching systems.
3. To gain knowledge on digital switching systems, stored program control system, traffic engineering, telephone networks and ISDN.
4. To apply the knowledge of Telecommunication Switching in designing switching systems.

Prerequisite: NONE

1. **Introduction to Switching Systems:** Introduction, simple telephone communication, basics of switching system [4]
2. **Electromechanical Switching Systems: Introduction to Strowger switching system,** Crossbar switching systems, single stage and multistage switching systems, common control, pulse dialling, tone dialling. [6]
3. **Digital Switching Systems:** Stored Program Control, centralised SPC, distributed SPC, software architecture, application software, space division, and time division switching, time multiplexed space division, time multiplexed time division switching and combination switching. [10]
4. **Traffic Engineering:** Erlang's equation, blocking probability and B-D equation. [4]
5. **Telephone Networks:** Subscriber loop, digital subscriber loop, high speed digital transmission over subscriber line, wire-in, wire-less media, coaxial cables, optical fibre cables, microwave propagation, satellite transmission, numbering plan, charging plan, Inchannel signalling, common channel signalling. [10]
6. **ISDN and ATM Standards:** ISDN architecture, channels, interfaces, protocol, B-ISDN architecture, frame relay, ATM protocols [6]

Comment [D53]: Skills Development

Comment [D54]: Skills Development

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of telecommunication Switching Systems.
2. Able to describe different mechanical and electronic switching systems, telephone networks.

Able to design various switching systems.

Text Books:

1. Telecommunication Switching Systems and Networks, Thiagarajan Viswanathan, PHI
2. Telecommunication Switching, Traffic and Networks, J. E. Flood, Pearson Education

EC 15.314 **FUNDAMENTALS OF MEMS** **Total Lectures: 40**
3-0-0-3

Objective: The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques. This enables them to design, analysis, fabrication and testing the MEMS based components.

Pre-requisite: Knowledge of materials and VLSI is highly desired.

1.	**Introduction:** MEMS Roadmaps, Benefits of Miniaturization, Benefits of Scaling.	**[2]**
2.	**Fabrication Process:** oxidation, film deposition, lithography, etching, ion implantation, diffusion.	**[8]**
3.	**Micromachining:** Surface Micromachining: basic process flow, release, stiction, material choices, residual stress, stringers and planarization, MUMPS, Summit, electroplating, 3D out-of-plane. Bulk Micromachining: wet etch based, dissolved wafer process, SOI MEMS, Scream, Hexsil MEMS, sealed cavity deep RIE.	**[6]**
4.	**Process Integration:** interleaved, MEMS-first, MEMS-last, bonded integration, wafer-to-wafer transfer, fluidic assembly.	**[4]**
5.	**Mechanics of Materials for MEMS:** stress, strain, material properties, measurement & characterization of mechanical parameters.	**[3]**
6.	**Microstructural Elements:** bending moment and strain, flexural rigidity, residual stress, boundary conditions, spring combinations.	**[3]**
7.	**Energy Methods:** application to clamped-clamped beam under axial load, resonance frequency determination, free-free beam, disk, ring, lumped-element mechanical equivalent circuits.	**[4]**
8.	**Circuit Modeling of MEMS:** resonator equivalent circuits, thermal circuits, fluidic circuits.	**[3]**
9.	**Electronic and Mechanical Noise:** electronic noise sources, Brownian motion noise, circuit noise calculation procedure, SNR, dynamic range.	**[3]**
10	**Micromechanical Circuits:** general filter topologies, insertion loss (noise figure), shape factor, design with k and q values, termination impedance, resonator and couplers, circuit modeling of coupled resonators, systematic micromechanical filter design procedure, oscillators, RF MEMS switches.	**[4]**

Comment [D79]: Skills Development

Comment [D80]: Skills Development

Outcome: 1. Be familiar with the important concepts applicable to MEMS, their fabrication.
2. Be fluent with the design, analysis and testing of MEMS.
3. Apply the MEMS for different applications.

Text Books:

1. Senturia's "Microsystem Design"
2. Kovacs' "Micromachined Transducers Sourcebook"
3. Jaeger's "Introduction to Microelectronic Fabrication"
4. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.

References Books:

1. Gaberiel M. Rebiz, "RF MEMS Theory, Design and Technology", John Wiley & Sons,2003
2. Charles P. Poole, Frank J. Owens, "Introduction to nanotechnology" John Wiley & sons, 2003.
3. Julian W. Gardner, Vijay K Varadhan, "Microsensors, MEMS and Smart devices", John Wiley & sons, 2001.

EC 15.315 **BASICS OF ROBOTICS** **Credit : 3-0-0-3**
Total Lectures: 40

• To introduce the basic concepts, parts of robots and types of robots.
• To make the student familiar with the various drive systems for robot, sensors and their applications in robots.

Prerequisite: Nil

Unit I- Introduction **[8]**

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system.

Unit II - End Effectors And Robot Controls **[8]**

Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.

Unit III-Robot Transformations And Sensors **[8]**

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors.

Unit IV-Robot Cell Design And Applications **[8]**

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot.

Unit V-Micro/Nano Robotics System **[8]**

Micro/ Nanorobotics system overview-Scaling effect-Top down and bottom up approach-Actuators of Micro/Nano robotics system-Nanorobot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nanorobot in targeted drug delivery system.

Outcomes: The Student must be able to understand the basics of Robot.

Text Books:

1. Niku Saeed B., Introduction to Robotics: Analysis, Systems, Applications, PHI, New Delhi 2001
2. John J.Craig, “Introduction to Robotics”, Pearson, 2009.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.

Comment [D58]: Skills Development

Comment [D59]: Skills Development

Comment [D60]: Employability

Comment [D61]: Employability

EC 15.316 **ROBOTICS AND CONTROLS** **Total Lectures: 40**
Credit : 3-0-0-3

OBJECTIVES:

- . To get exposure about basic robot kinematics, dynamics, control and programming.

Prerequisite: Basics of Robotics

UNIT I Introduction **[4]**

Definition, Structure, Classification and Specifications of Robots, Industrial Robots.

UNIT II Robot Elements and Control **[4]**

Manipulators, Drives, Sensors, End Effectors, Configuration, Force/Torque Relationship, Trajectory Planning, Position Control, Feedback System, Digital Control.

UNIT III Modeling of Robots **[10]**

Comment [D81]: Skills Development

Coordinate Frames, Mapping and Transformation; Direct Kinematic Model; Inverse Kinematics; Manipulator Differential Motion; Static Analysis; Jacobian.

UNIT IV Manipulator Dynamics **[10]**

Acceleration of a rigid body, mass distribution, Newtons equation, iterative Newton Euler dynamic formulation, Lagrangian formulation of manipulator dynamics, Bond graph modeling of manipulators, Trajectory Planning.

UNIT V Linear and Non Linear Control of Manipulators **[12]**

Comment [D82]: Skills Development

Control law partitioning, trajectory following control, multi input multi output control systems, Cartesian based control scheme. Force Control of manipulators: hybrid position/force control.

Outcomes: The Student must be able to design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.

Text Books:

1. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2. Mittal R. K. and Nagrath I. J., “Robotics and Control”, Tata McGraw Hill, New Delhi 2003.

Reference Books:

1. Ghosal Ashitava, “Robotics: Fundamental Concepts and Analysis”, Oxford University Press 2006.
2. Schilling R. J., “Fundamentals of Robotics Analysis and Control”, Prentice Hall Inc 1990.

EC 15.413 **Advanced Embedded System** **Total Lectures: 40**

3-0-0-4

Objective:

1. To teach the Fundamentals on design attributes of functional units of a Processor
2. To discuss on Hardware software partitioning in system design
3. To teach intra & Inter processor Communications
4. To discuss strategies for processor Communications

Understanding of necessity of operating system in advanced embedded systems.

Prerequisite: EC 14.202 Microprocessor Programming and Interfacing, EC 14.306 Microcontroller and Embedded System

7.	Introduction to Embedded Hardware and Software: Terminology – Gates – Timing diagram – Memory – Microprocessor buses – Direct memory access – Interrupts – Built interrupts – Interrupts basis – Shared data problems – Interrupt latency - Embedded system evolution trends – Interrupt routines in an RTOS environment.	[8]
8.	System Modelling with Hardware/Software Partitioning: Embedded systems, Hardware/Software Co-Design, Co-Design for System Specification and modelling- Single-processor Architectures &,Multi-Processor Architectures, comparison of Co- Design Approaches, Models of Computation, Requirements for Embedded System Specification, Hardware/Software Partitioning Problem, Hardware/Software Cost Estimation, Generation of Partitioning by Graphical modelling, Formulation of the HW/SW scheduling, Optimization.	[8]
9.	Hardware/ Software Co-Synthesis: The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation, Distributed System Co-Synthesis.	[8]
10.	Memory and Interfacing: Memory: Memory write ability and storage performance – Memory types – composing memory – Advance RAM interfacing communication basic – Microprocessor interfacing I/O addressing – Interrupts – Direct memory access – Arbitration multilevel bus architecture – Serial protocol – Parallel protocols – Wireless protocols – Digital camera example.	[8]
11.	Concurrent Process Models and Hardware Software Co-Design: Modes of operation – Finite state machines – Models – HCFSL and state charts language – state machine models – Concurrent process model – Concurrent process – Communication among process –Synchronization among process – Implementation – Data Flow model. Design technology – Automation synthesis – Hardware software co-simulation – IP cores – Design Process Model.	[8]

Comment [D89]: Skills Development

Comment [D90]: Employability

Outcomes: After completing this module, students will be expected to be able to:

1. Implement a RTOS based embedded system and uunderstand the embedded systems design process.
2. Define a specification for an embedded system.
3. Design an embedded system based on a specification.
4. Discuss methods for implementing reliable embedded systems to solve various problems.

EC 15.415 **ROBOT PROGRAMMING** **Total Lectures: 40**
Credit : 3-0-0-3

OBJECTIVES: To study the use of robot programming for various applications.

Prerequisite: Nil

UNIT I - Basics of Robot Programming **[8]**

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands- Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.

UNIT II - Val Language **[8]**

Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications.

UNIT III - Rapid Language **[8]**

RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command based programming. Move master command language- Introduction, syntax, simple problems.

UNIT IV - Practical Study of Virtual Robot **[8]**

Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studio online software- Introduction, Jogging, components, work planning, program modules, input 13 RB-2013 SRM and output signals-Singularities-Collision detection-Repeatability measurement of robot-Robot economics.

UNIT V - VAL-II and AML **[8]**

VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commands-Data processing.

Outcomes: Upon completion of this course the students can able to understand the basic of Robot programming.

Text Books:

1. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
2. Deb. S. R. “Robotics technology and flexible automation”, Tata McGraw Hill publishing company limited, 1994.

Reference Books:

1. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “*Robotics control, sensing, vision and intelligence”*, McGraw Hill Book co, 1987.
2. Craig. J. J. “*Introduction to Robotics mechanics and control”*, Addison-Wesley, 1999.

Comment [D91]: Skills Development

Comment [D92]: Employability

EC 16.305 **Semiconductor Physics** **Total Lectures: 40**

3-1-0-4

Course Objective

The aim of the course is to develop physics and engineering strategies of semiconductor materials and to discuss their functionalities in modern electronic and optoelectronic devices.

Prerequisites : Basic Modern physics , Optics

1	Introduction to solid state materials - crystal structure - Reciprocal lattice - Brillouin zone and rules for band (*k* - space) representation. Dynamics of electrons in periodic potential: Kronig - Penny and nearly free electron models - Real methods for band structure calculations; Bandgaps in semiconductors - Holes and effective mass concept - Properties of conduction and valance bands.	[8]
2	Fermi distribution and energy - Density of states - Valance and conduction band density of states - intrinsic carrier concentration - intrinsic Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors - Bandgap Engineering.	[8]
3	Scattering Mechanism: electron - electron and electron - phonon scattering. Macroscopic transport: Carrier transport by Diffusion - Carrier transport by Drift: Low field, High field and very high field (Impact ionization) - Einstein relation.	[8]
4	Electron - hole pair generation and recombination: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons : Origin, electronic levels and properties Radiative and nonradiative recombination (Shockley - Read - Hall and Auger) processes. Carrier transport - continuity equations. Optical constants: Kramers - Kronig relations.	[8]
5	Optical processes in semiconductor, choice of materials for LED, LED power and efficiency, LED structures - Planar LED, Dome LED, Surface Emitting LED, Edge Emitting LED, Optical detection principle, quantum efficiency, Photoconductor, p-n photodiode, p-i-n photodioe, APD, Heterojunction diode, optocouplers.	[8]

Comment [D51]: Skills Development

Comment [D52]: Skills Development

Course Outcome

This course will provide the students with a basic understanding of the physics and principles of semiconductor material and the operation of the most important semiconductor devices in modern microelectronics and photonics.

EC-14. 403 **Antenna and Wave Propagation** **Total Lectures: 40**

3-0-0-3

Objective: To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications and RADAR.

Pre-requisite: EC-14.208 Principles of Electromagnetics

1. **Introduction**: Basic properties of transmitting, and receiving antenna, gain, bandwidth, and polarization, Effective aperture and Friss transmission formula. [4]
2. **Physical Concept of Radiation:** Retarded potentials hertzian dipole, antenna parameters, radiation pattern, gain, directivity, effective aperture, reciprocity and radiation from dipoles of arbitrary length. [6]
3. **Theory of Array Antenna: A**rrays of point sources, Endfire and Broadside arrays, Log-periodic, Yagi-uda arrays, Analysis of Rhombic antenna. Design of Rhombic Antennas, Loop Antenna: Radiation from small loop and its radiation resistance. Helical antenna: Normal and axial mode operation. synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method [10]
4. **Frequency Independent Antenna:** Slot, horn antenna, parabolic antenna, aperture antennas and microstrip antenna:Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas. [8]
5. **Wave Propagation:** Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, Sky wave propagation- propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, troposphere propagation, Super refraction. [7]
6. **Antennas for Mobile Satellite System:** Antenna for aeronautical mobile systems, cell-site and mobile antenna, adaptive antennas. [5]

Outcomes: After completion of the course, students will be able to

- select the appropriate portion of electromagnetic theory and its application to antennas.
- distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.
- assess the need for antenna arrays and mathematically analyze the types of antenna arrays.
- distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.
- outline the factors involved in the propagation of radio waves using practical antennas.

Text Books:

1. C. A. Balanis, Antenna Theory and Design, 3rd Ed, John Wiley & Sons, 2005.
2. W. L. Stutzman, and G. A. Thiele, Antenna Theory and Design, 2nd Ed, John Wiley & Sons, 1998.
3. R. S. Elliot, Antenna Theory and Design, Revised edition, Wiley-IEEE Press, 2003.

Reference Books:

1. R. E. Collin, Antennas and Radio Wave Propagation, McGraw-Hill, 2014.
2. K.D. Prasad, Antenna and Wave Propagation, 3rd Ed., Satya Prakashan, New Delhi, 2003

Comment [D84]: Skills Development

EC-14.201 **Electronic Devices and Circuits** **Total Lectures: 40**
3-1-0-4

Objective To acquire fundamental knowledge of operation, design and application of various Electronic devices and circuits.

Prerequisite Basic Electronics and Physics of electron.

1. **Junction Diode:** Junction breakdown**,** Current components in a p-n diode, Quantitative analysis of p-n diode characteristics and equivalent circuit, diode resistance, interconnections of diodes, transition and diffusion capacitance. [6]

2. **Transistors**: Operation of transistor, transistor current components, transistor circuit configurations, transistor biasing schemes and operating point stabilization, hybrid-pi model of BJT, low and high frequency models of JFET, MOS Devices - NMOS, PMOS and CMOS [11]

3. **Small Signal Amplifiers at Low Frequency:** Coupling schemes for multistage amplifiers, frequency response of coupled amplifier, RC coupled transistor amplifier, transformer coupled transistor amplifier, cascode circuits, Differential amplifier, Darlington amplifier. [7]

4. **Power Amplifiers:** Power amplifier circuits, class-A, class-B, class-AB, class-C, push pull amplifiers- class-A, class-B, Class- AB, complementary symmetry push-pull and quasi-complementary symmetry, push-pull amplifiers. [8]

5. **Oscillators:** Classification criterion for oscillation, tuned collector, Hartley, Colpitts, RC phase shift, Wien bridge and crystal oscillators, astable, monostable and bistable multivibrators, Schmitt trigger [8]

Outcome: After completion of this course, students would be able to understand the working phenomena and applications of various electronic devices and circuits. Knowledge gained from this course would also be utilized to design different electronic circuits and devices.

Text Books:
1. Millman J. & Halkias C.C., "Electronic Devices and Circuits" McGraw Hill.
2. Thomas L. Floyd, "Electronic Devices", Pearson Education.
3. Robert L. Boylestad & Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education.

Reference Book: Bell, David A., "Operational Amplifiers & Linear ICS" Prentice Hall of India.

Comment [D6]: Skills Development

Comment [D7]: Skills Development

Comment [D8]: Skills Development

Comment [D9]: Skills Development

EC-14.202 **Microprocessor Programming and Interfacing** **Total Lectures: 40**
3-0-0-3

Objective: To develop an in-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques.

Pre-requisite: The students should have good background on digital circuits (should have attended the course Switching Circuits and Logic Design).

1. **The Microcomputer:** Evolution of microprocessor, address bus and data bus, introduction to machine language and assembly language, logic devices for interfacing: 74244, 74245, 74373 **[3]**
2. **The 8085 Processor:** Architecture, pin diagram and description of various signals, read, write and op-code fetch cycles, interrupt structure, instruction set and Assembly language programming. [12]
3. **The 8086 Microprocessor Architecture :** Architecture, details of sub-blocks such as EU, BIU; memory segmentation and physical address computations, pin diagram and description of various signals, minimum and maximum mode of operations, supporting chips viz. 8284, 8288 and memory mapping [8]
4. **Programming of 8086:** Addressing modes of 8086, instruction set of 8086, assembly language programming, counters and time delays, stack structure of 8086 and subroutine. [7]
5. **Interfacing of 8085 / 8086 with Programmable Chips:** Interfacing of 8255 Programmable peripheral interface, 8251 USART, 8253/8254 Programmable Interval Timer and Direct Memory Access Controller 8237/8257 DMA, 8259 Programmable Interrupt Controller. [10]

Outcome: **Upon completion of this course, the student will be able to:**

1. The student will learn the internal organization of some popular microprocessors and microcontrollers.
2. The student will learn hardware and software interaction and integration.
3. The students will learn the design of microprocessors/microcontrollers-based systems.

Text Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Application with the 8085; Penram International Publishing (India).
2. A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals; TMH.

Reference Books:

1. D. V. Hall, Microprocessors and Interfacings; TMH, second Edition.
2. B. P. Singh and Renu Singh, Advanced Microprocessors and Microcontrollers; New Age International Publishers, Third Edition.A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals; TMH.

Comment [D20]: Skills Development

Comment [D21]: Skills Development

Comment [D22]: Skills Development

Comment [D23]: Skills Development

EC-14.203 **Digital Electronics** **Total Lectures: 40**
3-1-0-4

Objective: The aim of this course is to present the principles and techniques of combinational and sequential digital logic design and optimization at a gate level. The use of transistors for building gates is also introduced.

Pre-requisite: Basic Electronics course in First Year.

1 **Number Systems and Codes:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic. [2]

2 **Introduction to Boolean Algebra:** Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [2]

3 **Logic Gates:** Diode and transistor as a switch, basic logic gates, derived logic gates, block diagrams and truth tables, logic diagrams from Boolean expression and vice versa, converting logic diagram to universal logic, positive logic, negative logic and mixed logic. [5]

4 **Simplification of Boolean Functions:** K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method. [5]

5 **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]

6 **Sequential Circuits:** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters. [10]

7 **Logic Families:** Logic gate characteristics (propagation delay, speed, noise margin, fan-in, fan-out, power dissipation), standard logic families (RTL, DCTL, TTL, ECL, MOS) [5]

8 **Programmable Logic:** Introduction to programmable logic array (PLA), programmable array logic (PAL). [1]

Comment [D10]: Skills Development

Comment [D11]: Skills Development

Comment [D12]: Skills Development

Comment [D13]: Skills Development

Comment [D14]: Skills Development

Outcome: Graduates will have knowledge of digital systems. They will understand how to analyze and design digital logic circuits, and be familiar with digital ICs.

Text Books: 1. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Patparganj, Delhi, 4thEdition, 2009.
2. Floyd, T. L. and Jain, R.P., "Digital Fundamental", Pearson Education, Patparganj, Delhi, 8thEdition, 2009.
3. Tocci, R. J., Widmer, N. and Moss, G., "Digital System: Principles and Applications", Pearson Education, Patparganj, Delhi, 10thEdition, 2007.

EC-14.204 **Integrated Circuit and Applications** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: EC-14.201(Electronics Devices and Circuits)

1.	**Differential Amplifier:** Operational amplifier, bipolar and FET differential amplifiers, constant current source, current mirror, level translator, block diagram of operational amplifier, frequency response and stability, operational amplifier parameters, offset compensation techniques.	**[6]**
2.	**Application of Op-amp:** Inverting and non-inverting amplifiers, voltage follower, integrator and differentiator circuits, instrumentation amplifier, current to voltage converter and voltage to current converter, voltage to frequency conversion, analog simulation of differential equations using operational amplifiers.	**[7]**
3.	**Oscillators:** Phase shift, Wein bridge, quadrature, square wave, triangular wave, sawtooth wave and voltage controlled oscillator.	**[5]**
4.	**Active Filters:** Low pass, high pass, band pass and band reject filters, designing of second order filters using Butterworth approximations, higher order filters and state variable filters.	**[6]**
5.	**ICs and Applications:** Clipping and clamping circuits, comparator, LM-311 comparator, schmitt trigger, log and antilog amplifiers, half and full wave rectification, IC-8038, IC LF-398, IC-555.	**[6]**
6.	**Voltage Regulator and PLL:** Voltage regulator IC-723, switching regulators, regulator IC series 78xx, 79xx, building blocks of PLL, IC-565 and its applications, four-quadrant multiplier and its applications.	**[10]**

Comment [D24]: Skills Development

Comment [D25]: Skills Development

Comment [D26]: Skills Development

Comment [D27]: Skills Development

Comment [D28]: Skills Development

Comment [D29]: Skills Development

Outcome: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Gayakwad R. A., "Op-Amps and Linear Integrated Circuits", PHI, New Delhi, 3rd Edition.
2. Singh B. P. and Singh Rekha, "Electronic Devices and Integrated Circuits", Pearson Education, Patparganj, Delhi.
3. Coughlin R. F. and Driscoll F. F., "Operational Amplifiers & Integrated Circuits", Pearson Education, Patparganj, Delhi.

Reference Books:

1. Franco S., "Design with Operational Amplifiers and Analog Integrated Circuits", Pearson Education, Patparganj, Delhi.

EC-14.206 **Consumer Electronics** **Total Lectures: 40**

3-1-0-4

Objective: This subject will introduce the students with working principles, block diagram and advance features of consumer electronics appliances. Also this will familiarize students with latest advancements in Electronic manufacturing industry. Knowledge so gained would also help in troubleshooting and maintaining different electronic gadgets and appliances.

Pre-requisite: Basic understanding of electric circuits and components and some knowledge of basic electronic devices such as diodes, transistors etc.

1. **Introduction to Electronics Engineering:** Review of basic electrical & electronic circuits and components. Difference in electrical and electronic engineering. Introduction to electronics industry in India and the world; consumer electronics gadgets classification and applications. Introduction to ESDM (Electronic System Design & Manufacturing). **[4]**
2. **Audio devices and systems:** Characteristics of sound signal: level and loudness, pitch, frequency response, fidelity and linearity, Reverberation. Audio level metering, decibel level in acoustic measurement. Microphone: working principle, sensitivity, response. Loud speaker: working principle, characteristic impedance, and watt capacity, loud speaker types. Sound recording: Optical recording, stereophony. Audio system: CD player, home theatre sound system. Digital console: block diagram, working principle, applications. FM tuner: concepts of digital tuning, ICs used in FM tuner TDA 7021T. PA system: planning, speaker impedance matching, Characteristics, power amplifier. **[12]**
3. **Television and Video Systems:** Monochrome TV standards, scanning process, aspect ratio, persistence of vision and flicker, picture resolution. Composite video signal: horizontal and vertical sync details. Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance. PAL system, channel bandwidth. Digital TVs: - LCD, LED, PLASMA, HDTV, 3-D TV, projection TV, DTH receiver. CD and DVD player: working principles. **[10]**
4. **Home and Office Appliances:** FAX and Photocopier Microwave Oven: types, technical specifications Washing Machine: wiring diagram, electronic controller for washing machine, technical specifications, types of washing machine, fuzzy logic Air conditioner and Refrigerators: Components features, applications and technical specification. Digital camera and cam coder. **[10]**
5. **Advanced trends in Electronic manufacturing industry:** Basics of semiconductor technology and integrated circuits. Introduction to embedded intelligence in electronic gadgets: microcontroller based systems; different ICs used in the systems such as 8051, Op-Amp, 555 timer, and Digital ICs. **[4]**

Outcome: After the completion of the course, students are able to acquire required learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

i. Troubleshoot different types of microphones, audio systems and colour TV receiver.
ii. Maintain various electronic home appliances.

Text Books:

1. Audio video systems : principle practices & troubleshooting ; Bali R. and Bali S.P. ; Khanna Book Publishing Co. (P) Ltd. , 2010
2. Consumer Electronics; S.P. Bali ; Pearson Education India, 2010
3. Audio video systems ; Gupta R. G. ; Tata Mc Graw Hill, New Delhi, 2010
4. Colour Television & Video Technology; A. K. Maini ; CSB Publishers

Reference Books:

1. Modern Television Practices ; Gulati R. R. ; New Age International Publication, New Delhi, 2010
2. Standard Handbook on Audio Engineering ; Whitaker Jerry & Benson Blair ; McGraw Hill Professional ; 2010
3. VCR-principles, maintenance & repair by S.P. Sharma, Tata Mc Graw Hill, New Delhi

Comment [D30]: Skills Development

Comment [D31]: Skills Development

Comment [D32]: Skills Development

EC-14.208 **Principles of Electromagnetics** Total Lectures: 40

3-0-0-3

Objective: To develop the understanding of basics concepts of electromagnetic field theory and its applications.

Pre-requisite: Basic understanding of laws of Physics and Mathematics

1. **Introduction**: Transformation of a point and a vector in different coordinate systems, Differential length, area, volume Physical meaning of gradient, divergence and curl, Laplacian of a scalar, Divergence theorem, Stoke's theorem, review of electrostatic and magneto static fields. [8]
2. **Time Varying Fields and Maxwell's Equations:** Faraday's law of electromagnetic induction, Maxwell's equations in integral and differential form, potential functions, electromagnetic boundary conditions. [8]
3. **Electromagnetic Waves:** Introduction, Helmholtz wave equation, Wave equations and their solutions for free space, lossy dielectric, Lossless dielectrics and good conductor medium, Poynting vector and the flow of power. Reflection of plane wave at dielectric media and conducting surfaces for normal incidence. [10]
4. **Transmission lines:** Types of transmission lines, transmission line parameters, two conductor transmission line equations, input impedance, standing wave ratio and power of transmission lines, smith chart, transmission line impedance matching techniques. [6]
5. **Guiding Structures:** General wave behaviors along uniform guiding structure, rectangular and circular wave guides, wave propagation in rectangular and cylindrical cavity resonators. [8]

Comment [D33]: Skills Development

Outcome: After completion of this course, students would be understanding the concept of electric and magnetic fields, both static and dynamic, and gain insight in various application areas like transmission lines and waveguides.

Text Books:

1 Matthew N. O. Sadiku, Principles of Electromagnetics (Fourth Edition); Oxford University Press.

2 William H. Hayt: Engineering Electromagnetic, TMH.

3 Raju, Electromagnetic field theory and Transmission lines, Pearson Education.

4 John D. Kraus: Electromagnetics, McGraw Hill.

Reference Books:

1 David J. Griffiths, Introduction to Electrodynamics (Third Edition); Pearson Education.

2 M. L. Sisodia and G. S. Raghuvanshi, Microwave Circuits and Passive Devices, New Age Publication.

EC-14.210 **Comprehensive I** **Total Lectures: 40**
0-0-0-3

Objective To acquire intensive knowledge and proficiency in some special field of knowledge.

Prerequisite Basic concepts of all prior program related courses such as, principles of semiconducting materials and devices, digital logic systems and theories of circuits and networks.

1. Comparative study of BJT and MOS transistors in respect of operation, circuit configuration, biasing stability, high and low frequency models, small-signal amplifiers and oscillator design issues.
2. Boolean function implementation using logic gates, comparative studies of RTL, DTL, TTL and ECL logic families in respect of speed, noise and power dissipation, logic function design based on PLA and PAL.
3. Application of Laplace transformation to network equations, steady-state and transient response of low-pass, high-pass and band-pass networks, hybrid and transmission parameters of two-port networks, RL, RC, and RLC network synthesis.

Comment [D36]: Skills Development

Outcome: After completion of this course, students would be able to understand the principles of entire field of major subjects till the second year of study.

Text Books:

1. Millman J. & Halkias C.C., "Electronic Devices and Circuits" McGraw Hill.
2. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Patparganj, Delhi, 4th Edition, 2009.
3. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", John Wiley and Sons, Inc., 1960.

Reference Book:

1. Robert L. Boylestad& Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education.
2. Karim, M.A. and Chen. X., "Digital Design: Basic Concepts and Principles", CRC Press Taylor & Francis Group, Printed in India by Saurabh Printers, 2nd Indian reprint, 2010.
3. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", Tata McGraw-Hill, 2007.

EC-14.301 **Signal Processing and Applications** **Total Lectures: 40**
3 – 1 – 0 – 4

Objective:

- To understand the fundamental characteristics of continuous- and discrete-time signals and systems in terms of both the time and transform domains and to develop the mathematical skills to solve problems involving convolution and sampling.
- The students would be familiar with different methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors. The course emphasizes intuitive understanding and practical implementations of the theoretical concepts.

Pre-requisite: None

1. **Representation and classification of Signals**: Signal classification - Continuous and discrete time, Periodic - aperiodic, even - odd, energy - power, Deterministic - random, real valued - complex exponential, sinusoidal, time scaling, time shifting, Sampling and discrete time processing of continuous-time signals, Concept of frequency in continuous-time and discrete-time signals. **[06]**
2. **Basics of Systems and Transformation**: Properties of systems – linearity, time invariant, causal, stable, inverse, static and dynamic, system impulse response, convolution, correlation, Transformation - Fourier series, continuous time and discrete time Fourier transform, Laplace transform, z-transform, its properties, limitations and inverse transforms, pole – zero concept, computation of impulse response and transfer function using transforms. **[06]**
3. **Analysis of Continuous time and discrete time systems:** Block diagram representation, linear time-invariant (LTI) systems, interconnection of LTI Systems, discrete time systems and their types, systems with finite and infinite duration impulse response, recursive and non-recursive structures, system realizations in direct , transpose, cascade and parallel forms. **[08]**
4. **DFT, FFT and DCT Algorithms:** Discrete Fourier transform (DFT), linear convolution using DFT, efficient computation of the DFT - Fast Fourier transform (FFT) algorithms, radix-2 & 4 FFT algorithms, discrete cosine transform (DCT) - DCT-1 and DCT-2, energy compaction property of DCT. **[06]**
5. **Digital Filter Design:** Review of analog filters – comb and notch types, Design of infinite Impulse Response (IIR) filter from analog filters - Bilinear and Impulse invariant transformation, Finite Impulse Response (FIR) filter - amplitude & phase responses, linear phase filters, transversal filters, windowing techniques, comparison between IIR and FIR filters. **[08]**
6. **Applications of signal processing:** DTMF signal detection, spectral analysis of deterministic and random signals, musical sound processing, signal compression and radar application. **[06]**

Outcome: After completion of the course, students will be able to

- Understand the process of sampling and spectral characteristics of periodic and aperiodic signals using Fourier analysis and determine the response of LTI system using Fourier analysis convolution.
- Understand the meaning and implications of the properties of signals and systems, and represent discrete-time signals analytically and visualize them in the time domain.
- Understand the Transform domain and its significance and problems related to computational complexity.
- Design discrete time filters, compute different errors in design process.

Text Books:

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edition.
2. Signals and Systems – Tarun Kumar Rawat, Oxford Higher Education, 2010
3. Digital Signal Processing – A Computer Based Approach, S. K. Mitra, 3rd Ed, McGraw-Hill.

Comment [D40]: Skills Development

Comment [D41]: Skills Development

Comment [D42]: Skills Development

Comment [D43]: Skills Development

EC-14.302 **Microwave Engineering** **Total Lectures: 40**

3-0-0-3

Objective: To acquire fundamental knowledge of Microwave and apply in engineering applications.

Pre-requisite: Electromagnetic Field Theory.

1. **Introduction:** **[03]**
   Microwaves, Generation: Brief idea of microwave tubes and microwave solid state devices, properties and applications.

2. **Microwave Circuits:** **[07]**
   Equivalent voltage and current definition in waveguides, concept of impedance, impedance matrix, admittance matrix, scattering matrix and transmission matrix**.**

3. **Microwave Passive Devices:** **[10]**
   Excitation of waveguides through probes, loops and apertures. Terminations: matched loads and short, attenuators, phase shifters, two hole directional coupler, E-plane tee, H-plane tee, magic tee, microwave propagation in ferrites, isolators and circulators.

4. **Microwave Active Devices:** **[14]**
   Reflex Klystron, Two cavity Klystron, Travelling Wave Tubes, Magnetrons, Gyrotron, construction, operation and practical applications of Gunn diode, Tunnel diode and IMPATT diode**.**

5. **Microwave Measurements:** **[06]**
   Detection of microwaves, measurement of microwave power, impedance, frequency, VSWR, Q-factor and scattering parameters.

Comment [D62]: Skills Development

Comment [D63]: Skills Development

Outcome: After completion of the course, students would be able to apply microwave concepts and equations in engineering and solve voltage and current equations.

Text Books:

1. David M. Pozar, Microwave Engineering (Third Edition), John Willey & sons.
2. Samuel Y. Liao, Microwave devices and Circuits (Third Edition), Pearson Education.
3. Annapurna Das &Sisir K Das, Microwave Engineering (Second Edition), McGraw-Hill Companies.

Reference Book:

1. Matthew N. O. Sadiku, Principles of Electromagnetics (Fourth Edition), Oxford University Press

EC-14.303 **Principles of Analog Communication** **Total Lectures: 40**
3-1-0-4

Objective:
- To develop a fundamental understanding on communication systems with emphasis on analog modulation techniques.
- To appreciate the mathematical concepts that form the foundations of analog communication

Pre-requisite: Signals and Systems, Statistics and Probability Theory

1. **Linear Modulation Techniques:** Basic blocks of communication systems, Review of signals and systems, Linear Modulation, Time domain and frequency domain description of AM (DSB-FC), DSB-SC, SSB and VSB signals. Generation and detection of linear modulation techniques, Super-heterodyne receivers and design. **[12]**
2. **Angular Modulation Techniques:** Basic concepts, Frequency Modulation Spectrum Analysis of FM Wave, Generation and detection of narrow band and wide band frequency modulation, Phase modulation, FM detection techniques-phase locked loops, Commercial broadcasting systems. **[8]**
3. **Sources of Noise and their characterization:** Random Variables, Random process and their characterization. Noise in Analog communication System. SNR calculations for synchronous detection of DSB and SSB and envelope detection of AM, SNR calculations for angle modulation system. Pre-emphasis and de-emphasis. Threshold effect in angle modulation. **[8]**
4. **Multiplexing and Multiple Access Techniques:** Frequency division Multiplexing, time division multiplexing, multiple access techniques. **[5]**
5. **Sampling and Pulse Modulation:** Sampling theorem – ideal and natural sampling and reconstruction, Pulse-Amplitude Modulation, Pulse-Time Modulation. **[7]**

Comment [D44]: Skills Development

Comment [D45]: Skills Development

Comment [D46]: Skills Development

Outcome:

1) Apply the basic knowledge of signals and systems and understand the basics of communication system and analog modulation techniques.
2) Evaluate the communication system performance in the presence of noise and summarize the merits and demerits of all the conventional analog modulation system.
3) Understand the basics of different of multiplexing and multiple access techniques and their application in cellular networks.
4) Understand the fundamentals of digital transmission of analog signals.
5) Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for modulators, demodulator and communication systems using CAD tool.

Text Books:

1) B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford university press, 4th Edition.
2) P. K. Ghosh, Principles of Analog and Digital Communication, Orient Black Swan Publishers Pvt. Ltd., 1st Edition
3) Taub and Schilling, Principles of Communication Systems, TMH.
4) E. Ziemer William H. Tranter, Principles of Communication, John Wiley & Sons 5th Edition.

Reference Books:

1) S. Haykins, Communication Systems (4/e), Wiley.
2) *Kennedy, Davis, Electronic Communication Systems (4/e), McGraw Hill.*

EC-14.304 **Principles of Digital Communication** **Total Lectures: 40**
3-1-0-4

Objective: The objective of this course is to introduce the students to the basic concepts of digital communication. The aim of this course is to study the fundamental aspects of digital communication systems. The understanding of the fundamentals of digital communication by studying theory, numerical and implementation of circuits.

Pre-requisite: The basics of Communication Systems and Techniques.

1. **Model of a Communication System:** Introduction, advantages of digital communication over analog communication, probability theory random process and random variables. **[6]**
2. **Digital Communication Techniques:** Sampling theorem and techniques, uniform and non-uniform quantization techniques, PCM, DPCM, DM, and ADM, compression standards, time division multiplexing and synchronization, Digital multiplexing hierarchy, Electrical representation of binary sequences Bandwidth requirement of PCM. **[10]**
3. **Information Theory and Coding:** Channel capacity, Shannon capacity, source entropy, Shannon-Fano, Huffman coding, linear block codes and syndrome decoding, cyclic codes, BCH codes, convolution, Viterbi coding and decoding. **[10]**
4. **Digital Modulation Techniques:** Base-band transmission, inter-symbol interference and adaptive equalization, digital modulation and demodulation techniques, bandwidth consideration of different digital modulation schemes, matched filter and probability of error analysis, carrier and timing recovery techniques. **[14]**

Comment [D64]: Skills Development

Comment [D65]: Skills Development

Outcome:

- The students can understand the concepts of digital communication.
- They acquire and apply the knowledge to implement the concepts for designing an efficient communication system.
- They become able to identify, analyse and implement new ideas in digital communication systems for proposing alternate solutions.

Text Books:

1. B. P. Lathi, “Modern Digital and Analog communication Systems”, Oxford University Press, 2010.
2. P. K. Ghosh, Principles of Analog and Digital Communication, Orient Black Swan Publishers Pvt. Ltd., 1st Edition
3. H. Taub, D L Schilling, Goutom Saha, “Principles of Communication”, TMH.

Reference Books:

1. Simon Haykin, “Communication Systems”, Wiley India.
2. H P HSU and D Mitra, “Analog and Digital Communications”, TMH
3. John G. Proakis, “Digital Communications”, McGraw-Hill International.

EC-14.306 **Microcontroller and Embedded Systems** **Total Lectures: 40**
3-0-0-3

Objective: The objective of this course is to teach students design and interfacing of microcontroller-based embedded systems. The course covers fundamentals, The 8051 Architecture, Assembly Language Programming, Instruction set, Serial Communication and Interfacing techniques of 8051 Microcontroller.

Pre-requisite: Programming skills and fundamental knowledge of microcontrollers, microprocessors and digital design.

1. **Introduction to Microcontrollers, Architecture and Memory Interfacing:** Overview of the 8051 family, 8051 Microcontroller's Architecture, Pin configuration, Common memory types and Tradeoffs, External Memory interfacing. **[7]**
2. **Programming of 8051:** Addressing modes of 8051, instruction set of 8051, assembly language programming of 8051, stack structure of 8085, delays, and subroutines, Applications of interrupts, timer/counter and serial port, Components of Integrated Development Environment for software development. **[16]**
3. **Interfacing of 8051:** Interfacing of 8051 with sensors, Keyboard, ADC, DAC, LCD, Stepper Motor and D.C motor. **[8]**
4. **Introduction to Embedded systems and processors:** Introduction and Examples of Embedded Systems, Concept of Embedded System. Design challenge, Processor technology, IC technology, Design technology, Trade-offs: Custom single purpose processor hardware, general-purpose processor: introduction, basic architecture, operation, super-scalar architecture, application specific instruction set processors, microcontrollers, digital signal processors, selection of embedded processor. **[6]**
5. **Software aspect of embedded system:** Challenges and issues in embedded software development, Software and hardware requirements, Real time system, Real time operating systems, Kernel, architecture: mutex, semaphore, testing and verification. **[3]**

Comment [D66]: Employability

Comment [D67]: Employability

Comment [D68]: Skills Development

Comment [D69]: Employability

Outcome: Upon completion of this course, the student will be able to:

1. Program, build and test a microcontroller system.
2. Interface a microcontroller system to user controls and other electronic systems.
3. Describe the internal architecture of microcontroller systems, including counters, timers, ports, and memory.
4. Understand and design embedded systems and real-time systems.
5. For real-time systems:
   - Identify the unique characteristics of real-time systems.
   - Explain the general structure of a real-time system.
   - Define the unique design problems and challenges of real-time systems.

Text Books:

1. M. A. Mazidi, The 8051 Microcontroller & Embedded Systems; Pearson Education.
2. I. Scott McKenzie and Raphael C.W. Phan; The 8051 Microcontroller; Pearson Education.
3. Raj Kamal, Embeded System; Tata Mcgraw-Hill.

Reference Books:

1. David E Simon, An Embedded Software Primer; Pearson Education.

EC-14.401 **VLSI Design** **Total Lectures: 40**
3-1-0-4

Objective:	The educational objectives of the VLSI design course are: **1.** Graduates who desire to pursue an engineering career in VLSI Design arena will be widely employed in positions they find appropriate and desirable. **2.** Graduates who desire to pursue higher degrees will be successful in gaining mission and advancing in programs they find appropriate and desirable.
Pre-requisite:	EC-14.201 Electronics Devices and Circuits, EC-14.203 Digital Electronics.

1.	**Basic VLSI Design Issues:** IC design techniques- hierarchical design, design abstraction and computer-aided design	[4]
2.	**MOS Transistor Theory:** Current-voltage characteristics of MOSFETS, threshold voltage and body effect, MOSFET design equations, second order effects, MOSFET capacitances	[8]
3.	**NMOS and CMOS Inverter:** NMOS and CMOS inverters, W/L ratio for NMOS and CMOS inverters, β_n/β_p ratio, noise margin, NMOS and CMOS Voltage transfer Characteristics, CMOS delay and power dissipation	[8]
4.	**MOS Inverter's Switching Characteristics:** Calculation of delay times, Inverter design with delay constraints	[6]
5.	**Stick Diagram & Layout:** Stick diagrams, CMOS design style, design rules: lambda based design rules, layout design	[8]
6.	**Basic VLSI Circuit Design Techniques:** Inverter equivalent of series and parallel MOS circuits, logic design with delay and power constraints, worst case design, complex logic design	[6]

Outcomes:

- Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing fundamental areas of VLSI design.
- Ability to apply in-depth knowledge of VLSI design principles, systems, and devices to the solution of real time problems.
- Ability to design and evaluate a component or system to meet desired needs within the field of VLSI design.
- Ability to function as a member of a multidisciplinary team in the solution of engineering problems such as providing CAD solution for device fabrications.

Text Books:

1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI, 3rd Ed., 2011
2. Neil H.E. Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 4th Ed., 2011
3. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design, Tata Mc-Graw-Hill, 3rd Ed., 2003

Reference Books:

1. Jab M. Rabaey, Anantha Chandra Kasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI, 2nd Ed., 2012
2. Michal John Sebastian Smith, Application-Specific Integrated Circuits, Pearson Education, 6th Ed., 2009

Comment [D83]: Employability

EC-14.433 **Industrial Training Seminar** **Credits: 2**

Industrial training plays a very important role for engineering graduates of all disciplines. As an engineering student, training can help to implement the concepts that students have learnt in their classes.

Objective: To enhance the knowledge of the students on different cutting edge technologies which have become important part of respective industries.

Industrial training offers the following:

1. Experience of industrial environment/conditions to girls students.
2. Enable the students to learn engineering techniques by observation and practice.
3. Show how theory presented in class is applied in practice.
4. Provide contact with practicing engineers.
5. Familiarize the student with practices and problems faced by companies employing engineers.
6. Give the student the responsibility of completing a piece of work.
7. Enable and accord industry opportunity to shape and participate in the development of future human resources.

Comment [D87]: Employability

Training Outcomes and Assessment

1. Ability to acquire and apply fundamental principles of science and engineering.
2. Capability to communicate effectively
3. Ability to identify, formulate and model problems and find engineering solution based on a systems approach.
4. Ability to conduct research in the chosen fields of engineering.
5. Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.
6. Ability to be a multi-skilled engineer with good technical knowledge, management, leadership and entrepreneurship skills.
7. Awareness of the social, cultural, global and environmental responsibility as an engineer.
8. Capability and enthusiasm for self-improvement through continuous professional development and life-long learning.

EC-14.441 **Principles and Practices of Management** **Total lectures : 26**
Credits : 2-0-0-2

Prerequisite(s): None

Objective(s):

1. To expose the students to fundamental concepts of management and its processes in organizations.
2. To describe the various skills necessary for effective managers.
3. To explain the Individual and Group Behavior along with various leadership Styles

1. **Planning and Organizing** [5]
   Management: Concept, Nature and functions; Planning: Concept, Missions, Objective and Strategies, Steps in Planning; Organizing: Concept, Formal an Informal Organization, Decentralization of Authority, Delegation of Authority, Principles of Organizing, Line and Staff Authority.
2. **Staffing and Controlling** [4]
   Staffing: Definition, Recruitment, Selection, Placement, Promotion, Separation, Performance Appraisal; Controlling: Concepts and Process, Controlling as a Feedback System, Requirements for Effective Control.
3. **Motivation** [4]
   Concept; Theories and Process of Motivation: Maslow's Need-Hierarchy Theory, Herzberg's Hygiene Theory, Goal-Setting Theory, Vroom's Expectancy Theory.
4. **Personality** [3]
   Concept and Determinates, Types and Traits, Personality Attributes Influencing Organizational Behavior, Locus of Control, Machiavellianism, Self-Esteem, Self-Monitoring, Risk-Taking.
5. **Group Behavior and Interpersonal Relationship** [6]
   Groups: Concept and Classification, Stages of Group Development, Rolesand Norms, Group Decision-Making: Group versus Individual, Group Decision Making Techniques and Process, Interpersonal Relationships, Understanding Self and Others, Developing Interpersonal Relationships, Transactional Analysis, Johari Window.
6. **Leadership** [4]
   Concept and Functions; Theories of Leadership: Traits, Behavioral, Situational/Contingency; Inspirational approaches to Leadership: Charismatic Leadership, Transformational Leadership, Transactional Leadership, and Contemporary Leadership.

Outcome(s): By studying this Course, students would be able to understand various Management functions, individual and group behavior. They would also know various styles of Leadership and its applicability. The course would help the students in understanding various organizational contexts and help them understand organizational systems in a better way.

Text Books:

1. Koontz, Harold and Weihrich, Heinz, Essentials of Management: An International, Innovation and Leadership Perspective, 10th Edition, McGraw Hill Private Limited, India, 2015
2. Robbins, Stephen P., Timothy Judge and Neharika Vohra, Organizational Behavior, 12th Ed., Pearson Education, 2011.

Reference Books:

1. Prasad L. M., Principles and Practice of Management, 9th Edition, Sultan Chand & Sons, 2015
2. Aswathappa K. Organizational Behavior, Eighth Edition, Himalaya Publishing House.
3. James A. F. Stoner, Freeman A. Edward, and Daniel A. Gilbert Jr., Management, Pearson Education
4. Fred Luthans, Organisational Behaviour, 11th Ed., Mc - Graw Hill, 2009

Comment [D86]: Entrepreneurship

EC-15.312 **Advance Radio Access Network (ARAN)** **Total Lectures: 40**

3-0-0-3

Objective:
To acquire skills on different legacy and advance RAN's Architecture, Design & Optimization along with latest industries concepts on 5G, IOT, Volte, RAN Cloud etc.

Prerequisite:
Digital Modulation Techniques & Data Transmission, Antenna and Wave Propagation, Basics of Mobile Communication

1.	**Introduction to RAN:** Telecom E2E approach, RAN Life Cycle,RF basics, Microwave Theory, Propagation Models, Modulation Theory, Antenna Theory. Latest Industry Concepts – 5G, IOT, Volte, RAN Cloud	[4]
2.	**RAN Overview**:Introduction to Cellular Concepts, Introduction to Power Control, Introduction to Protocol Stacks, GSM, WCDMA, LTE (Overview, Architecture, Air Interface), Generalized Call Flows	[12]
3.	**RAN Design:**RF Design Overview, Initial Radio Network Design (Link Budget, Radio Network Dimensioning & Nominal Design), Final Radio Network Design, Radio Planning Tools & IBS Introduction, Radio Propagation Model Tuning, LRAN Initial Radio Network Design (Sample Report)	[12]
4.	**RAN Optimization:**Pre Launch Optimization (Process Overview, Introduction to Drive Testing (Data Collection Methodology, Data Post Processing),Post Launch Optimization, (Process Overview, Introduction to Counters and OSS, KPI Improvement Methodology)	[12]

Outcome: After completion of this course, students would be able to understand the industry level ways of working of RAN with different design and optimization techniques. Students will get heads up in terms of upcoming advance technologyconcepts.

Text Books:

1. Ericsson Academy (Ericsson Internal)
   - Air Interface
   - Protocol and Procedures
   - GSM, UMTS, LTE Fundamentals
   - RAN Design & Performance Management.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2007.
3. Theodore S. Rappaport, "Wireless Communication", Pearson Education, Asia, New Delhi, 2002.

Reference Books:

1. John G. Prokis and Masoud Salehi," Digital Communication", McGraw-Hill, Fifth edition.

Comment [D78]: Employability

EC-15.313	System Design Using HDL	Total Lectures: 40
		3-0-0-3

Objective: To acquire fundamental knowledge of designing of digital systems using VHDL.Students will acquire practical working knowledge of creating digital circuits using commercial Computer-Aided-Design (CAD) tools.

Pre-requisite: Knowledge of digital logic and digital circuits are highly desired.

1. **Programmable Logic Design:** ASIC, ROM, PLA, PAL, CPLD and FPGA. **[3]**
2. **VHDL Based Design:** An overview of VHDL, Role of VHDL in system design, Introduction to CAD tools for system design, Introduction to Xilinx IDE software. **[3]**
3. **VHDL Fundamentals:** Entity and architecture declaration, Introduction to behavioral, dataflow and structural models, package, package declarations and package body. **[6]**
4. **Basic Elements of VHDL:** Data objects – constant, variable and signal, Data types – scalar and composite, Predefined Operators – logical, relational, shift, adding and multiplying, Overloading – literal and operator. **[4]**
5. **VHDL Statements:** Process, variable assignment, signal assignment, sequential statements, conditional statements, loop**,** if, case, next statements, assertion and report statements, signal drivers and signal assignment statements, conditional signal assignments, select and generic. **[10]**
   Subprograms: Application of functions and procedures, Overloading and signal assignments, Component declaration, Component instantiation.
6. **Combinational Circuit Design:** VHDL models of combinational circuits such as Adder, Multiplexer, De-multiplexer, Encoder, Decoder, Code converters, Comparators, Parity generators, Multipliers and implementation of Boolean functions. **[7]**
7. **Sequential Circuit Design:** VHDL Models of sequential such as edge triggered D flip flop, T flip flop and J K flip flop, serial in serial out register, serial in parallel out register, parallel in parallel out register, counter, memory, ALU. **[7]**

Comment [D55]: Employability

Comment [D56]: Skills Development

Comment [D57]: Employability

Outcome: After completion of the course, students would be able to:

- Identify, formulate, and solve engineering problems
- To use the technique, skills, and modern engineering tools necessary for engineering practice.

Text Books:

1. J. Bhaskar, VHDL Primer, Pearson Education Asia, 3rd Ed.
2. Douglas L. Perry, VHDL Programming by Examples, Tata McGraw Hill, 4th Ed.
3. Yogesh Misra, Digital System Design Using VHDL, Dhanpat Rai & Co., 1st Ed.

EC-18.402 **Wireless Networks** **Total Lectures: 40**
3-1-0-4

Objective: To acquire fundamental knowledge of various types of wireless networks and apply them to wireless communication applications.

Pre-requisite: EC-14.303 Principles of Analog Communication, EC-14.304 Principles of Digital Communication

1. **Introduction:** Introduction to wireless networks, Wireless communication systems – Paging system, cordless telephone system, cellular telephone system [4]

2. **Basics of cellular communication systems**: Frequency reuse, channel assignment, call handoff, interference and system capacity, Mobile radio propagation – path loss and fading, 2G, 2.5 G and 3G wireless networks**.** [10]

3. **Multiple Access Techniques**: Frequency Hopped Multiple Access, Code Division Multiple Access, Hybrid Spread Spectrum Multiple Access, Packet Radio, Carrier Sense Multiple Access, Reservation Protocol [10]

4. **Equalization, Diversity and Channel Coding**: Fundamentals of equalization, Linear equalization, Nonlinear equalization, Diversity techniques – space diversity, time diversity, frequency diversity, polarization diversity, RAKE receiver, Block code and convolution code. [8]

5. **Wireless Networking**: Wireless local area network, RF and IR WLAN, advantages and applications, IEEE 802.11, IEEE 802.16, HYPERLAN, Bluetooth, WiMax, Ultra Wide Band communication. [8]

Comment [D93]: Skills Development

Comment [D94]: Skills Development

Comment [D95]: Skills Development

Outcome: After completion of the course, students would be able to apply wireless communication concepts and ideas to engineering applications and to develop high performance wireless communication network.

Text Books:

1. T. S. Rappaport, Wireless Communication, Principles and Practice, 2nd Ed, Pearson Education, 2009
2. Upena Dalal, Wireless Communication, Oxford University Press, 1st Ed., 2009.
3. J. Schiller, Mobile communications, Addison-Wesley.

Reference Book:

1. William C. Y. Lee, Mobile cellular telecommunication – Analog and Digital systems, McGraw Hill, 2nd Ed, 2006

EC-18.442 **Engineering Economics** **Total Lectures: 26**
Credit: 2-0-0-2

Prerequisite(s): Nil

Objective(s):
1. Provide students with fundamental concepts of engineering economics.
2. Provide students with economical methods to compare and evaluate alternatives based on present, annual, rate of return, and benefit over cost analyses.
3. Emphasize practical engineering-based applications and the use of real data examples.

1. **Introduction**: Definitions, Scope; Microeconomics vs. Macroeconomics; Engineering and engineering economics; Principles of engineering economics. [2]
2. **Theory of Demand & Supply**: Determinants, law of demand, law of supply, equilibrium, elasticity of demand. [3]
3. **Economics Applied to Industries**: Theory of production; production function, Law of variable proportions, Returns to scale, Theory of cost; Various concepts of cost: Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost, average cost, marginal cost, total cost etc; Break even analysis. [6]
4. **Market Structures& Pricing Techniques:** Meaning of Market, Types of Market- perfect competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets). [5]
5. **Replacement analysis and depreciation**: Replacement Analysis Decision Map, Basic aspects of depreciation, Deterioration & Obsolescence, and its methods [3]
6. **Optimization technique**: Optimization under constraints and without constraints, optimal resource allocation, optimization under risk and uncertainty. [4]
7. **Capital budgeting**: Concept; under certainty and uncertainty, Techniques; Discounting &compounding techniques, IRR, NPV, PBP, Profitability index, Accounting rate of return. [3]

Comment [D96]: Skills Development

Comment [D97]: Skills Development

Outcome(s):
1. Understand major principles of economic analysis for decision making among alternative courses of action in engineering.
2. Apply cost estimation and alternative analysis techniques for engineering applications.
3. Recognize the economic impact of engineering solutions.
4. Calculate depreciations and understand the impact of inflation.
5. Perform breakeven analysis for a single project and between two alternatives.

Text Books:
1. Salvatore, Dominick. Managerial Economics, Prentice Hall of India, 6th Ed.
2. D. N. Dwivedi, Managerial Economics, OUP, Vikas Publication, 7th Ed.

Reference Books:
1. Suma Damodran, Managerial Economics, OUP, 2nd Ed.

EE-14.201 **Network Analysis & Synthesis** **Total Lectures: 40**
3-1-0-4

Objective: This course helps in analysis of A.C & D.C circuits and it also help to design the circuit models for the minor and major projects.

Prerequisite: Knowledge of Laplace transformation

1. **Development of Circuit Concept:** Introduction, capacitance, inductance and resistance parameters, approximation of a physical system as a circuit, reference directions for current and voltage, voltage and current sources, active element conventions, dot convention for coupled circuits, topological description of networks, linear graphs of a network and its parts, loops and trees, incidence matrix, cut-set matrix and tie-set matrix. [8]
2. **Network Equations**: Kirchhoff's laws, minimum number of network equations, source transformations, formulation of network equations, loop variable analysis & node variable analysis and duality. [6]
3. **Analysis of RLC Circuits**: Laplace transformation, some basic theorems for the Laplace transformation, transient response of RL, RC and RLC circuits using Laplace transform with D.C input and A.C. with sinusoidal input, partial fraction expansion, solution of problems by Laplace transformation. [8]
4. **Network Theorems**: Superposition and reciprocity theorems, Thevenin's and Norton's theorems, Millman's theorem, Tellegen's theorem, and maximum power transfer theorem, application of these theorems to networks with a.c and d.c excitation. [8]
5. **Two Port Network** Two port parameters, impedance, admittance, hybrid, inverse hybrid, transmission parameters, relationship between various parameters, reciprocity and symmetry of two port network, inter connection of two port networks. [6]
6. **Synthesis of Passive Network**: Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [6]

Comment [D15]: Skills Development

Comment [D16]: Skills Development

Comment [D17]: Skills Development

Comment [D18]: Skills Development

Comment [D19]: Skills Development

Course outcome: Upon successful completion of this course, students should be able to:

1. Gain fundamental knowledge of the basic electrical elements such as resistance, capacitors and inductances.
2. Understand circuit representation as graphs and implementation of KVL and KCL in the circuits and to solve the circuit problems by Laplace transformation method and also by applying various networks theorems.
3. Analyze small RLC circuits by hand. Use network techniques, like node analysis and loop analysis, to write equations for large linear circuits.
4. Apply Thevenin and Norton theorems and concept of linearity and superposition to analyze and design circuits and networks.

Text Books

1. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", John Wiley and Sons, Inc., 1960.
2. A. Chakrabarti, "Circuit Theory – Analysis and Synthesis", Dhanpat Rai & Co., 2001. International Editions, 1993.
3. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", Tata McGraw-Hill, 2007.
4. W. H. Hyatt Jr. and J. E. Kemmerly, "Engineering Circuits Analysis", McGraw-Hill.

EE-14.204 **Electrical Measurement and Instrumentation** **Total Lectures: 40**
3-0-0-3

Objective: To make students conversant with concepts of measurement and various electrical and electronics instruments, transducers and bridges.

Pre-requisite: Basic Electrical engineering, Basic Electronics engineering

1	**Concepts of Measurements:** Introduction, accuracy and precision, repeatability, errors in measurement, sources of errors, types of errors, statistical analysis of measurement data, graphical representation of measurement, data as distributions, Gaussian graph and precision indices.	[6]
2	**Analog Instruments:** Types of operating torques in an analog instrument, Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Shunts and multipliers. Applications of instruments for measurement of single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment.	[6]
3	**Bridge:** DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, Weins bridges.	[6]
4	**Electronic Instruments for Measuring Basic Parameters:** Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, Q meter, Vector Impedance meter, signal analyzers- wave analyzers, harmonic distortion analyzers and spectrum analyzers.	[6]
5	**Potentiometers:** DC and AC potentiometers, Principles, Standardization and application.	[5]
6	**Transducers:** Introduction , Classification, Selection Criteria, Characteristics, Construction, Working Principles and applications of following Transducers- RTD, Thermocouples, Thermistors, LVDT, RVDT, Strain Gauges, Tachogenerators, Piezoelectric Transducers, Ultrasonic Flow Meters.	[6]
7	**Oscilloscopes:** CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay.	[5]

Comment [D47]: Skills Development

Comment [D48]: Skills Development

Comment [D49]: Skills Development

Comment [D50]: Skills Development

Outcome: Students will be able to understand electrical and electronic measuring devices and instrumentation like bridges, transducers, CRO etc.

Text Books:

1. Albert D. Helfrick, Wiliam D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning Private Limited, 2011.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai and Co., 2005.

Reference Books:

1. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill, II Edition 2004.
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2007.
3. A.J. Bouwens, 'Digital Instrumentation', Tata McGraw Hil.,1997
4. E.O. Doebelin, 'Measurement Systems – Application and Design', Tata McGraw Hill publishing company, 2007.

EE-14.303 **Control System Engineering** **Total Lectures: 40**
3-1-0-4

Objective: The student gains the knowledge of the fundamental principles of analog and digital control system engineering, time response and frequency response analysis with its practical implementation. This course helps in understanding the design of Compensator and PID controller for the Automatic control of Industry.

Pre-requisite: MA-14.201 Applied Mathematics, EE-14.201 Network Analysis & Synthesis

1.	**Introduction:** Introduction to control systems, digital control system, types of control systems and their examples, mathematical modeling of systems (mechanical and electrical).	[10]
2.	**Reduction Techniques:** Block diagram reduction and signal flow graph representation of systems.	[10]
3.	**Domain Analysis:** Time domain and frequency domain analysis of systems.	[7]
4.	**Stability:** Concept of stability and algebraic criteria (Hurwitz's and Routh's stability criterion).	[4]
5.	**Plotting Techniques:** Root locus techniques, Bode plots, polar plots Nyquist criterion and Nichol's chart.	[7]
6.	**State Variables:** State variable analysis and design.	[2]

Outcome: After completion of the course,

- The student will be able to get acquainted of analog and digital control system.
- The student will analyze and to design and development of automatic controller for industrial application.
- The student will gain the knowledge of stability analysis and improvement of stability for control system.
- This course becomes very beneficial for the graduates who wish to work in core sectr industry as most of the core sector is state-of-art control.
- This course becomes very beneficial for the 4th year student who will choose elective paper in Digital control system and other control system elective.

Text Books:

1. K. Ogata, "Modern Control Engineering," Pearson Education/Prentice Hall of India, 2003.
2. I. J. Nagrath and M. Gopal, "Control System Engineering," New Age International Publishers, 2003.
3. M. N. Bandyopadhyay, "Control Engineering Theory and Practice," Prentice Hall of India, 2003.

Reference Books:

1. Syed Hasan Saeed, "Automatic Control Systems (with MATLAB Programs)," S. K. Kataria & Sons, Publisher of Engineering & Computer Books.
2. Samarjit Ghosh, " Control Systems: Theory and Applications," Pearson Education, Second Edition, 2009

Comment [D85]: Skills Development

EE-14.304 **Power Electronics** **Total Lectures: 40**

3-0-0-3

Objective:

- To introduce to students the theory and applications of power electronics systems for high efficiency, renewable and energy saving conversion systems
- To prepare students to know the characteristics of different power electronics switches, drivers and selection of components for different applications
- To develop students with an understanding of the switching behavior and design of power electronics circuits such as DC/DC, AC/DC, DC/AC and AC/AC converters

Prerequisite: Network Analysis, Basics of Electronics Engineering, Engineering Mathematics

1. **Introduction:** Review of power semiconductor devices, SCR, Static and dynamic characteristics, Turn-on and Turn-off methods and circuits, Ratings and protection of SCRs, Series and parallel operation of thyristor, Other members of thyristor family. [8]
2. **Phase Controlled Converters:** Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits, Single phase dual converters and their operation with circulating and non-circulating currents. [10]
3. **AC Voltage Controllers:** Types of single-phase voltage controllers, Single-phase voltage controller with R and RL type of loads, gate pulse requirements to trigger the SCRs of ac voltage controllers. [5]
4. **Cyclo-converters:** Principles of operation, Single phase to single phase step up and step down cycloconverters. Three phase to single phase cycloconverter. [5]
5. **DC Choppers:** Principle of chopper operation, Control strategies, Types of choppers, Step up and step down choppers, Types of choppers and operations. [5]
6. **Inverters:** Single phase VSI: half bridge and full bridge inverters and their steady state analysis, Series and parallel inverters, three phase bridge inverters with 180 degree and 120 degree modes of operation. Current source inverters, CSI with R load (qualitative approach). [7]

Comment [D70]: Skills Development

Comment [D71]: Skills Development

Comment [D72]: Skills Development

Comment [D73]: Skills Development

Outcome:

- The student will be able to understand the principle of operation of commonly employed powerelectronic converters
- The student will be capable of analyzing non-linear circuits with several power electronic switches
- The student will be equipped to take up advanced courses in Power Electronics and its application areas

Text Books:

1. Rashid, M., Power Electronics, Prentice Hall of India Private Limited (2006).
2. P. S. Bimbhra, Power Electronics, Khanna publishers.

Reference Books:

1. Mohan, N., Undel, T. M. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley and Sons (2007).

MA 14.201 **Applied Mathematics** **Total Lecture: 40**
3-1-0-4

Objective: To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1. Linear Programming: Introduction**,** Graphical method (bounded & unbounded solutions); Simplex method, Artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). **[12]**

2. Numerical Methods: Solution of system of equations (Gauss elimination and Gauss - Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector Runge-Kutta methods). **[10]**

Comment [D20]: Skills Development

3. Complex Analysis: Function of complex variable, analytic function, Cauchy- Riemann equations(without proof), integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula(without proof), zeros and singularities of complex functions, residues. **[06]**

4. Integral Transform: Laplace transform and inverse Laplace transform First and Second Shifting theorems, Convolution theorem (without proof), Solution of ordinary differential equations with initial conditions by Laplace transforms. Fourier series of periodic functions, even and odd functions, Fourier half-range series; Basics of Fourier transforms. **[12]**

Comment [D21]: Skills Development

Outcome: After completion of the course, students would be able to apply the knowledge of linear programming , numerical methods ,complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. Grewal B.S. & Grewal J.S., Higher Engineering Mathematics, Khanna publishers, 39th Edition: 2005.
3. Taha H.A., Operation Research: An Introduction, Pearson.
4. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.

Reference Books:

1. Jain R.K. & S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 2003.
2. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
3. James B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Babu Ram, Engineering Mathematics, Pearson, Year 2010.

MA 14.202 **Statistics and Probability Theory** **3-1-0-4**
Total Lecture: 40

Prerequisite: Basic Mathematics

Objective: To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

1	Introductory Ideas: Recapitulation of Basic Probability theory; Law of addition and law of multiplication ;conditional probability; total probability; Bayes' theorem and it's applications.	[06]
2	Random Variables and Distribution: Discrete and continuous random variables; types of distribution; probability mass and density functions; mean, variance and standard deviation of distribution.	[04]
3	Theoretical Probability Distribution: Discrete types (Binomial) and Continuous type (Normal,Students'); applications of basic ideas to these distributions.	[08]
4	Sampling Theory: Sampling distribution of mean and variance; central limit Theorem.	[04]
5	Testing of Hypothesis: Simple and Composite hypothesis; Type I and Type II errors; tests of significance and level of significance.	[04]
6	Correlation and Regression: Simple, partial and multiple correlations; linear regression.	[06]
7	Queuing Theory and Queuing Models: Birth and death process; pure birth and pure death process; Classification of queuing models: M/M/1, M/M/1/N, M/M/S and M/M/S/N.	[08]

Comment [D34]: Skills Development

Comment [D35]: Skills Development

Outcome: After completion of the course, students would be able to apply the knowledge of Statistics and Probability in engineering and solve curriculum problems.

Text Books:

1. A.P.Baisnab and Manoranjan Jas, Elements of Probability and Statistics, 2003, TMH.
2. Pugalararasu, Probability and Queuing Theory, TMH.
3. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, June 2002.
4. Gupta & Kapoor, Fundamental of Applied statistics, SCS Publisher, Jan 2001.
5. B.V. Ramana, Higher Engineering Mathematics, TMH, 2006.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH.
2. Palaniammal, Probability and Random Processes, PHI.
3. Spiegel, Probability and Statistics (Schaum's outline Series), TMH.
4. Miller and Freund's, Mathematical Statistics with Applications, 7e, Pearson.
5. Richard A. Jonson, Probability and Statistics for Engineers, Pearson.

RM 17.101 **Research Methodology** **2-0-0-2**

1	**Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research.	[2]
2	**Problem Formulation:** Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature.	[2]
3.	**Research Design:** Research Framework, Meaning & Significance of Research Designs, Features of a good Research Design, Types of Research Design.	[4]
4.	**Data for research:** Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis.	[6]
5.	**Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAb, Network Simulators, ETAP, Solid Works, MultiSim.	[6]
6.	**Thesis Writing:** Contents, Referencing Styles, Ani Plagiarism Policy, Literature Review, Motivation, Objectives, research gap, Methodology, Research Deasin and Analysis, Results, Findings, Implications, Contributions, Significance of research, Scope for future work and conclusion.	[6]

Comment [D74]: Skills Development

Comment [D75]: Skills Development

Comment [D76]: Skills Development

Comment [D77]: Skills Development

Text Books:

1. R. Pannershelvam, "Research Methodology" Prentice Hall India, New Delhi, 11th Edition, 2013.
2. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International (p) Limited, Publishers New Delhi, 2nd edition, 2008.
3. William G.Zikmund, "Business Research Methods", Cengage Learning New Delhi, 9th edition,2009.
4. Mark Saunders, "Research Methods for Business Students" Pearson Education New Delhi, 5th edition, 2013.
5. Donald R Cooper, "Business Research Methods" Tata McGraw-Hill Publishing Company Limited New Delhi, 9th edition, 2008.
6. Dr.A.K.Phophalia, "Modern Research Methodology: New Trends and Techniques" Paradise Publishers Jaipur, 1st edition, 2010.
7. Pankaj Madan, "Research Methodology", Global Vision Publishing House, New Delhi, 1st edition, 2010.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of EE

Course structure for

B.Tech EE

EE-14.201 **Network Analysis & Synthesis** **Total Lectures: 40**
3-1-0-4

Objective: This course helps in analysis of A.C & D.C circuits and it also help to design the circuit models for the minor and major projects.

Prerequisite: Knowledge of Laplace transformation

1. **Development of Circuit Concept:** Introduction, capacitance, inductance and resistance parameters, approximation of a physical system as a circuit, reference directions for current and voltage, voltage and current sources, active element conventions, dot convention for coupled circuits, topological description of networks, linear graphs of a network and its parts, loops and trees, incidence matrix, cut-set matrix and tie-set matrix. [8]
2. **Network Equations**: Kirchhoff's laws, minimum number of network equations, source transformations, formulation of network equations, loop variable analysis &node variable analysis and duality. [6]
3. **Analysis of RLC Circuits**: Laplace transformation, some basic theorems for the Laplace transformation, transient response of RL, RC and RLC circuits using Laplace transform with D.C input and A.C. with sinusoidal input, partial fraction expansion, and solution of problems by Laplace transformation. [8]
4. **Network Theorems**: Superposition and reciprocity theorems, Thevenin and Norton theorems, Millman theorem, Tellegen theorem, and maximum power transfer theorem, application of these theorems to networks with a.c and d.c excitation. [8]
5. **Two Port Network**: Two port parameters, impedance, admittance, hybrid, inverse hybrid, transmission parameters, relationship between various parameters, reciprocity and symmetry of two port network, inter connection of two port networks. [6]
6. **Synthesis of Passive Network**: Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [6]

Course Outcome: Upon successful completion of this course, students should be able to:

- Gain fundamental knowledge of the basic electrical elements such as resistance, capacitors and inductances.
- Understand circuit representation as graphs and implementation of KVL and KCL in the circuits and to solve the circuit problems by Laplace transformation method and also by applying various networks theorems.
- Analyze small RLC circuits by hand. Use network techniques, like node analysis and loop analysis, to write equations for large linear circuits.
- Apply Thevenin and Norton theorems and concept of linearity and superposition to analyze and design circuits and networks.

Text Books:

1. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", Pearson, 3rd Edition, 2016.
2. A. Chakrabarti, "Circuit Theory – Analysis and Synthesis", Dhanpat Rai & Co., 6th Edition, 2010.

Reference Books:

1. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", McGraw-Hill, 5th Edition, 2015.
2. W. H. Hyatt Jr. and J. E. Kemmerly, "Engineering Circuits Analysis", McGraw-Hill, 7th edition, 2010.

EE-14.202 **Electrical Machines-II** **Total Lectures: 42**

3-1-0-4

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction and performance of A.C machines and synchronous machines.

Pre-requisite: Electrical Machine-I

1. **Basic Concept of A.C. Rotating Machines:** Introduction to Armature winding, Integral slot and fractional slot winding, Distribution factor (K_d), Pitch factor (K_p) and winding factor (K_w). Production of rotating magnetic field, EMF and torque equations, Effect of tooth harmonics and methods of reduction. [4]
2. **Synchronous Generator:** Construction, Cylindrical rotor and salient pole rotor, Principle of operation, Excitation system, Effect of winding factor on EMF, Armature reaction, Circuit model, Phasor diagram, O.C. and S.C. tests, Short-circuit ratio, Determination of voltage regulation by synchronous impedance, MMF and zero power factor methods. [7]
3. **Performance Characteristics of Synchronous Generator:** Two reaction theory, Phasor diagram, Power-angle characteristic of synchronous generators, Synchronizing power and torque, Synchronizing methods, Parallel operation of synchronous generator, Effect of change in excitation and mechanical power input on load sharing, Operation of alternator on infinite bus bars, Slip test. [6]
4. **Synchronous Motor:** Construction, Principle of operation, Equivalent circuit, Phasor diagram, Circuit model, Effect of change in excitation on armature current and power factor, Starting of synchronous motor, Synchronous condenser, Hunting, Applications. [6]
5. **Induction Motor:** Introduction, Construction, Principle of operation, Slip and rotor frequency, Comparison with transformer, Equivalent circuit model, Representation of mechanical load, No load and blocked rotor tests. Torque and power output, Losses and efficiency, Separation of losses. [7]
6. **Performance Characteristics of Three-Phase Induction Motor:** Circle Diagram, Torque-slip characteristics, Effect of rotor resistance, Starting torque and maximum torque, Starting and speed control methods, Cogging and crawling, Introduction to induction generator, Applications. [6]
7. **Single-Phase Induction Motor & special machines:** Introduction, Double revolving field theory, Cross field theory, Torque-speed characteristic, Equivalent circuit model, Starting methods, Applications, Stepper Motor, and Reluctance motor. [6]

Outcome: The students shall develop an insightful knowledge on various ac motors and ac generators.

Text Books:

1. D.P. Kothari and I.J. Nagrath,. "Electric Machines", McGraw-Hill,2nd Edition, 2004
2. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 5th Edition, 2013.

Reference Books:

1. A.E. Fitzgerald, Charles Kingsley and Stephen D.U Electric Machinery, Mc Graw-Hill, 2nd Edition, 2003.
2. J.B. Gupta, Theory and Performance of Electrical Machines, S.K. Kataria and Sons, 3rd Edition, 2002

EE-14.203 **Electrical Machines-I** **Total Lectures: 43**

3-1-0-4

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction details and performance of D.C machines and Transformer.

Pre-requisite: Electrical Engineering course of First Year.

1. **Basic Concepts of Electrical Machines:** Introduction, Electromagnetic induction, flux linkage, statistically and dynamically induced emf, Classification and description of electrical machines, Heating and cooling of electrical machines. [4]
2. **Elements of Rotating Machines**: Introduction, Basic Components, Rotor, Stator and field excitation. Generator and motor action, EMF and torque equations, Leakage flux, Losses and efficiency, Rating and loss dissipation, Electrical and mechanical degrees. [5]
3. **Introduction to D.C. Machines:** Constructional parts of d.c. machines and their function, Principle of operation, Armature winding- Lap and wave, Simplex and duplex, Method of excitation, Classification, Derivation of emf and torque equations, Process of commutation, Armature reaction, Interpoles, Compensating winding and equalizer rings. [6]
4. **D.C. Generator**: Operating characteristics- Magnetization, Internal and external characteristics, Critical resistance and critical speed, Process of building up of voltage, Causes of failure of voltage build-up and remedies, Parallel operation of d.c. generators, Applications. [6]
5. **D.C. Motor**: Basic equation for voltage, Power, Torque and speed, Condition for maximum power, Operating characteristics- Torque-current, Speed-current and Torque-speed characteristics. Comparison, Starters, Speed control methods, testing of d.c. machines-Swinburne, Hopkinson's and Series field tests. Calculation of efficiency, Applications. [6]
6. **Transformers**: Principle of operation, Construction and practical considerations, Ideal and physical transformer, emf equation, Transformation ratio, Phasor diagram. Performance analysis, Equivalent circuit, Losses and efficiency, Condition for maximum efficiency, Determination of equivalent circuit parameters by O.C. and S.C. tests, Per unit calculation, Polarity test, Voltage regulation, All day efficiency. [10]
7. **Transformer Connections and Operation**: Back-to-back test, Parallel operation, Autotransformer, 3-phase transformer, Vector group, Three-phase transformer connections- Star-star, Delta-delta, Star-delta, Delta-star, Zig-zag connections, Scott connection, Open delta connection, Transformer cooling. [6]

Outcome: Graduates will have the knowledge of DC Electric motor, DC Generator and Transformer. They will understand how these motors are operated for applications.

Text Books:

1. D.P. Kothari and I.J. Nagrath,. "Electric Machines", McGraw-Hill, 2nd Edition, 2004.
2. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 5th Edition, 2013.

Reference Books:

1. A.E. Fitzgerald, Charles Kingsley and Stephen D.U Electric Machinery, Mc Graw-Hill, 2nd Edition, 2003.
2. J.B. Gupta, Theory and Performance of Electrical Machines, S.K. Kataria and Sons, 3rd Edition, 2002.

EE-14.204 **Electrical Measurement and Instrumentation** **Total Lectures: 40**
3-0-0-3

Objective: To make students conversant with concepts of measurement and various electrical and electronics instruments, transducers and bridges.

Pre-requisite: Basic Electrical engineering, Basic Electronics Engineering

1. **Concepts of Measurements:** Introduction, accuracy and precision, repeatability, errors in measurement, sources of errors, types of errors, statistical analysis of measurement data, graphical representation of measurement, data as distributions, Gaussian graph and precision indices. [6]
2. **Analog Instruments:** Types of operating torques in an analog instrument, Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Shunts and multipliers. Applications of instruments for measurement of single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment. [6]
3. **Bridge:** DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, Weins bridges. [6]
4. **Electronic Instruments for Measuring Basic Parameters:** Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, Q meter, Vector Impedance meter, signal analyzers- wave analyzers, harmonic distortion analyzers and spectrum analyzers. [6]
5. **Potentiometers:** DC and AC potentiometers, Principles, Standardization and application. [5]
6. **Transducers:** Introduction , Classification, Selection Criteria, Characteristics, Construction, Working Principles and applications of following Transducers- RTD, Thermocouples, Thermistors, LVDT, RVDT, Strain Gauges, Tacho-generators, Piezoelectric Transducers, Ultrasonic Flow Meters. [6]
7. **Oscilloscopes:** CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay. [5]

Outcome: Students will be able to understand electrical and electronic measuring devices and instrumentation like bridges, transducers, CRO etc.

Text Books:

1. Albert D. Helfrick, Wiliam D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning Private Limited, 2011.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai and Co., 2005.

Reference Books:

1. H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, 2nd Edition, 2004.
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2nd Edition 2007.
3. A.J. Bouwens, 'Digital Instrumentation', McGraw Hil, 2nd Edition, 2002.
4. E.O. Doebelin, 'Measurement Systems – Application and Design', McGraw Hill publishing company, 3rd Edition, 2007.

EE-14.210 **Comprehensive-I**

0-0-0-3

Objective: This course provides the:

1. The fundamental principles in electric circuit theory and to be able to extend these principles into a way of thinking for problem solving in mathematics, science, and engineering.
2. To expose the students to the concepts of various types of electrical machines and applications of electrical machines.
3. Build a foundation of basic knowledge required for electrical power engineers.
4. Understand the sources of energy and their contributions to the energy and power needs of the nation and the world.

Pre-requisites: Network Analysis, Electrical Machine-I, Electrical Machine-II, Power Plant Engineering, Electrical Measurement & Instrumentation

1 **Network Analysis:** Kirchoff's Laws in the frequency domain and impedance combinations, Nodal and mesh analysis for phasor circuits, Power in the Unbalanced three-phase systems, Application of the Laplace transform to electric circuits and the transfer function

2 **Special Machines:** Tacho-generator, AC and DC servomotor, Linear induction motor, Single phase motor, Double field revolving theory, Capacitor start capacitor run motors, Shaded pole motor, Repulsion type motor, Universal motor, Stepper motor.

3 **Electrical Measurement and Instrumentation:** Instrumentation amplifiers- single differential amplifier and three amplifier configurations, D/A and A/D converters, and concepts of a measurement channel and its components, Data acquisition and distribution configurations, analyze sample and hold circuits and multiplexers, Transducer interfacing techniques, passive and active transducer measurement requirements, Error analysis in the measurement channel, types of errors; consider transducer errors, transducer output linearization, instrumentation amplifier errors, filter errors, A/D converter errors, sample and hold and multiplexer errors.

4 **Power Generation System:** Steam power plant generation cycles, Nuclear Power Generation Safety considerations in the nuclear industry. Developments in nuclear fusion. Decommissioning problems of nuclear sites. Nuclear waste disposal systems, Fuel Cells-Definition and principles of operation. Losses and efficiency. Possible fuels. Fuel-cell technologies and applications, Combined Heat and Power (CHP) schemes, Application of CHP systems for the provision of heating, cooling and electric power. Selection criteria of CHP prime-movers.

Outcome: Upon completion of this course, the students should be able to:

1. Use network techniques, to analysis large circuits.
2. Understand constructional details, principle of operation of Special Machines.

Text Books:

1. I.J Nagrath, "Electric Machines", McGraw hill Edition.4th Ed. 2010.
2. F. F. Kuo "Network Analysis & Synthesis", John Wiley & Sons, 2nd Ed., 1999.

Reference Books:

1. M. G Say, "Alternating Current Machines", ELBS & Piman, London, 2nd Ed 1984.
2. D Roy Choudhury., "Networks and Systems", New Age International Publishers, 2nd Ed 2010.
3. A K Sawhney, "A course in Electrical & Electronic Measurements & Instruments", Dhanpat rai, 3rd Edition, 2005.

EE-14.301 **Transmission & Distribution** **Total Lectures: 40**

3-1-0-4

Objective:
1. To learn the fundamentals of power system for designing a system that meets specific need.
2. To understand the factors affecting Insulators and also in Under Ground cables.
3. To calculate the various parameters in Distribution System.

Pre-requisite: Network Analysis& Synthesis

1. **Introduction:** Structure of a power system, Effect of Transmission voltage, Load factor, diversity factor, plant capacity factor, plant utilization factor, different types of tariffs, per unit quantities and its advantages, Impedance and Reactance Diagram. [5]

2. **Transmission Line Parameter:** Configuration, Type of conductors, Resistance of line, Skin & Proximity Effects, Calculation of Inductance and capacitance of single phase, three phase, Single circuit and double circuit transmission lines. [7]

3. **Performance of Transmission Lines:** Representation of short, medium and long transmission lines, Ferranti effect, SIL, Tuned Power Line, Power flow through transmission lines. [6]

4. **Insulator and Corona:** Overhead lines insulators type of insulators and their applications Potential distribution over a string of insulators, Methods of Equalizing the potential, Phenomenon of Corona, Corona Loss, Factors affecting Corona, Methods of reducing corona. [6]

5. **Mechanical Design of Transmission Lines:** Catenary curve, Calculation of sag and Tension, Effects of wind and ice Loadings, Sag Templates, Vibration dampers. [5]

6. **Underground Cables:** Types of Insulation for Cable, Sheath, Armour and Covering, Classification of cables, Effective Conductor Resistance, Inductive Reactance, Capacitance of single phase and three phase cables, Grading of Cables, Problems with Underground cables. [5]

7. **Distribution:** Comparison of various Distribution systems, type of Primary Distribution systems and Secondary Distribution systems, Choice of transmission voltage, Kelvin's law, Limitation of Kelvin's law. Necessity of neutral grounding, various methods of neutral grounding. [6]

Outcome: At the end of this course the student is expected to have understood the following:
- Basic principles of supply systems.
- Mechanical & electrical design of overhead lines.
- Performance of transmission lines.

Text Books:
1. Wadhwa C.L. "Electrical Power Systems Electronics", New Age International Publishers, 4th Edition, 2011.
2. Gupta, B.R., "Power System Analysis and Design" S.Chand and Co., Ltd, 2nd Edition, 2005.

Reference Books:
1. Grainger, J.J. and William D. Stevenson Jr., "Power System Analysis", McGraw Hill, 3rd Edition,2005.
2. AbhijitChakrabarti, SunitaHalder "Power System Analysis: Operation and Control", Prentice Hall of India, 2nd Edition, 2008.

EE-14.302 **Power System Analysis** **Total Lecture: 40**

3-1-0-4

Objective:
- To know the necessity of load flow in a regulated system.
- To examine the need of various analysis like fault analysis, short circuit analysis stability analysis, steady state and transient analysis.

Prerequisite: Transmission & distribution

1. **Load Flow Studies:** Bus admittance(Y bus) and Impedance (Z bus) matrices and their formation. Power flow in a transmission system, bus classification, Load flow equations and solution techniques-Gauss iterative method, Gauss-Seidel method, Newton-Raphson method, comparison of load flow solution techniques. [9]
2. **Fault Calculation and Network:** Symmetrical fault, Significance of Positive, Negative and Zero Sequence Components, Fault calculation, Sequence Networks, Unsymmetrical fault analysis – Single Line to Ground faults, Line to Line fault, Double line to Ground fault. [9]
3. **Power System Stability:** Steady state stability and transient stability- stability problem, rotor dynamics and swing equation, power angle equation and diagram, equal area criterion and its application, critical clearing angle, fault clearing time, factors influencing transient stability, methods of improving stability. [8]
4. **Economic Load Dispatch:** Station performance and operating characteristics, Incremental rate theory, optimal Load distribution within generating station and between various generating stations in a region, Transmission loss equation, Calculation of losses and Generation scheduling and dispatch. [8]
5. **Power System Control:** Load Frequency control:Load Frequency Problems, Speed Governing System, Reasons for Limits on Frequency. Excitation systems, Automatic Voltage Regulators, SCADA and Computer control. [6]

Outcome:
- Apply the load flow application to various power system problems like minimization of transmission line losses, minimization of the total fuel cost etc.,
- Analyze the economic dispatch problem in thermal power plant
- Design a power system solution based on the problem requirements and realistic constraint.

Text Books:
1. Grainger,J.J. and William D. Stevenson Jr., "Power System Analysis", McGraw Hill, 4th Edition,2005.
2. Wadhwa.C.L. "Electrical Power Systems Electronics", New Age International Publishers, 3rd Edition, 2011.

Reference Books:
1. Ashfaq Husain "Electrical Power Systems", CBS Publishers and Distributors, 4th Edition, 1996.
2. AbhijitChakrabarti, SunitaHalder "Power System Analysis: Operation and Control", Prentice Hall of India, 2nd Edition, 2008.

EE-14.303 **Control Systems Engineering** **Total Lectures: 40**

3-1-0-4

Objective: The student gains the knowledge of the fundamental principles of analog and digital control system engineering, time response and frequency response analysis with its practical implementation. This course helps in understanding the design of Compensator and PID controller for the Automatic control of Industry.

Pre-requisite: Mathematics, Network Analysis& Synthesis

1. **Introduction:** Introduction to control systems, digital control system, types of control systems and their examples, mathematical modeling of electrical and mechanical systems (f-v and f-i analogy). [8]

2. **Reduction Techniques:** Block diagram reduction and signal flow graph representation of systems. [6]

3. **Domain Analysis:** Introduction, correlation between Transient response and frequency response, standard input signals, Response of 1st and 2nd order systems, time domain specifications i.e. rise time, peak time, delay time, peak overshoot, settling time steady state error etc., different types of feedback systems, Steady state errors for unit step, unit ramp and unit parabolic inputs, controller components. [10]

4. **Stability:**Introduction, concept of stability, conditions for stable system, asymptotic, relative and marginal stability, Routh-Hurwitz criterion for stability. [4]

5. **Plotting Techniques:** Root locus techniques, Bode plots, polar plots Nyquist criterion and Nichol's chart. [8]

6. **State Variables:** Analysis of systems, state vector, state space, advantages of state space techniques, state space representation, State variable analysis and design. [4]

Outcome: After completion of the course,

- The student will be able to get acquainted of analog and digital control system.
- The student will analyze and to design and development of automatic controller for industrial application.
- The student will gain the knowledge of stability analysis and improvement of stability for control system.
- This course becomes very beneficial for the graduates who wish to work in core sectr industry as most of the core sector is state-of-art control.
- This course becomes very beneficial for the 4th year student who will choose elective paper in Digital control system and other control system elective.

Text Books:

1. K. Ogata, "Modern Control Engineering," Pearson Education/Prentice Hall of India, 4th Edition, 2003.
2. I.J. Nagrath and M. Gopal, "Control System Engineering," New Age International Publishers, 2nd Edition, 2003.

Reference Books:

1. Syed HasanSaeed, "Automatic Control Systems (with MATLAB Programs)," S.K. Kataria& Sons Publishers, 6th edition, 2008.
2. SamarjitGhosh, "Control Systems: Theory and Applications," Pearson Education, 2nd Edition, 2012.
3. M.N. Bandyopadhyay, "Control Engineering Theory and Practice," Prentice Hall of India, 2nd Edition, 2003.

EE-14.304 **Power Electronics** **Total Lectures: 40**
3-0-0-3

Objective:
- To introduce to students the theory and applications of power electronics systems for high efficiency, renewable and energy saving conversion systems
- To prepare students to know the characteristics of different power electronics switches, drivers and selection of components for different applications
- To develop students with an understanding of the switching behavior and design of power electronics circuits such as DC/DC, AC/DC, DC/AC and AC/AC converters

Prerequisite: Network Analysis and Synthesis, Basics of Electronics Engineering, Engineering Mathematics

1. **Introduction:** Review of power semiconductor devices, SCR, Static and dynamic characteristics, Turn-on and Turn-off methods and circuits, Ratings and protection of SCRs, Series and parallel operation of thyristor, Other members of thyristor family. [8]

2. **Phase Controlled Converters:** Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits, Single phase dual converters and their operation with circulating and non-circulating currents. [10]

3. **AC Voltage Controllers:** Types of single-phase voltage controllers, Singlephase voltage controller with R and RL type of loads, gate pulse requirements to trigger the SCRs of ac voltage controllers. [5]

4. **Cycloconverters:** Principles of operation, Single phase to single phase step up and step down cycloconverters. Three phase to single phase cycloconverter. [5]

5. **DC Choppers:** Principle of chopper operation, Control strategies, Types of choppers, Step up and step down choppers, Types of choppers and operations. [5]

6. **Inverters:** Single phase VSI: half bridge and full bridge inverters, three phase bridge inverters with 180 degree and 120 degree modes of operation, Series and parallel inverters, Introduction to current source inverters. [7]

Outcome:
- The student will be able to understand the principle of operation of commonly employed powerelectronic converters
- The student will be capable of analyzing non-linear circuits with several power electronic switches
- The student will be equipped to take up advanced courses in Power Electronics and its application areas

Text Books:

1. Rashid, M., Power Electronics, Prentice Hall of India Private Limited, 4th Edition,2006.
2. P.S. Bimbhra, Power Electronics, Khanna publishers, 5th edition, 2012.

Reference Books:

1. Mohan,N., Undel, T.M. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley and Sons, 3rd Edition, 2007.
2. Jain,A., Power Electronics and its Applications, Penram International Publishing (India) Pvt. Ltd., 4th Edition, 2008.
3. Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.N.K., Thyristoried Power Controllers, New Age International (P) Limited, Publishers, 2nd Edition, 2004.

EE-14.305 **Power Plant Engineering** **Total Lectures: 40**

3-0-0-3

Objective: This course facilitates the students to understand the basic functioning of generation and design/economics consideration of various power plants.

Pre-requisite: Electrical Engineering course of First Year.

1	**Introduction:** Energy sources and their availability, Principle types of power plants, Their special features and applications, Present status and future trends. Economic aspects in power Generation: Terms commonly used in system operation, various factors affecting cost of generation: Load curves, load duration curves, Connected load, maximum load, Peak load, base load and peak load power plants, load factor, Plant capacity factor, Plant use factor, Demand factor, diversity factor, Cost of power plant.	[10]
2	**Thermal Power Plant:** General developing trends, Essentials, Plant layout, Coal storage, Preparation, Handling, Feeding and burning, Ash handling, Dust collection, High pressure boilers and steam turbines, Their main components like super heaters, Economizers, Pre-heaters etc., Fuel efficiency/heat balance.	[8]
3	**Hydro Electric Power Plants:** Classifications, Plant layout, various components, Types of turbines, Pumped storage, hydro-electric plants, advantages and disadvantages. Environmental aspects for selecting the sites and locations of hydro power stations.	[8]
4	**Gas Turbine Power Plants:** Schematic arrangement, advantages and disadvantages of Gas turbine power plant. Open cycle and Closed cycle gas turbine power plant, Combined cycle power plant, Comparison of various power plants.	[6]
5	**Nuclear Power Plant:** Nuclear fuels, Nuclear energy, Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect.	[8]

Outcome: The students shall develop an insightful knowledge to apply the basic laws and operating principles in various power plants.

Text Books:

1. Deshpande, M.V., "Power Plant Engineering", McGraw Hill, 4th Edition 2004.
2. Gupta B. R., "Generation of Electrical Energy", S. Chand Publications, 14th Edition, 2011.

Reference Books:

1. Wood A.J. & Wallenberg B.F, "Power Generation and Control", John Wiley & Sons, 2nd Edition, 2012.
2. P.K Nag "Power Plant Engineering", McGraw Hill publications, 2nd Edition, 2008.
3. Arora S.C & Domkundawar S, "A course in Power Plant Engineering", Dhanpat Rai, 2nd Edition, 2002.

EE-14.310 **Reliability of Electrical Power System** **Total Lectures: 40**
3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to the concept of probability theory, distribution, network modeling and reliability analysis.

Pre-requisite: Power system analysis, Power system transmission and distribution, Matrices, Probability and Calculus.

1. **Review of Probability Theory:** Element of probability theory Probability Distribution, Random variable, Density and distribution functions. Mathematical expectation. Binominal distribution, Poisson distributions, Normal distribution, Exponential distribution, Weibull distribution.. [8]
2. **Reliability of Engineering Systems**:Component reliability, Hazard models, Reliability of systems with non-repairable components, series, Parallel, Series-Parallel, Parallel-series configurations. Non-series-parallel configurations, minimal tie-set, minimal cut-set and decomposition methods. Power System reliability. [8]
3. **Reliability of Engineering Systems**:Reliability model of a generating unit, State space methods, Combing states, sequential addition method, Load modeling, Cumulative load model, merging of generation and load models, Loss of load probability, Percentage energy loss, Probability and frequency of failure, Operating reserve calculations. [8]
4. **Power Network Reliability:** Weather effect on transmission lines, Common mode failures, Switching after faults, three, state components, Normally open paths, Distribution system reliability. [8]
5. **Composite System Reliability:** Bulk Power supply systems, Effect of varying load, Inter connected systems, correlated and uncorrelated load models, Cost and worth of reliability. [8]

Outcome: The students shall have a thorough understanding of the main principles in power system reliability analysis as well as knowledge of different methods and tools for reliability analysis.

Text Books:
1. J. Endreny, “Reliability Modeling in Electric Power Systems”, John Wiley & Sons. 1980
2. Roy Billinton& Ronald, N allan, “Reliability Evaluation of Power Systems”, Plenum Press, New York. 1990

Reference Books:
1. Sullivan, R.L., “Power System Planning”, Heber Hill, 1987.
2. Patrick O'Connor, Andre Kleyner“Practical Reliability Engineering”, Wiley 5th Edition,2012

EE-14.403 **Electric Drives and Control** **Total Lectures: 40**
3-1-0-4

Objective: This course aims to equip the students with a basic understanding of Electric drive system and their controls. The course also equips students with ability to understand selection of motor for industrial drive applications, and develops the ability to understand the characteristics and speed control of motors using power electronics based circuits.

Pre-requisite: Power Electronics, Electrical Machines and Control System.

1 **Introduction :**Introduction to an electric drive system, parts of electric drive system, choice criteria for drive system [5]

2 **Dynamics of Electric Drives:** Dynamic equations of an electric drive, torque equations, multi-quadrant operation, type of loads, energy loss during transients and load equalization. [5]

3 **Electric Drive Control:** Control of electric drives, modes of operation, speed control, open & closed loop drives, current limit control, torque limit control, position, PLL and speed control. [6]

4 **Selection of Motor Drive Rating:** Selection of motor rating – thermal model of motor, classes of duty and determination of motor rating for different classes of drive operation duty. [6]

5 **Control of DC Motor:** DC motor drive – starting, braking, transient analysis, speed control, controlled rectifier converters for DC drives and chopper fed DC drives. [9]

6 **Control of AC Motors:** Induction motor drive – starting, braking, transient analysis, speed control, Control of Induction Motor by AC Voltage controllers-Waveforms, Speed torque characteristics, Variable frequency control of induction motor by Voltage Source, Current Source inverters and cycloconverters. [9]

Outcome: After completion of the course, students would be able to apply the knowledge of various drives, their selection criteria and its control mechanisms for domestic and industrial applications.

Text Books:

1. Dubey G.K. “Fundamentals of Electrical Drives”,Narosa Publications, New Delhi, 2nd Edition 1995.
2. Gopal K. Dubey, “Power semiconductor Controlled Drives”, PHI publications, Newest 1st Edition 1989.

Reference Books:

1. Murphy J. M. D., Turnbull F.O., “Power Electronic Control of AC motors”, Pergamon Press, 1st Edition 1988.
2. Pillai S.K., “A first course on Electrical Drives”, New age International Publisher, 2nd Edition 1989.
3. U. A. Bakshi, M. V. Bakshi, “Electrical Drives and Controls”, Technical Publications Pune, 1st Edition 2009.

EE-14.404 **Renewable Energy Systems** **Total Lectures: 40**

3-0-0-3

Objective: This course provides the principles of renewable technologies for sustainable future. It also provides the details of renewable resources, energy conversion techniques and applications of solar, wind, biomass, geothermal, hydro-electric, wave and tidal energy technologies.

Pre-requisite: Power Plant Engineering

1	**Energy Scenario:** Energy Resources: Conventional and non-conventional, Energy needs of India, Energy consumption patterns, Worldwide Potentials of these sources, Energy efficiency, Energy security, Energy and its environmental impacts, Global environmental concern, Kyoto Protocol, Concepts of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF),Factors favoring and against renewable energy sources.	[8]
2	**Solar Energy:** Solar Energy basics-Extraterrestrial and Terrestrial radiation, Spectral energy distribution, Solar Radiation Geometry, Empirical equation for estimating solar radiation on horizontal surface. Solar Thermal Systems, Types of collectors-Concentrating and Flat plate, Efficiency calculations, Solar water heater- thermosiphon and pumped, Greenhouses heating and cooling, Photo Voltaic (PV) technology, Solar cells, Characteristic of PV systems, Equivalent circuit, Array design, Standalone and grid interactive system.	[8]
3	**Wind Energy:** Wind Energy, Wind speed and power relation, Power extracted from wind, Wind distribution and wind speed predictions, Wind power systems, System components, Types of turbine, Turbine rating, Variable speed operation, Maximum power Operation, Control systems, System design features, Standalone and grid connected operation.	[8]
4	**Other Energy Sources:** Biomass, Various resources, Energy contents, Technological advancements, Conversion of biomass in other form of energy, solid, liquid and gases, Gasoliers, Biomass fired boilers, Co firing, Energy Generation from agro-dairy apart from municipal waste ,used for vehicles , Hydro energy, Feasibility of small, mini and hydel plants: scheme, layout and economics, Tidal and wave energy, Geothermal and Ocean, Thermal Energy Conversion (OTEC) systems, Schemes, feasibility and viability	[8]
5	**Energy Storage and Hybrid System Configurations:** Energy storage, Battery, Types, Equivalent circuit, Performance characteristics, Battery design, Charging and charge regulators, Battery management, Fly wheel energy relations, Components, Benefits over battery,Fuel cell energy, Storage systems and Ultra capacitors, Energy Management.	[8]

Outcome: Upon completion of this course, the students should be able to:

1. Recognize the need of renewable energy technologies and their role in the world energy demand.
2. Distinguish between the sustainable energy sources and fossil energy sources
3. Describe the principles of renewable energy production from various renewable sources.

Text Books:

1. Rai G.D. “Non- Conventional Energy Sources”, Khanna Publishers, 4th Edition,2004.
2. Khan B.H., “Non-Conventional Energy Resources”,McGraw-Hill Education Private Limited, 2nd Edition, 2015.

Reference Books:

1. Kothari D.P. and Singal K.C. “Renewable Energy Sources and Emerging Technologies”, PHI Learning Private Limited, 2nd Edition, 2011.
2. Boyle, G. “Renewable energy: Power for a sustainable future” Oxford University press, 3rd Edition, 2014.

EE-14.405 **Electrical Machine Design** **Total Lectures: 42**

3-1-0-4

Objective: To provide knowledge of design aspects of various dc machines, ac machines and transformers.

Pre-requisite: Electrical Machines

1 **Fundamentals of Electrical Machine Design:** Standard specification of frame size, conductors and insulation, Magnetization and loss curves, Choice of specific loadings Heating and cooling of electrical machines. [6]

2 **D.C Machines:** Construction details, output equation, main dimensions, Choice of specific loadings, choice of number of poles, armature design, design of field poles and field coils ,design of commutator and brushes. [10]

3 **Transformers:** Construction details of core and shell type transformers, output rating of single phase and three phase transformers, optimum design of transformers, design of yoke, core and winding for core and shell type transformers, equivalent circuit parameters from design data and design of tank and cooling tubes of transformers. [10]

4 **A.C. Machines:** Construction details of A.C. machines, output equation, main dimensions, Choice of specific loadings, design of stator, design of squirrel cage and slip ring rotor equivalent circuit parameter from design data, Short circuit ratio, design of rotor of cylindrical pole and salient pole machines. [10]

5 **Computer Aided Design:** Need for computer aided design, Analysis method, Synthesis method, Introduction to analysis of Electric machine parameters using FEM. [6]

Outcome: After completion of the course, students would be able to apply the knowledge of magnetism in the design of transformer and rotating electrical machines.

Text Books:

1. A.K. Sawhney, A course in Electrical Machine Design, DhanpatRai and sons, New Delhi, 2nd Edition, 2002.
2. S K Sen, Principles of Electrical Machine Design with Computer Programme,Oxford and IBH publishing Co. Pvt Ltd., New Delhi, 3rd Edition, 2004.

Reference Books:

1. R.K Agarwal, Principles of Electrical Machine Design, S.K.Katariasons, New Delhi, 4th Edition, 2002.
2. V.N. Mittle and A. Mittle, Design of Electrical Machines, Standard Publications and Distributors, Delhi, 3rd Edition, 2002.

EE-14.411 **Smart Grid** **Total Lectures: 40**

3-0-0-3

Objective:

- This course aims to equip the students to understand the change in electricity power business from conventional sectors to smart grid sectors.
- To understand and analyze the basic architecture of smart grid and functions of its various components like renewables generation, measurement and communication system etc.

Pre-requisite: Power system , Electrical Measurement & Instrumentation

1	**The Traditional Power Generation and Transmission System:** Introduction, Power System reliability and quality, Voltage profile of power system, Power transfer Through radial feeder, Power system stability and control, Protection system, SCADA System.	[8]
2	**Smart Grid:** Introduction, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, The Environmental Impacts of Smart Grid, Technologies Required for Smart Grid.	[8]
3	**Renewable Energy Integration:** Introduction, Solar Energy, Wind Energy, Distributed Energy Resources Integration Challenges, Forecasting and Scheduling, Impacts of Renewable Energy into the Grid.	[8]
4	**Smart Grid Communications and Measurement Technology:** Communication, Measurement and Monitoring Technologies, Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) ,Smart Appliances, Advanced Metering Infrastructure (AMI),Communication Protocols.	[10]
5	**Smart Meter:** Details Description of Smart Meter, Benefits of Smart Meter, Technical Configurations of Smart Meter, Components of Smart Meter Network in Distribution System, and Characteristics of smart meters.	[6]

Outcome: Upon completion of the course the student will be able to:

1. Understand the difference between conventional grid and smart grid.
2. Understand the integration necessity and challenges of renewable in conventional grid system.
3. Understand the operation of communication and measurement technology in modern grid context.

Text Books:

1 Momoh James., "Smart Grid Fundamentals of Design and Analysis" ,John Wiley &Sons, Inc., Hoboken, New Jersey, 4th Edition, 2012

2 Bollen, Math and Hassan F, "Integration of Distributed Generation in The Power System", IEEE press, 2011.

Reference Books:

1 Shawkat Ali A. B. M., "Smart Grids Opportunities, Developments and Trends", Springer Verlag, London, 4th Edition, 2013.

2 Chowdhury S., Crossley P. "Microgrids and Active Distribution Networks" The Institution of Engineering and Technology, UK, 3rd Edition, 2009.

EE-14.412 **EHV AC & DC Transmission** **Total Lectures: 40**
3-0-0-3

Objective: To provide an in-depth understanding of the different aspects of Extra High Voltage A.C. and D.C. Transmission system design and Analysis.

Pre-requisite: Transmission & Distribution & Power System Analysis

1. **EHV AC System:** Flexible AC transmission, control of FACTS devices, reactive power planning, static VAR compensation, optimal location, Sub-synchronous resonance, Ferro-resonance, true saturation characteristic. [6]
2. **Transients in Three Phase EHV AC system:** Switching of three phase transformer banks, transmission lines, capacitive banks, effects of neutral connection. Symmetrical component method of analysis of three phase switching transients, effect of open conductors. EMTP application. [6]
3. **Traveling Waves:** Generation of traveling waves, refraction and attenuation of waves, effects of line terminators, multi-conductor systems. [6]
4. **Protection of EHV AC Lines:** Protection against switching over-voltages, lightning over-voltages. Surge diverters, surge capacitors and reactors, overhead ground wires. [6]
5. **HVDC Systems:** Comparison with AC systems. Various configurations, inversion and conversion, operation and control, harmonics and filters. Parallel operation of HVDC/AC system. Back to back connections. Multi-terminal HVDC system. Transients in HVDC converters. [6]
6. **Overvoltage and Insulation Coordination:** Lightning, switching and temporary overvoltage, BIL and SIL, methods of insulation coordination, conventional and statistical methods. [6]
7. **Gas Insulated Systems:** Gas Insulated lines, substations, advantages and problems. [4]

Outcome:
1. Understand issues of concern with EHVAC& DC transmission
2. identify and calculate the various parameters of EHV line for modeling
3. Estimate the over–voltages in EHV AC systems and protect against it.
4. Understand insulation coordination and gas insulated system.

Text Books:
1. Rakesh Das Begamudre, “Extra High Voltage Ac Transmission Engineering”, New Age International, 4th Edition, 2011.
2. Padiyar. K. R.,"HVDC Power Transmission Systems", New Academic Science, 2nd Edition, 2011

Reference Books:
1. A Chakraborti, D.P. Kothari “Performance, Operation and Control of EHV Power Transmission Systems”, T.M.H publication,2nd Edition, 1983.
2. TuranGonen “Electric Power Transmission System Engineering”,Taylor & Francis, 2nd Edition,2007.

EE-14.413 **Modern Control System** **Total Lectures: 40**
3-0-0-3

Objective: To impart knowledge about advances in control system in the areas of state-space modeling & stability of continuous & discrete system. It will also make students familiar with the non-linear system – their modeling and analysis. At the end of the course a student will be equipped to handle linear and non-linear control problems.

Pre-requisite: Linear Control System

1 **State Space Analysis of Continuous Time Systems**: State variable representation – Conversion of state variable form to transfer function and vice versa – Eigenvalues and Eigenvectors – Solution of state equation – Controllability and observability –Pole placement design – Design of state observer [8]

2 **Z-Transform and Sampled Data Systems:** Sampled data theory – Sampling process – Sampling theorem – Signal reconstruction –Sample and hold circuits – z-Transform – Theorems on z-Transforms – Inverse z-Transforms – Discrete systems and solution of difference equation using z transform – Pulse transfer function – Response of sampled data system to step and ramp Inputs – Stability studies –Jury's test and bilinear transformation. [6]

3 **State Space Analysis of Discrete Time Systems**: State variables – Canonical forms – Digitalization – Solution of state equations –Controllability and Observability – Effect of sampling time on controllability – Pole placement by state feedback – Linear observer design – First order and second order problems [6]

4 **Nonlinear Systems:**Types of nonlinearity – Typical examples – Phase-plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Basic concepts –Dead Zone – Saturation – Relay – Backlash – Liapunov stability analysis – Stability in the sense of Liapunov – Definiteness of scalar functions – Quadratic forms – Second method of Liapunov – Liapunov stability analysis of linear time invariant systems and non-linear system [6]

5 **MIMO Systems:**Models of MIMO system – Matrix representation – Transfer function representation – Poles and Zeros – Decoupling – Introduction to multivariable Nyquist plot and singular values analysis – Model predictive control. [5]

Outcome: Upon completion of the course the student will be able to develop the mathematical models for various types of systems using different techniques.

Text Books:
1. M. Gopal, "Digital Control and State Variable Methods", McGraw Hill Publication,4th Edition, 2012.
2. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 3rd Edition, 1997.

Reference Books:
1. Katsuhiko Ogata, "Discrete-Time Control Systems", Pearson Education, 2nd Edition, 2002.
2. Richard C. Dorf and Robert H., "Modern Control Systems", 8thEdition, PearsonEducation, 2004.

EE-14.414 **Computer Application in Power Systems** **Total Lectures: 40**
3-0-0-3

Objective: This course is designed to give students the required knowledge for the design and analysis of electrical power grids by using computer programs or a software. The computer programs or software make easy calculation of power flow in a power system network using various techniques.

Pre-requisite: Transmission & Distribution & Power System Analysis

1 **Network Modeling**: Development of network matrices using graph theory, Z-Bus and Y-Bus formation, component models, fixed tap, variable tap and phase shifting transformers. [5]

2 **Short Circuit Studies of Large Systems:** Symmetrical and asymmetrical fault analysis using Z-Bus and Y-Bus Method. [6]

3 **Advanced Load Flow Studies:** Load models, non-convergence of load flow solutions, remedial measures, second order methods, continuation power flow, sparse vector method. [8]

4. **Economic Operation and Security Analysis:** Optimal power flow problem and its solution methods, contingency evaluation methods; distribution factors, direct and indirect methods, contingency ranking and screening. [8]

5. **Angular and Voltage Stability Analysis:** Steady state and transient stability, mathematical models and numerical solution, voltage stability. [8]

6. **State Estimation:** Algorithm, tracking state estimator, bad data identification, Observability. [5]

Outcome:
1. Upon completing this course student able to analysis of different type fault in a power system by computer methods.
2. Student able to apply computer methods in different load flow techniques.

Text Books:
1. J.J.Grainger & W.D.Stevenson, "Power system Analysis",McGraw Hill, 3rd Edition, 2007.
2. HadiSaadat, "Power System Analysis",McGraw Hill ,2nd Edition, 2002.

Reference Books:
1. D.P.Kothari and I.J.Nagrath, "Modern power system analysis", McGraw HillEducation, 2nd Edition, 2003.
2. T.K.Nagsarkar M.S.Sukhija ,"Power System Analysis", OXFORD university press,4th Edition, 2007.

EE-14.415 **Power Quality** **Total Lectures: 40**

3-0-0-3

Objective: This course aims to equip the students with an understanding of emanation of various power quality disturbances their cause, effects and remedial action in particular to harmonics distortion.

Pre-requisite: Power system, Power Electronics

1 **Introduction:** Introduction, power quality -voltage quality, power quality evaluations procedures term and definition:general classes of power quality problem, causes & effect of power quality disturbances. [6]

2 **Voltage Sags and Interruption:** Voltage sags and interruption: sources of sags and interruption, estimating voltages sag performance, fundamental principles of protection, monitoring sags. [6]

3 **Transient Over Voltages:** Sources of transient over voltages, principles of overvoltage protection, devices for overvoltage protection, utility capacitor-switching transients, utility system lightning protection, managing ferro-resonance , switching transient problems with loads. [8]

4 **Harmonics:** Harmonic distortion, voltage versus current distortion, harmonics versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from industrial loads, locating harmonic sources, system response characteristics, effects of harmonic distortion, inter-harmonics. [10]

5 **Applied Harmonics:** Harmonics distortion evaluations, principles for controlling harmonics, harmonics studies devices for controlling harmonic distortion, filters, passive input filter standards of harmonics. [10]

Outcome: Upon completion of the course The student will be able understand

1. The reason for occurrence of power quality disturbances.
2. The difference between disturbing signals like sag, swell transients, harmonics.
3. Various types of filters to filter out the harmonic problems.

Text Books:

1. Dugan R. C.,"Electrical Power System Quality", McGraw Hill Publication, 3rd edition, 2008.
2. Arrillga A.J., "Power System harmonics", Wiley publication, 2nd edition, 2003.

Reference Books:

1. Derek A. Paice, "Power electronic converter harmonics",Wiley publication, 3rd Edition,1999.

EE-14.441 **Engineering Economics** **Total Lectures: 26**

2-0-0-2

Objective(s):

1. Provide students with fundamental concepts of engineering economics.
2. Provide students with economical methods to compare and evaluate alternatives based on present, annual, rate of return, and benefit over cost analyses.
3. Emphasize practical engineering-based applications and the use of real data examples.

Prerequisite(s): Nil

1. **Introduction**: Definitions, Scope; Microeconomics vs. Macroeconomics; Engineering and engineering economics; Principles of engineering economics. **[2]**
2. **Theory of Demand & Supply**: Determinants, law of demand, law of supply, equilibrium, elasticity of demand. **[3]**
3. **Economics Applied to Industries**: Theory of production; production function, Law of variable proportions, Returns to scale, Theory of cost; Various concepts of cost: Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost, average cost, marginal cost, total cost etc, Break even analysis. **[6]**
4. **Market Structures& Pricing Techniques:** Meaning of Market, Types of Market- perfect competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets). **[5]**
5. **Replacement analysis and depreciation**: Replacement Analysis Decision Map, Basic aspects of depreciation, Deterioration & Obsolescence, and its methods **[3]**
6. **Optimization technique**: Optimization under constraints and without constraints, optimal resource allocation, optimization under risk and uncertainty. **[4]**
7. **Capital budgeting**: Concept; under certainty and uncertainty, Techniques; Discounting &compounding techniques, IRR, NPV, PBP, Profitability index, Accounting rate of return. **[3]**

Outcome(s):

1. Understand major principles of economic analysis for decision making among alternative courses of action in engineering.
2. Apply cost estimation and alternative analysis techniques for engineering applications.
3. Recognize the economic impact of engineering solutions.
4. Calculate depreciations and understand the impact of inflation.
5. Perform breakeven analysis for a single project and between two alternatives.

Text Books:

1. Salvatore, Dominick. Managerial Economics, Prentice Hall of India, 6th Ed., 2010.
2. D.N. Dwivedi, Managerial Economics, Oxford University Press,Vikas Publication, 7th Ed., 2014.

Reference Books:

1. Suma Damodran, Managerial Economics, Oxford University Press, 2nd Ed, 2005.

EE-14.442 **Principles and Practices of Management** **Total Lectures : 26**

2-0-0-2

Objective(s):

1. To expose the students to fundamental concepts of management and its processes in organizations.
2. To describe the various skills necessary for effective managers.
3. To explain the Individual and Group Behavior along with various leadership Styles

Prerequisite(s): Nil

1. **Planning and Organizing:** Management: Concept, Nature and functions; Planning: Concept, Missions, Objective and Strategies, Steps in Planning; Organizing: Concept, Formal an Informal Organization, Decentralization of Authority, Delegation of Authority, Principles of Organizing, Line and Staff Authority. **[5]**
2. **Staffing and Controlling:** Staffing: Definition, Recruitment, Selection, Placement, Promotion, Separation, Performance Appraisal; Controlling: Concepts and Process, Controlling as a Feedback System, Requirements for Effective Control. **[4]**
3. **Motivation:** Concept; Theories and Process of Motivation: Maslow's Need-Hierarchy Theory, Herzberg's Hygiene Theory, Goal-Setting Theory, Vroom's Expectancy Theory. **[4]**
4. **Personality:** Concept and Determinates, Types and Traits, Personality Attributes Influencing Organizational Behavior, Locus of Control, Machiavellianism, Self-Esteem, Self-Monitoring, Risk-Taking. **[3]**
5. **Group Behavior and Interpersonal Relationship:** Groups: Concept and Classification, Stages of Group Development, Roles and Norms, Group Decision-Making: Group versus Individual, Group Decision Making Techniques and Process, Interpersonal Relationships, Understanding Self and Others, Developing Interpersonal Relationships, Transactional Analysis, Johari Window. **[6]**
6. **Leadership:** Concept and Functions; Theories of Leadership: Traits, Behavioral, Situational/Contingency; Inspirational approaches to Leadership: Charismatic Leadership, Transformational Leadership, Transactional Leadership, and Contemporary Leadership. **[4]**

Outcome(s): By studying this Course, students would be able to understand various Management functions, individual and group behavior. They would also know various styles of Leadership and its applicability. The course would help the students in understanding various organizational contexts and help them understand organizational systems in a better way.

Text Books:

1. Koontz, Harold and Weihrich, Heinz, Essentials of Management: An International, Innovation and Leadership Perspective, McGraw Hill Private Limited, India, 10th Edition, 2015.
2. Robbins, Stephen P., Timothy Judge and Neharika Vohra, Organizational Behavior, Pearson Education, 12th Ed., 2011.

Reference Books:

1. Prasad L. M., Principles and Practice of Management, Sultan Chand & Sons, 9th Edition, 2015
2. Fred Luthans, Organizational Behavior, McGraw Hill, 11th Ed., 2009

EE-17.419 **Power System Protection** **Total Lectures: 40**

3-1-0-4

Objective: To provide a broad coverage on all types of protective relays, circuit breakers and its working for practical power system protection system.

Pre-requisite: Electrical Machines & Power Plant Engineering

1 **Introduction to Protection System:** Introduction to protection system and its elements, functions of protective relaying, protective zones, primary and backup protection, desirable qualities of protective relaying, basic terminology. [4]

2 **Operating Principle and Relay Characteristics:** Electromagnetic relays, thermal relay, gas actuated relay. Amplitude and phase comparators, over current relays, directional relays, distance relays, differential relay. [8]

3 **Static Relays:** Comparison with electromagnetic relay, classification and their description, over current relays, directional relay, distance relays, differential relay. [6]

4 **Protection of Transmission Line:** Over current protection, distance protection, pilot wire protection, carrier current protection, protection of bus. [6]

5 **Apparatus Protection:** Protection of Transformer, Generator and Motor. [3]

6 **Circuit Breaking:** Properties of arc, arc extinction theories, re-striking voltage transient, current chopping, Resistance switching, capacitive current interruption, short line interruption, circuit Breaker ratings, [6]

7 **Circuit Breaker:** Operating modes, selection of circuit breakers, ratings of circuit breaker, constructional features and operation of Bulk Oil, Minimum Oil, Air Blast, SF6, Vacuum circuit breakers, HVDC circuit breaker, Testing of Circuit Breaker. [7]

Outcome: After completion of the course, students would be able to apply the knowledge of CB, various relaying schemes and overvoltage and protection against overvoltage.

Text Books:

1. Badri Ram and Vishwakarma, D.N., "Power System Protection and Switchgear", McGraw HillPublishing, 3rd Edition, 2001.
2. Ravindranath, B. and Chander, N., "Power System Protection and Switch Gear", New AgeInternational (P) Ltd,3rd Edition, Reprint 1996.

Reference Books:

1. Sunil S.Rao, "Protective Switch Gear", Khanna Publishers, 2nd Edition, 2000.
2. Y. G. Paithangar, "Fundamentals of power system protection", PHI Learning Private Limited, 4th Edition, 2010.

EE-17.501 **Energy Resources** **Total Lectures: 40**

3-1-0-4

Objective:

- To provide an exposure on various concepts of Non-renewable and renewable energy and also its domestics and industrial applications
- To understand the environmental and economic aspects of renewable energy sources

Prerequisite: Power Plant Engineering

1. **Commercial Energy:** Coal, Oil, Natural Gas, Nuclear power and Hydro – their utilization pattern, future projections of energy consumption, environmental impactof fossil fuels, Energy scenario in India – Growth of energy sector and its planning in India. [8]

2. **Solar Energy:** Solar radiation at the earth's surface, measurements and estimation of average solarradiation, solar thermal flat plate collectors, concentrating collectors, solar thermal applications, solar electric power plant - principle ofphotovoltaic conversion of solar energy, types of solar cells, Photovoltaic applications: batterycharger, domestic lighting, street lighting, water pumping etc - solar PV power plant, Net meteringconcept. [8]

3. **Wind Energy:** Nature of the wind, power in the wind, factors influencing wind, wind data and energy estimation, wind speed monitoring, wind resource assessment, Betz limit, site selection, wind energyconversion devices, classification, applications, safety and environmental aspects, wind energy potential and installation in India -Repowering concept. [8]

4. **Bio Energy:** Biomass resources and their classification, Biomass conversion processes, Thermo chemicalconversion - direct combustion, biomass gasification, pyrolysis and liquefaction, biochemicalconversion, anaerobic digestion, types of biogasPlants, applications, alcohol production frombiomass, bio diesel production, Urban waste to energy conversion, Biomass energy program inIndia. [8]

5. **Other Types of Energy:** Ocean energy resources, principle of ocean thermal energy conversion (OTEC), ocean thermalpower plants, ocean wave energy conversion, tidal energy conversion, small hydro, geothermal energy, geothermal power plants, hydrogen production and storage, Fuel cell: principle ofworking, various types, construction and applications. [8]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understanding of commercial energy and renewable energy sources
- Knowledge in working principle of various energy systems
- Capability to do basic design of renewable energy systems

Text Books:

1. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill, 4th edition 2006.
2. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, 3rd edition, 2012.

Reference Books:

1. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 6th edition 2011.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd, 2nd edition, 2006.

EE-17.502 **Energy Audit and Management** **Total Lectures: 40**

3-1-0-4

Objective:

- To provide a broad knowledge on current energy scenario and audit for various applications.
- To acquire the in-depth knowledge of the Energy management systems.

Prerequisite: Renewable Energy System

1. **Energy Scenario**: Role of Energy Managers in Industries , Energy monitoring, auditing & targeting , Economics of various Energy Conservation schemes, Total Energy Systems [8]
2. **Energy Audit**: Various Energy Conservation Measures in Steam, Losses in Boiler. Energy Conservation in Steam Systems, Case studies. [8]
3. **Basics of Energy Conservation:** Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor, energy consumption & energy saving potentials, Design consideration. [8]
4. **Refrigeration & Air conditioning:** Heat load estimation, Energy conservation in cooling towers & sprays ponds; Case studies Electrical Energy, Energy Efficiency in Lighting, Case studies. [8]
5. **Energy Management:** Organizational background desired for energy management motivation, detailed process of M&T-Thermostats, Boiler controls, proportional, differential and integral control, optimizers; compensators. [8]

Course Outcome: Upon successful completion of this course, students should be able to

- Perform energy audit on the systems and know in depth the energy management systems.

Text Books:

1. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.
2. Reay D.A, Industrial Energy Conservation, 1st Edition, Pergamon Press, 6th edition, 2008.

Reference Books:

1. L. C Witte, Philip S. Schmidt, D. R. Brown, Industrial Energy Management & Utilization, Hemisphere Publisher Corp., 1st edition, 1988.
2. Power System Engineering 2nd Ed. D P Kothari, I J Nagrath, McGraw-Hill, 4th edition, 2008.

EE-17.503 **Solar Energy Engineering** **Total Lectures: 40**

3-1-0-4

Objective:
- To develop the ability to understand / analyze the various solar energy design principles.
- To study the various applications of solar energy and storage systems.

Prerequisite: Renewable Energy System.

1. **Introduction:** Source of radiation, solar constant, solar charts, Measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder [5]

2. **Solar Non-Concentrating Collectors**: Design considerations, Classification- air, liquid heating collectors, Derivation of efficiency and testing of flat plate collectors, Analysis of concentric tube collector, Solar green house. [6]

3. **Solar System Design**: Classification, Concentrator mounting, Focusing solar concentrators, Heliostats. Solar powered absorption A/C system, water pump, chimney, drier, dehumidifier, still, cooker. [10]

4. **Photo-Voltaic Cell**: Characteristics-cell arrays-power electric circuits for output of solar panels, choppers, inverters, batteries-charge regulators, Construction concepts. [7]

5. **Energy Storage**: Sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change-Glauber's salt-organic compounds. [12]

6. **Solar Energy Applications**: Introduction and principle of operation of solar cooker, solar air heater, solar water heater, solar distillation, solar pond, solar thermal power generation – Greenhouse - Solar PV system.

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze and design the solar energy system with energy storage devices and perform the selection based on techno-economic view point.

Text Books:

1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003.
2. Edward E. Anderson, "Fundamentals for solar energy conversion", Addison Wesley Publ. Co., 2nd edition 2000.

Reference : Books

1. G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable energy Sources", Narosa Publishing House, New Delhi, 4th edition, 2007.
2. Energy Studies, Second Edition, by W. Shepherd and D. W. Shepherd, Imperial College Press, London, 3rd edition, 2004.

EE-17.504 **Wind Energy Conversion System** **Total Lectures: 40**

3-1-0-4

Objective: To provide the current status, importance, future trends and potential for Wind energy technologies as a complement to, or replacement for, conventional technologies.

Prerequisite: Renewable Energy System

1. **Wind Resource:** Wind characteristics: Meteorology of wind – wind speed distribution across the world – spatial and temporal factors – Eolian features - Biological indicators. Wind measurement: Anemometers – balloon trackers. Wind energy conversion systems (WECS) - classifications. [8]

2. **Wind Energy Conversion:** Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and Strip theory; Maximum power coefficient; Prandlt's tip loss correction; Rotor design and characteristics; Power, torque and speed characteristics – Wind turbine performance measurement – Loading analysis. [8]

3. **Wind Turbines Types:** Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator. [8]

4. **Wind Energy Application:** Wind pumps: Performance analysis, design concept and testing; Principle of Wind Energy Generators; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies. [8]

5. **Cost Economics**: Wind resource assessment and R & D costs, Fixed and variable costs, Value of wind energy, Life cycle costing and cash flow of wind power projects, Wind project owners / developers, Wind energy market. [8]

Course Outcome: Upon successful completion of this course, students should be able to

- Understand the atmospheric processes that produce wind energy.
- Explain the fundamental principle of wind turbine operation.
- Analyze the economics of wind energy.
- Explain recent commercial developments in wind energy and its future potential.

Text Books:

1. S. Rao & B.B. Parulekar, Energy Technology, Khanna publishers, 4th edition, 2005.
2. T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, Wind energy Handbook, John Wiley & Sons, 6th edition, 2011.

Reference Books:

1. Mukund. R. Patel, Wind and Solar Power Systems, Taylor & Francis, 2nd Edition 2001.
2. L .L. Freris, Wind Energy Conversion Systems, Prentice Hall, 4th Edition, 2010.

EE-17.505 **Advanced Energy Storage** **Total Lectures: 52**
4-0-0-4

Objective:
- To develop the ability to understand / analyze the various types of energy storage.
- To study the various applications of energy storage systems.

Prerequisite: Power Plant Engineering

1. **Introduction:** Necessity of energy storage, types of energy storage, comparison of energy storage technologies, Applications. [7]

2. **Thermal Storage System:** Thermal storage, Types, Modelling of thermal storage units, Simple water and rock bed storage system, pressurized water storage system, Modelling of phase change storage system, Simple units, packed bed storage units, Modelling using porous medium approach, Use of Transys. [9]

3. **Electrical Energy Storage:** Fundamental concept of batteries, measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries, Lead Acid, Nickel-Cadmium, Zinc Manganese dioxide and modern batteries: zinc-Air, Nickel Hydride, Lithium Battery. [12]

4. **Fuel Cell:** Fuel Cell, History of Fuel cell, Principles of Electrochemical storage, Types, Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis, advantage and drawback of each type. [10]

5. **Alternate Energy Storage Technologies:** Flywheel, Super capacitors, Principles & Methods, Applications, Compressed air Energy storage, Concept of Hybrid Storage, Applications. [14]

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze various types of energy storage devices and perform the selection based on techno-economic view point.

Text Books:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons, 2nd edition, 2011.
2. Ru-Shiliu, Leizhang, Xueliang Sun, Electrochemical technologies for energy storage and conversion, Volume 1 & 2, Wiley publications, 2nd Edition, 2012.

Reference Books

1. James Larminie and Andrew Dicks, Fuel cell systems Explained, Wiley publications, 1st edition, 2003.

EE-17.506 **Solar Photovoltaic Technology** **Total Lectures: 40**

3-1-0-4

Objective:

- To attain a broad comprehension of solar photovoltaic systems used for various applications.
- To know in depth the types and design of various PV-interconnected systems.

Prerequisite: Renewable Energy System

1. **Photovoltaic Basics:** Structure and working of Solar Cells - Types, Electrical properties and Behavior of Solar Cells – Cellproperties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays -Basics of Load Estimation. [8]

2. **Stand Alone PV Systems:** Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications - Typical applications for lighting, water pumping etc. [8]

3. **Grid Connected PV Systems:** Site selection and land requirements - Techno-economic analysis of solar PV power plants - Environmental considerations.Schematics, Components, Charge Conditioners, Interface Components - Balance of systemComponents - PV System in Buildings. [8]

4. **Design of PV Systems:** Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability - Simple Case Studies. [8]

5. **Solar Economics:** Application of economic methods to analyze the feasibility of solar systems to decide project / policy alternatives - Net energy analysis - and cost requirements for active and passive heating and cooling - for electric power generation - and for industrial process-heating. [8]

Course Outcome: Upon successful completion of this course students will be able to

- Explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems.

Text Books:

1. CS Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2nd Edition 2011.
2. Martin A. Green, Solar Cells: Operating Principles, Technology and System Applications, Prentice- Hall, 4th Edition, 2011.

Reference Books:

1. Nelson J., The Physics of Solar Cells, Imperial College Press, 2nd Edition, 2003.
2. Thomas Markvart, Solar Electricity, John Wiley and Sons, 2nd Edition, 2012.

EE-17.507 **Biomass and Small Hydel Plants** **Total Lectures: 52**
4-0-0-4

Objective:

- To provide understanding of the processes for converting biomass feedstocks to fuels by various approaches.
- To learn to evaluate technological, economic and business dimensions of energy production from biomass.
- To provide understanding of energy generation from small hydro power plant and hydel power plants management.

Prerequisite: Renewable Energy Sources

1. **Biomass Resources and Biomass Properties:** Biomass: definition, classification, availability, estimation of availability, consumption and surplus biomass, energy plantations. Potential of biomass and assessment. [8]
2. **Energy Conversions Techniques:** Thermo chemical conversion: Direct combustion, incineration, pyrolysis and gasification; Biomass stoves, improved chullahs and some exotic designs, Biological conversion: Biodegradation and biodegradability of substrate; Biochemistry and process parameters of biomethanation; Biogas digester types; Digester design and biogas utilisation; Bioconversion of substrates into alcohol: Methanol & ethanol Production, Chemical conversion: Hydrolysis and hydrogenation; Solvent extraction of hydrocarbons; Bioethanol; Chemicals from biomass. [11]
3. **Bio Diesel:** History, Production methods of Bio-diesel: Transesterification, Fuel quality, standards and properties, Availability of Raw materials for bio-diesel, Applications, Bio-diesel potential in India. [8]
4. **Waste To Energy** Introduction to Energy from waste, classification of waste as fuel, agro based, forest residue, industrial waste, Environmental monitoring system for land fill gases, Environmental impacts; Measures of mitigate environmental effects due to incineration. [7]
5. **Hydro Power:** Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works. [9]
6. **Hydel Plant Management:** Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in North East India. [9]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understand the challenges and problems associated with the use of various bioenergy sources with regard to future resource and the environment.
- Evaluate the cost-benefit of various biomass energy conversion processes.
- Identify remedies/potential solutions to the supply and environmental issues associated with biomass based energy resources.
- Conceptualize energy generation techniques and understand different small hydro power plant and hydel power plants management.

Text Books:

1. Capareda S, Introduction to biomass energy conversion, CRC Press, 4th Edition, 2014.
2. Harvey A. & Brown A, Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes. Practical Action publication, 2nd Edition, 2003.

Reference : Books

1. Brown RC and Stevens C, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons, 4th Edition, 2011.

EE-17.508 **Environmental Impact of Energy System** **Total Lectures: 52**

4-0-0-4

Objective: To achieve environmental improvements and know the environmental values and behavior.

Prerequisite: Power Plant Engineering.

1. **Impact of Energy Systems on Environment:** Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants. Methods of Environmental Impact Assessment. [12]
2. **Pollution Due To Thermal, Hydel and Nuclear Power Plants:** Potential sources of Pollution in thermal power plant, Air, water, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control. Various pollution control equipments such as dust collector, bag filter, electrostatic separator, working principle and selection criteria, designing the pollution control system, methods and limitation. Water pollution in thermal power plant, physical and chemical methods of pollution control, Land pollution effect of land pollution, measurement of land pollution. Limitations and advantages of pollution control systems. Hydrothermal plant environmental assessment, hydrothermal plant and rehabilitation measures for hydrothermal plant. Nuclear power plants and environmental pollution, pollution control measures. Effect of Hydroelectric power stations on ecology and environment. [14]
3. **Industrial and Urban Waste & Waste Energy Recovery:** Industrial waste, Waste and effluent treatment, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy. Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control. [10]
4. **Environmental and Pollution Control Laws:** United Nations Framework Convention on Climate Change (UNFCC), Protocol, Conference of Parties (COP) 19 Clean Development Mechanism (CDM), Prototype Carbon Funds(PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project. [10]
5. **Global Environmental Concern:** Global Environmental Issues, ozone layer depletion, Global Warming, Green House Gases Emission. [6]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understand environmental effects and act accordingly to improve the environmental conditions globally.

Text Books:

1. W.K. Foell, Management of Energy Environment Systems, John Wiley and Sons, 6th Edition, 2013.
2. M.C. Macedo Jr, Energy Management and Control Systems, John Wiley and Sons, 4th Edition, 2004.

Reference Books:

1. J.G. Rau, D.C. Wood, Environmental Impact Analysis Handbook, McGraw Hill, 7th Edition, 2005.
2. J.M. Fowler, Energy & Environment, McGraw Hill,, ERIC, 2nd edition, 2009.

EE-17.509 **Power System and Smart Grid** **Total Lectures: 52**

4-0-0-4

Objective:

- To provide the students a systems perspective of modern electricity markets and a systems approach to address various issues faced by the electricity sector.
- To present the student a vision of how Smart Grid will transform the current electricity grid to a reliable and sustainable modern energy system.

Prerequisite: Transmission and Distribution, Power System Analysis.

1. **Supply Side and Demand Side of Electricity:** Basics of electricity, Fossil fuels and hydro power plants, Renewable and alternative energy, Supply curve, Load characteristics, Load curve and load duration curve, Demand side management. [11]

2. **Transmission and Distribution Network:** Physical law of electricity, AC vs. DC power flow, Optimal Power flow and unit commitment models, Distribution network basics. [10]

3. **Basic Elements of Smart Grid:** The origin of power grid, dependency on power grid, desirable features of power grid, reliability, security, economic, efficiency, environmental friendly, safety. [11]

4. **Key Characteristics of Smart Grid:** Demand-side participation, Impact of Smart Grid on reliability, Impact of Smart Grid on air pollutant emissions reduction. [10]

5. **Issues Related to Smart Grid:**Communication and sensing in a smart grid, smart grid threats, vulnerabilities, cyber security strategies. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Gain Knowledge about the economic fundamentals of power systems and electricity markets.
- Understand the concepts of various components of Smart Grid, and their impacts on the energy industry, including renewable integration, demand side management, and greenhouse gas emission reduction.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 4th Edition, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 4th Edition, 2009.

Reference Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2017.

EE-17.510 **Power System for Renewable Energy Sources** **Total Lectures: 52**

4-0-0-4

Objective: To know the grid integration of renewable energy sources, different machines, power electronics devices uses in renewable energy power plants.

Prerequisite: Power System Analysis, Renewable Energy System.

1. **Introduction To Renewable Energy Grid Integration:** concept of mini/micro grids, and smart grids. Review of synchronous generators, Introduction to power system stability problems: rotor angle stability, voltage stability and voltage collapse, classification of stability. Modelling of synchronous machines: transformations, synchronous machine representation in stability studies. [12]
2. **Introduction To Induction Machines:** electrical characteristics, slip, speed torque characteristicsetc. Self-excited induction generator, Constant speed Induction generators, Variable speedInduction generators, Doubly fed Induction generators. [10]
3. **Introduction To Power Electronic Devices:** AC/DC converters, PWM, THD. Permanent magnetsynchronous generator, solar PV systems, fuel cell, aquaelectrolizer. [10]
4. **Issues in Integration of Different Generators:** Issues in integration of synchronous generator based, induction generator based and converterbased sources together.Network voltage management (discusses the issue of voltage levels). [10]
5. **Power Quality Management:** Voltage dips, harmonics and flickers.Frequency management. Influence of WECS on system transient response – IEEE standard and Polices. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Analyze the power quality management in renewable power plants.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 2nd Edition, 2009.

Reference : Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2006.

EE-17.512 **Power Electronics for Renewable Energy Source** **Total Lectures: 52**

4-0-0-4

Objective:
- To impart knowledge on Standalone, Grid connected and Hybrid renewable energy systems.
- To understand the different types of Electrical Machines and Power Converters employed for renewable energy conversion systems

Prerequisite: Power Electronics,Renewable Energy System.

1. **Introduction:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission), Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. [12]

2. **Electrical Machines For Renewable Energy Conversion:** Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG. [8]

3. **Power Converters:** Solar: Block diagram of solar photo voltaic system, Principle of operation: line commutated converters (inversion-mode), Boost and buck-boost converters, selection of inverter, battery sizing, array sizing, Wind: three phase AC voltage controllers, AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. [12]

4. **Analysis of Wind and PV Systems:** Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system, Grid connection Issues, Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system. [10]

5. **Hybrid Renewable Energy Systems:** Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Wind-PV, Maximum Power Point Tracking (MPPT). [10]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understand the concepts of Standalone, Grid connected and Hybrid Energy System
- Understand different types of Electrical Machines and Power Converters employed for Renewable Energy Conversion Systems.

Text Books:

1. Leon Freris, David Infield, Renewable Energy in Power Systems, John Wiley & Sons, 2008.
2. Rashid .M. H, Power Electronics Hand book, Academic press, 1st edition, 2007.

Reference Books:

1. Rai. G.D, Non-Conventional Energy Sources, Khanna publishes, 2nd edition, 2010.
2. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, John Wiley & Sons, 4th edition, 2011.
3. S.N. Bhadra, D.Kastha, Wind Electric Systems, Oxford University Press, 5th edition, 2005.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of ME

Course structure for

B.Tech ME

ME 14.401 **Thermal Engineering System** **Total Lectures: 40**
Credit 3-1-0-4

Prerequisite(s): Engineering Thermodynamics

Objective(s):

Thermodynamics is an essential part of engineering curricula, and has a broad application area such as transportation vehicles, power generation and cooling systems. The course will cover the basic principles of thermodynamics and will give students knowledge about how thermodynamics is applied in engineering practice.

1. **Steam Generator and Draft:** Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox etc, boiler mountings and accessories; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation. Introduction to high pressure boiler [8]
2. **Steam & Gas Nozzles:** Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, Off design operation of nozzle, Effect of friction on nozzle, critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. [8]
3. **Steam Turbines:** Introduction; classification of steam turbine; impulse turbine; working principal; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; efficiency of blade height; condition of maximum efficiency; internal losses in steam turbine; governing of steam turbine. [10]
4. **Compressors:** [6]
Classification, single and multistage reciprocating compressors, isothermal and volumetric efficiencies, centrifugal and axial flow compressors, surging, choking and stalling.
5. **Steam Condensers:** Component of steam condensing plant; types of condensers; air leakage in condensers; Dalton's law of partial pressure; Condenser vacuum, sources of air leakage & its disadvantages, vacuum efficiency; calculation of cooling water requirement; air expansion pump. [8]

Outcome(s):

Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques, including the use of empirical data and property tables, to the analysis of representative fluid and thermal energy components and systems.

Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques, including the use of empirical data and property tables, to the design analysis of auxiliary fluid and thermal energy components and systems representative of the systems encountered in the practice of electrical, industrial, and related disciplines of engineering.

Text Books:

1. P.K. Nag , “Basic and Applied Thermodynamics”, Tata Mc Graw Hill Pub
2. Kearton W. J, “Steam Turbine Theory and Practice”, CBS Publisher & Distribution Pvt Ltd, Latest Edition
3. R.K. Rajput, “Thermal Engg.”, Laxmi Publication

Reference Books:

1. Ballaney P. L, “Thermal Engineering”, Khanna Publishers, Latest Edition.
2. Yadav R, “Thermodynamics and Heat Engines”, Central Publishing House, Latest Edition
3. Chattopadhyay P, “ Boiler Operation Engineering”, TMH, 11th Edition, 2008.

ME 14.403 **Refrigeration and Air Conditioning** **Total Lectures: 40**

Credit-3-1-0-4

Prerequisite(s): Engineering Thermodynamics
Heat Transfer

Objective(s): *This course deals with the heating and cooling effects produced in domestic and industrial applications. The objectives of the course is to enable the student;*

- *To understand the principles of refrigeration and air conditioning.*
- *To calculate the cooling load for human comfort & different applications.*
- *To select the right equipment for a particular application.*
- *To understand the effect of temperature and pressure on moist air.*

6. **Introduction:** Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP), Fundamentals of air-conditioning system. [2]
7. **Air Refrigeration System:** Carnot refrigeration cycle; Temperature Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems. [4]
8. **Vapor Compression Refrigeration Systems:** Simple Vapour Compression Refrigeration systems-Limitations of Reversed Carnot cycle with vapour as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP. [5]
9. **Multistage Vapor Compression Refrigeration Systems:** Necessity of multistage compression, Compound VC cycle, Inter cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers. [7]
10. **Vapor Absorption Refrigeration Systems:** Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; Steam Jet Refrigerating System. [3]
11. **Refrigerants:** Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics. [3]
12. **Psychrometry:** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer. [7]

13. **Air Conditioning:** Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air-conditioning system; year round air conditioning; unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor; Inside design conditions; comfort conditions; components of cooling loads; internal heat gains; system heat gain: external heat gain; Transport air conditioning. [9]

Outcome(s):

Able to understand basic principles of refrigeration.
Able to understand simple and multiple vapour-compression cycle, gas refrigeration cycles and absorption cycles.
Ability to understand the principles of thermal comfort & ventilation
An ability to use refrigerant property tables and psychrometric chart.

Text Books:

1. Stocker W. F. and Jones J.W., "Refrigeration & Air conditioning", TMH, New Delhi, Latest Edition.
2. Arora C. P., "Refrigeration & Air conditioning", TMH, New Delhi, Latest Edition.

Reference Books:

1. Prasad M, "Refrigeration & Air conditioning", Wiley Eastern limited, New Delhi, Latest Edition.

ME 14.404 **CAD/CAM** **Total Lecture 40**
3-0-0

Prerequisite(s) **Mathematics (Matrix), Machine Design, C programming, Machine tool and Machining**

Objective(s)

- Understand the applications and benefits of CAD
- Understand geometric transformation.
- Understand various representations of curves and surfaces.
- Understand the various concepts and characteristics in geometric modeling.
- Understand the basic concepts of CAM. Analyze the components and systems of NC and CNC machine tools. Understand and apply various programming methods for specific jobs.
- Classify various CAPP systems.
- Understand FMS and CIMS with reference to components, advantages and applications.

1. **Fundamentals of CAD**: Introduction: Design Process: Application of computers in design: Creating manufacturing database: benefits of CAD. Computer Hardware; Graphic input devices; display devices; Graphics output devices; Central processing unit (CPU). CAD software and Database: Software configuration of a graphics system: functions of a graphics package: geometric modeling: Database structure and control; Graphics standard: GKS and IGES. **[4]**

2. **Geometric Transformations**: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrices. Application of geometric transformations. **[8]**

3. **Representation of curves and surfaces**: Polygon, meshed and ruled surfaces: Bezier curves; B-spline curves. **[6]**

4. **Geometric Modeling**: Wireframe model: solid modeling: representation, volumetric properties, surface modeling, concepts of hidden-line removal and shading: Kinematics analysis and simulation. Application of CAD techniques to finite Element Mesh Generation. Computer Aided Manufacturing (CAM) **[9]**

5. **Introduction of CAM**: Basic concepts of manufacturing system and CAD/CAM. NC/CMNC Machine Tools; NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system. **[9]**

6. **Computer Aided Process Planning**: Introduction and benefits of CAPP. Types of CAPP systems, machinability data selection systems in CAPP. **[2]**

7. **FMS and CIMS**: Flexible Manufacturing System (FMS) and Computer integrated manufacturing system: FMS and its advantages, components of a FMS system. Introduction to CIMS. **[2]**

Outcome(s)

- Understand the capabilities of general Computer Aided Designing Systems and CAD Systems for designing mechanical parts and elements in 2D and 3D dimensions.
- Use effectively CAD / CAM systems in order to produce the final NC code for the manufacturing of various mechanical parts and carry out exchange of data between CAD and CAM systems.
- Describe the principles of various manufacturing processes, manufacturing technology.

TEXT BOOKS:

1. Groover M.P., "Automation, Production Systems and Computer-Integrated Manufacturing", PHI, Latest Edition.
2. Zeid Ibrahim, "CAD/CAM : Theory & Practice", Tata Mc Graw Hill Publication, Latest Edition.

REFERENCE BOOKS:

1. Rao P.N., "CAD/CAM : Principle and Applications", Tata McGraw Hill Publication, Latest Edition

ME 14.405 **Total Lectures: 40**

Production Technology III

Pre – requisites: Material Science, Production Technology I **Credit-3-0-0-3**

Objective: *The course should enable the students :*

1. To exposed to fundamental concept of machining processes like grinding, super-finishing, thread and gear manufacturing.
2. To familiar with rapid prototyping.
3. To understand various non conventional manufacturing processes.

1 **Abrasive Machining:** Grinding machines, various grinding operations; Grinding wheels, preparation for wheel operation. Lapping, honing, super finishing. **[7]**

2 **Threads and Gear manufacturing:** Introduction, thread making, thread grinding, thread rolling, Gears types and gear making, machining of gears, gear finishing. **[6]**

3 **Powder Metallurgy:** Introduction, basic process, powder manufacturing, powder mixing and blending, composting, sintering. **[5]**

4 **Rapid prototyping and Micro Manufacturing:** Introduction, role of rapid prototyping & rapid tooling, features and classifications. Micro & Nano manufacturing processes, fabrication of electronics products and IC. **[6]**

5 **Jigs & Fixtures:** introduction, necessity for jigs & fixtures, elements of fixtures, locators, types of locators, clamping, locating principles. **[4]**

6 **Non Traditional Machining:** AJM, WJM, EDM, ECM, USM: working principle, components of set up, field of application, Parameters affecting machining characteristics, Material removal mechanism. **[12]**

Outcome *The students should be able to:*

1. Apply the knowledge of various advance manufacturing processes.
2. Identify various process parameters and their effect on processes.
3. Figure out application of modernization in machining.
4. Get the knowledge of Jigs and Fixtures so as to utilize machine capability for variety of operations

Text Book

1. Lindberg, "Processes and Materials of Manufacture", Prentice hall India (P) Ltd, Latest Edition.
2. Rao P. N, "Manufacturing Technology", TMH, Latest Edition.
3. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Pearson Publications.

Reference Book

1. Degarmo, Black and Kosher, "Material and Processes in Manufacturing", Latest Edition.
2. Kempster M. H. A, "Introduction to Jigs and Fixtures Design", Latest Edition.
3. Ghosh A, "Rapid Prototyping", EWP, Latest Edition.

ME 14.406 Operations Management

Total Lectures: 40

Pre – requisites: Elementary knowledge of calculus

Credit 3-1-0-4

Objective: *The course should enable the students :*

1. To understand the strategic significance of Operation management

2. To impart knowledge on Forecasting, Project management, Inventory, Scheduling & capacity planning with appropriate tools and techniques needed for understanding the operational situation.

1	**Manufacturing System:** Introduction to operation management, Types and characteristics of manufacturing systems.	[3]
2	**Forecasting Technique:** Use and types of forecasting, Methods of forecasting. Regression analysis	[6]
3	**Project Management:** Project management techniques; Introduction to CPM and PERT techniques, network analysis, activities and events, conventions adopted in drawing networks, graphical representation of events and activities.	[5]
4	**Materials Planning and Control:** Field and scope, materials planning; Inventories-types and classification; ABC analysis, economic lot size, EOQ model, leads time and reorder point, inventory control systems. Aggregate planning: definition, aggregate planning methods, Introduction to MRP and MRP-II, Master Production Schedule, Bill of materials.	[12]
5	**Operations Scheduling:** Concepts, loading, scheduling and sequencing, single processor scheduling, flow shop scheduling, job shop scheduling, scheduling criteria; Gantt chart.	[6]
6	**Capacity Planning:** Definition of capacity, capacity planning, capacity requirement planning, Capacity available and required.	[4]
7	**JIT & ERP:** Introduction to the new manufacturing concepts; JIT, lean manufacturing, pull and push systems of production; Kanban system. Introduction to ERP.	[4]

Outcome *The students should be able to:*

1. Understand and recognize key issues and problems in Operations Management.

2. Develop an understanding of how Operations Management functions relate to overall organization strategy, effectiveness and performance.

Text Book

1. Monks, J. G, "Operations Management", TMH, Latest Edition.
2. Russel Taylor, "Operations Management"**,** Wiley India.
3. Adam & Ebert, "Productions & Operations Management", PHI, Latest Edition.

Reference Book

1. Buffa W, "Modern Production/Operations Management", Eastern Ltd, Latest Edition.
2. Chary S.N, "Production and Operations Management", TMH, Latest Edition.

ME 14.407 **Industrial Engineering & Operation Research** **Total Lectures: 40**

Pre – requisites: Knowledge of linear algebra and basic mathematical concepts **Credit-3-0-0-3**

Objective: *The course should enable the students :*

1. To understand Concept of Industrial Engineering
2. To learn various Industrial Engineering techniques
3. To understand and apply operations research techniques to industrial applications
4. To understand Linear Programming concepts
5. To understand sequencing game theory

1 **Introduction to Industrial Engineering:** Relevance & importance of industrial engineering in industry. Productivity Management*:* Productivity measurement and improvement. [3]

2 **Plant Layout & Material Handling***:* Factors affecting plant location, Selection of plant site, Quantitative techniques of plant location decision, Plant layout, Types of layout Principles of layout design, Methods for evaluation of a layout, Quantitative techniques of developing layouts, Manual assembly lines, line balancing problems way to improve line balancing. Group Technology, parts family, parts classification and coding, production flow analysis. Introduction to material handling. [12]

3 **Work study & Ergonomics:** Method study, micro - motion study and principles of motion economy. Work measurement: time study, work sampling, standard data, PMTS. Introduction to ergonomics and its scope in relation to work. [7]

4 **Linear Programming**: Introduction to Operation Research, Problem formulation, Simplex methods, primal & dual problem, dual Simplex, sensitivity analysis. Transportation, & Assignment problems, Dynamic Programming. [12]

5 **Decision & Queuing Theory:** Decision under various conditions. Game Theory, Minimax & Maximin strategies. Introduction to Queuing Models. [6]

Outcome: *The students should be able to:*

1. Understand Concept of Industrial engineering and its role in industry.
2. Be good team member and project leaders to carry out projects in companies.
3. Build and solve Linear programming, Transportation models and assignment models.
4. Develop critical thinking and objective analysis decision making.

Text Books:

1. Khanna O P, "Industrial Engineering and Management", Dhanpat Rai Publications, Latest Edition.
2. Monks J. G, "Production/Operations Management", McGraw Hill, Latest Edition.

3. Taha H. A, “Operations Research – An Introduction”, Prentice Hall India, Latest Edition

Reference Books:

1. Chitale A. K & Gupta R. C, “Product Design and Manufacturing”, McGraw Hill Latest Edition.
2. Sanders M. and Mc Cormic, E., “Human Factors in Engineering”, McGraw Hill, Latest Edition.
3. Work Study, ILO, Geneva, Latest Edition.
4. Curie R, “Introduction to Work Study”, McGraw Hill, Latest Edition.
5. Philips R & Solberg, “Operations Research”, John Wiley, Latest Edition.
6. J K Sharma, Operations Research, Macmillan, 1997

ME 14.415 **Mechatronics** **Total Lecture 40**

Credit 3-1-0-4

Prerequisite(s) EC 14.101

Objective(s)

- *To study the definition and elements of mechatronics system.*
- *To learn how to apply the principles of mechatronics for the development of productive and efficient manufacturing systems.*
- *To study the hydraulic and pneumatic systems employed in manufacturing industry.*

1. **Introduction**: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. **[5]**

2. Review of fundamentals of electronics. Data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs. **[9]**

3. **Drives:** stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer **[6]**

4. **Hydraulic systems**: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. **[8]**

5. **Pneumatics:** production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description **[6]**

6. Description of PID controllers. CNC machines and part programming. Industrial Robotics. **[6]**

Outcome(s)

- *Be able to analyze and design mechatronics system used for automstion.*
- *Demonstrate knowledge on basic electronics used in manufacturing systems.*
- *Be able to design hydraulic systems for automating manufacturing systems.*
- *Be able to design pneumatic systems for automating manufacturing systems.*

Text Books:

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. J. Musa, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012.

Reference Books:

1. G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile and industrial applications, SAE, 1994.
2. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.
3. R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005

ME 14.419 **Non Convectional Energy Resources** **Total Lectures: 40**

Credit: 3-1-0

Prerequisite(s): Nil

Objective(s):

- *To familiarize students with the various renewable energy sources.*
- *Awareness of the potential of renewable energy technologies, for sustainability in particular.*
- *Suitable applications of solar, wind, biomass, hydro, geothermal and ocean energy.*
- *Awareness and development of suitable social and economic models with implications.*

1. **Energy Scenario**
   Energy resources in India and worldwide, energy needs and consumption patterns, social and economic implications, global environmental impact, Kyoto protocol, salient features of renewable energy technologies, pollution control and sustainability, Indian govt. policies and Supreme Court directive on renewable energy, subsidies, incentives and other financial implications, ROI., energy audit, energy optimization, green buildings. **10**

2. **Solar Energy Applications**
   Solar thermal systems: Domestic and industrial water heating, green houses, concentrated solar power (CSP), solar refrigeration and air conditioning, solar appliances- cookers, dryers, desalination of water, turbines.
   Solar photovoltaic systems (PV): Solar cell fundamentals, classification, comparison of silicon, thin film, Building Integrated photovoltaic (BIPV) panel technologies, stand alone and grid – integrated systems including storage and other components, economics. **10**

3. **Wind Energy**
   Fundamentals of wind energy, wind power systems- turbines, site selection and economics. grid connected operation, comparison with other renewable systems. **10**

4. **Other Energy Sources**
   Biomass-Conversions and energy content, mini hydro power plant, advantages and economics, geothermal, ocean tidal, wave and thermal energy, fuel cells, hybrid Systems, energy storage, emerging technologies. **10**

Outcome(s):

- *Identify appropriate renewable technology for application.*
- *Assess the economics and ROI.*
- *Implement concepts of clean development mechanism (CDM) and carbon credits.*
- *Utilize energy management and renewable energy systems in everyday life.*
- *Select ecofriendly, cost effective, energy efficient alternatives to unsustainable practices.*

Text Books:

1. B.H. Khan, "Non-Conventional Energy Resources", Tata McGraw-Hill, Latest Edition.
2. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publication, First Edition

Reference Books:

1. M. M. El-Wakil, "Power Plant Technology", McGraw-Hill, Latest Edition.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

BCA

CA 16. 101 **Computers Fundamentals** **3-0-0-3**

Total Lectures: 40

1. **Introduction to Computers:** Definition, Block Diagram, characteristics, Applications in Modern Society, History, Classification of computers and Generation of computers. [6]
2. **Functional Units of Computer Processing System:** Hardware, CPU, Memory and secondary storage devices, Input devices, Output Devices, Information Concept and Processing: Data, Information, Knowledge and Wisdom. [8]
3. **Data representation:** Representation of Data, Bits and Bytes, Number System: Decimal, Binary, Octal, Hexadecimal, Conversions b/w number system, Arithmetic Operations in Binary Number, ASCII, EBCDIC and BCD Codes. [8]
4. **Software Concepts:** Types of Software, Generation of Programming Language: Machine Language, Assembly Language, High Level Language, Translator: Assembler, Interpreter, Compiler, Operating System**:** Functions, types of operating system: Batch Processing, Multiprogramming, Multiprocessing, Multitasking, Time Sharing and Real Time System, MS-DOS, MS-Windows. [9]
5. **Data Communication and Computer networks:** The Basic Communication System, Data Transmission Modes, Network types, Network Topologies, Internet and its Applications: E-mail, World Wide Web, Intranet, Extranet, Computer Threats: Virus, Worm, Trojan horse, Malware. [9]

Text Books:

1. Sinha , Pradeep K. and Sinha, Priti, “Computer Fundamentals”, BPB Publications, Third Edition.

Reference Books:

1. ITL Education Solutions Limited, “Introduction to Computer Science”, Pearson Education, Third Edition, New Delhi.
2. Rajaraman, V., “Introduction to Computer”, PHI, New Delhi.
3. Thareja, Reema, “Fundamentals of Computers”, Oxford University Press India, Second Edition.

CA 16.102 **Operating System** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Definition and types of operating systems, Batch Systems, multi programming, time sharing, distributed and real-time systems, Operating system structure, Operating System Components and Services, System calls, System Programs, Virtual Machines. [4]
2. **Process Management:** Process Concept, Process States, Process Control Block, Operations with examples from UNIX (fork, exec) and/or Windows, Inter-process communication (shared memory and message passing), Scheduling Algorithms, Performance Evaluation. [7]
3. **Threads:** multithreaded model, scheduler activations, examples of threaded programs. Scheduling: multi-programming and time sharing, scheduling algorithms, multiprocessor scheduling, thread scheduling. [5]
4. **Process synchronization and Deadlocks:** critical sections, classical two process and n-process solutions, hardware primitives for synchronization, semaphores, monitors, classical problems in synchronization (producer-consumer, readers-writer, dining philosophers, etc.). Deadlocks-System model, Characterization, Deadlock prevention, Avoidance and Detection, Recovery from deadlock, Combined approach to deadlock handling. [8]
5. **Memory Management:** Logical and Physical Address Space, Swapping, Contiguous Allocation, paging and segmentation, demand paging, virtual memory, page replacement algorithms. [5]
6. **File Management:** Directory systems, File System Implementation issue, access methods, Allocation Methods, Free Space Management. [4]
7. **I/O Management:** Disk Structure, Disk Scheduling, Disk Management, Control of Various Devices, Device Drivers, Interrupt Driven and Poll Driven Data Transfer. [4]
8. **Security and Protection Mechanism:** Computer Security classification, Authentication, System threats, Goals of Protection, Access Matrix. [3]

Text Books:

1. Silbersachatz A.H. and Galvin P.B., "Operating System Concepts", Pearson Education.
2. Tannenbaum Andrew S., "Operating Systems", PHI, New Delhi

Reference Books:

1. Stallings William, "Operating Systems: Internals and Design Principles", Prentice-Hall, New Delhi
2. Dhamdhere D. M. "System Programming and Operating System", TMH New Delhi
3. Godbole Achyut S, "Operating Systems", TMH, New Delhi

CA 16.103 **C- Programming** **3-0-0-3**

Total Lectures: 40

1. **Introductory Concepts:** Introduction to computers, Computer characteristics, Types of programming languages, Introduction to C, identifiers and keywords, Data types: declaration and definition, Type conversion. [6]
2. **Operators:** Arithmetic, relational, logical, bitwise, unary, assignment, Increment and Decrement operators, conditional operators and their hierarchy, associativity, Data input/output. [8]
3. **Control Structure:** Introduction, Conditional Statements; Simple If-Else; Nested Statements, switch, Loops- For, While, Do-While; Break, Continue, Go-To Statements, Labels, Printf, Scanf function. [7]
4. **Array:** Defining an array, processing an array, passing arrays to functions, Multidimensional arrays, Arrays and strings. [6]
5. **Function and Pointer:** A brief overview, Defining a function, accessing a function, function prototypes, passing arguments to a function, recursion. Pointers: Declaration, operations on pointers, array of pointers, pointers to arrays. [7]
6. **Advance C Concepts:** Structure, Union, storage classes in C, Concept of files file access in different modes, reading from and writing into a file, Library Functions. [6]

Text Books:

1. Kernighan, Brain W. and Ritchie, Dennis M., "The C Programming Language," Second edition 2013, Pearson Education.
2. Gottfried ,Byron S. and Schaum's, "Programming with C," 2nd Edition, Tata McGraw-Hill, 2006.

Reference Books:

1 Schildt ,Herbert, "C: The Complete Reference," Fourth edition, McGraw- Hill Education, 2000.

2 Kanetkar ,Yashwant, "Let us C," Fifth Edition BPB Publication,2006.

3 Balagurusamy , E, "Programming in ANSI C," Tata McGraw-Hill Education.

CA 16. 104 **Data Structures** **3-0-0-3**

Total Lectures: 40

1. **Introduction**: Overview of data structure, types of data structures and operations. Applications of data structures [2]

2. **Pointer and dynamic memory allocation:** Pointer declaration and initialization, accessing a variable through its pointer, meaning and advantages of dynamic memory allocation, Memory allocation functions. [3]

3. **Array:** Representation of single and multidimensional array. [2]

4. **Sorting and Searching Techniques:** Insertion Sort, Selection Sort, Merge Sort, quick sort, Linear Search, Binary Search [8]

5. **Stack :** Definition and representation of stack, operations on stack, Infix, Postfix, Prefix Expressions, Conversion from Infix to Postfix (Algorithms only). [7]

6. **Queue**: Introduction and types of queues, Primitive Operations on Queues. [7]

7. **Linked List:** Introduction to Linked List, implementation of Linked List, operations on linked list: creation, deletion, search and display [7]

8. **Tree:** Introduction and Terminology, Traversal of Binary Trees [4]

Text Books:

1. Schaum Series, "Data Structures", TMH, New Delhi.

Reference Books:

1 Langsam , Augenstein and Tannenbaum, "Data Structure Using C and C++", PHI, New Delhi.
2 Horowithz and Sahani, "Fundamentals of Data Structure", Galgotia Book Source Pvt. Ltd. , New Delhi.
3 Kanitker Y., "Let us C", BPB Publication New Delhi.
4 Balagurusamy, E , "Programming in C", TMH, New Delhi.

CA 16.105 **Management Accounting** **2-0-0-2**

Total Lectures: 26

1. **Basics of Accounting:** Nature of accounting information, accounting principles – concepts and conventions, accounting equation and financial statements – sole trade, corporate entities (P&L account, balance sheet including adjustments). [6]
2. **Computerized Accounting:** Uses of Microsoft Excel in accounting, analyses of balance sheet with Excel, Tally software - application. [2]
3. **Analysis and Interpretation of Financial Statements:** Ratio analysis as a tool of decision-making; fund flow statement, cash flow statement. [5]
4. **Basic Cost Concepts:** Meaning, nature, classification; inventory valuation, marginal costing and its usage in managerial decision-making. [7]
5. **Long Term Financing and Capital Budgeting:** Sources of long term finance- shares, debentures, capital budgeting – types of projects, non-discounted and discounted cash flow techniques – payback period, internal rate of return and net present value method. [6]

Text Books:

1. Maheshwari S.N., Management Accounting & Financial Control, Sultan Chand & Sons, 14th Ed., 2003
2. Bodhanwala R. J., Understanding and Analyzing Balance Sheets Using Excel Worksheet, Prentice-Hall of India, 2004.

Reference Books:

1. Horngren C. T., Sundem G.L. and Stratton W. O., Management Accounting, Prentice-Hall of India, 12th Ed., 2003.
2. Narayan S. R., Financial Accounting- A Managerial Perspective, Prentice-Hall of India, 2004.
3. Banerjee A., Financial Accounting – A Managerial Emphasis, Excel Publishing House, 2004.

CA 16.106 **System Analysis and Design** **3-0-0-3**

Total Lectures: 40

1. **Introduction to system:** Definition, characteristics and elements of system, types of system, System development life cycle, Role of system analyst. [6]

2. **System Planning and Initial Investigation**: Introduction, bases for planning in system analysis, initial investigation, fact finding, information gathering, information gathering tools, fact analysis, determination of feasibility. [6]

3. **Structured Analysis:** Tools of structured analysis: DFD, data dictionary, flow charts, Gantt charts, decision tree, decision table, structured English, pros and cons of each tool. [7]

4. **Feasibility Study**: Objective, types, Steps in feasibility analysis, feasibility report, oral presentation, cost and benefit analysis, classification of costs and benefits. [5]

5. **System Design**: Objective, logical and physical design, design methodologies, structured design, form-driven methodology (IPO charts), structured walkthrough. [6]

6. **Input/ Output and Form Design**: Objectives of input and output design, form design, classifications of forms, requirements of form design. [5]

7. **System Testing and Implementation**: Objectives of testing, test plan, testing techniques/types of system tests, quality assurance goals in system life cycle, System implementation. [5]

Text Books:

1. Awad Elias M, "System Analysis and Design", Galgotia Pub.(P) Ltd.,2nd Edition,2008

Reference Books:

1 Hawayszkiewyez Igor, "Introduction To System Analysis and Design" PHI, New Delhi

2 Mark Lejk and Deeks David , "An Introduction to System Analysis Techniques" PHI, New Delhi.

3 Whitten , Jeffrey L and Lonnie, D Bentey, "System Analysis and Design Methods", TMH. New Delhi

CA 16. 107 **Mathematics** **3-1-0-4**

Total Lectures: 40

1. **Matrix and Determinant:** Definition, types of matrices, addition, subtraction, scalar multiplication and multiplication of matrices, adjoint, inverse, rank of matrix, dependence of vectors, Eigen values and vectors of a matrix, Cayley-Hamilton Theorem (without proof), solution of system of simultaneous equations, definition of determinant, minors, cofactors, properties of determinants. [12]
2. **Differentiation:** : Limit at a point, properties of Limit, computation of limits of various types of functions, continuity at a point, derivative, derivatives of sum, differences, product and quotients, chain rule, derivatives of composite functions, logarithmic differentiation, maxima and minima of functions of single variable. [12]
3. **Integration:** Indefinite integrals, methods of integration substitution, by parts, partial fractions, integration of algebraic and transcedental functions, definite integrals and properties. [8]
4. **Ordinary Differential Equations:** Definition, order and degree of equation, solution of ordinary differential equations of first order and first degree, equations in which variables are separable, homogeneous and reducible to homogeneous equations, linear and reducible to liner equations, exact and reducible to exact equations.. [8]

Text Books:

1. Narayan, Shanti “Integral Calculus”, S. Chand & Company, 19993.

2 Dass, H.K., “Advanced Engineering Mathematics”, S. Chand & Company.

Reference Books:

1 Zill, Dennis G. ,Warren Jones, S. ,Wright and Barlett Learning “Advanced Engineering Mathematics”, Student Edition, Canada,2011

2 Ramana B. V., “Higher Engineering Mathematics”, McGraw Hill, New Delhi,2006.

CA 16. 108 **Digital Electronics** **3-1-0-4**

Total Lectures: 40

1. **Number System:** Binary, octal, Hexadecimal Number, their addition and substraction, Base conversions, Number code: 8421, Other BCD codes, Grey, ASCII, EBCDIC. Boolean Algebra: Laws and theorems of Boolean algebra. De Morgan's theorem, XOR and XNOR gates, Half and Full Adder and Subtractor circuits. [10]
2. **Fundamentals**: Products, Sum of products and Product of sums, Form of Boolean expressions, Truth Tables and Karnaugh maps, pair reads octets and Karnaugh simplification. Mltiplexers BCD to Decimal to BCD decoders and, decoders' characteristics of digital integrated digitals. [10]
3. **Flip Flop:** RS Flip Flop, Clocked, RS Flip Flop, Edge trigger D Flip Flop. Flip Flop Switching time, OK Flip Flop. JK Master Slave Flip Flop, Clock wave forms, Shift registers: Serial in and serial out, Parallel in and parallel out, Counters: Asynchronous counters Synchronous counters, ring counter. [10]
4. **Memories for Digital:** System: Semiconductor Memories, Memory organization and expansion, classification of memories on' the basis of principles of operation, physical characteristics and fabrication technology, ROM and basic memory cells. [10]

Text Books:

1. Moris Mano, "Digital Logic and Computer Design", PHI Publications, 2002
2. R. P. Jain, "Modern Digital Electronics", TMH, 3rd Edition, 2003.

Reference Books:

1. R.L. Tokheim, "Digital Electronics, Principles and Applications", Tata McGraw Hill, 1999.
2. W. Gothman, "Digital electronics", PHI.
3. S. Salivahanan & S. Arivyhgan. "Digital circuits and design", Vikas Publication, 2001

Testing:

- MS Word

Programs:

- Working with Documents.
- Formatting Documents.
- Setting Page style.
- Creating Tables.
- Drawing.
- Tools.
- Printing Documents.

Testing:

- MS Excel

Programs:

- Spread Sheet & its Applications, Opening Spreadsheet, Menus.
- Entering & Deleting Data.
- Setting Formula.
- Formatting Spreadsheets.
- Working with sheets.
- Creating Charts.
- Using Tools.

Testing:

- MS Access

Programs:

- Starting Access, Access Screen, Creating a New Database.
- Creating Tables.
- Working with Forms.
- Creating queries.
- Finding Information in Databases.
- Creating Reports.
- Types of Reports.
- Printing & Print Preview – Importing data from other databases viz. MS Excel etc.

Testing:

- MS Power Point

Programs:

- Creating a presentation.
- Formatting a Presentation.
- Adding Effects to the Presentation.
- Printing Handouts.

Testing:

- One Dimensional Array
- Two Dimensional Array

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of Linked List
- Operations on Linked list

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of stack using array and Link List.
- Operations on stack.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of Queue using array
- Operations on queue.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Searching
- Sorting

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

CA 16.135 **C Programming Laboratory** **0-0-4-2**

1. Introduction to C
Testing:
• Data Types & Operators
• Type Conversions

Programs:
• Significant number of programmes in order to cover all contents of unit 1 (at least 6)

2. Operators
Testing:
• Arithmetic, Relational, logical operators
• Bitwise, unary, assignment operators
• Increment and Decrement operators
• Conditional operators
Programs:
• Significant number of programmes in order to cover all contents of unit 2 (at least 10)

3. Control Structure
Testing:
• If-Else statements
• Nested If-Else statements
• Switch
• Loops- For, While, Do-While
• Break, Continue, Go-To Statements, Labels
Programs:
• Minimum 12 programmes to cover all contents of unit 3

4. Array
Testing:
- Processing an array
- Passing arrays to functions
- Multidimensional arrays
- Strings

Programs:
• Minimum 6 programmes to cover all contents of unit 4

5. Function and Pointer
Testing:
- Function prototypes and passing arguments to a function
- Recursion
- Pointers declaration, operations on pointers
- Array of pointers, pointers to arrays

Programs:
• Minimum 6 programmes to cover all contents of unit 5

6. Advance C Concepts

Testing:

- Structure
- Union
- Storage classes in C
- Reading and writing from/to a file

Programs:

• Minimum 6 programmes to cover all contents of unit 6.

1. Process and Thread Creation

Testing

- Creation of Process and Thread
- Operations with Process

Programs

- A process to be created with structure or class containing parameters like process- id, arrival time, starting time, end time etc.

2. CPU Scheduling Algorithms

Testing

- Average Waiting Time
- Average Turnaround Time
- Response Time
- Multithreading

Program

- FCFS (with and without arrival time)
- SJF (Preemptive and non-preemptive)
- Round Robin (with and without context switch time)
- Priority scheduling (With and without arrival time)
- Demonstrating time sharing

3. Memory Management Techniques

Testing

- External Fragmentation
- 50% Rule for Fragmentation

Program

- First Fit
- Best Fit
- Worst Fit.

4. Page Replacement Algorithms

Testing

- Belady's Anomaly
- No. of page hits and misses

Program

- FIFO
- LRU
- Optimal Page Replacement Algorithm

5. Deadlock

Testing

- Safety algorithm
- Request algorithm

Program

- Deadlock Avoidance (Banker's Algorithm) for multiple instances of different resource types.
- Deadlock Detection Algorithm for multiple instances of different resource types.

6. I/O

Testing

- Disk Scheduling

Programs

- FCFS algorithm
- Scan algorithm
- C-Scan algorithm

CA 16. 201 **Computer Architecture** **3-1-0-4**

Total Lectures: 40

1. **Design of Simple Computer**: Micro Operation, Macro Operation, Bus and Memory Transfers, Arithmetic and Logic Micro Operations, Shift Micro Operation, Instruction and Instruction Types. [8]
2. **Instruction Cycle**: Timing and Control Instruction Cycle, Memory Reference Instructions, Input Output and Interrupts, Machine Language Instructions. [5]
3. **Computer Arithmetic**: Hardware algorithm and implementation for Addition, Subtraction, multiplication and division operations, floating point arithmetic operations. [6]
4. **Central Processing Unit**: General Register Organization, Stack Organization, Addressing Modes, Risc vs Cisc Pipeline and Vector Processing, Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Risc Pipeline, Pipeline Difficulties. [8]
5. **Input Output Organization**: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Programmed I/O, Interrupt I/O Direct Memory Access. [5]
6. **Memory Organization**: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative, Cache Memory, Virtual Memory and Memory Management Hardware. [8]

Text Books:

1. Mano Morris, M., "Computer System Architecture", 3rd edition, Pearson.
2. Stallings William , "Computer Organization and Architecture", 9th Edition, Pearson

Reference Books:

1. Hwang Kai and Jotwani ,Naresh, "Advanced Computer Architecture", 2nd Edition, Tata McGraw Hill.
2.Blanchet ,Gérard, Dupouy, Bertrand, "Computer Architecture", 1st Edition, Wiley Publication.

CA 16.203 **Database Management System** **3-0-0-3**

Total Lectures:40

1. **Introduction**: An Overview of Database Management System, Comparison of Database System and File System, Characteristics of Database Approach, DBMS Architecture, Data Models, Schema and Instances, Data Independence. Data Modeling Using Entity Relationship Model: Entity, Entity Types, Entity Set, Notation for ER Diagram, Attributes and Keys, Concepts of Composite, Derived and Multivalued Attributes, Super Key, Candidate Key, Primary Key, Relationships, Relation Types, Weak Entities, Inheritance, Specialization and Generalization. [10]

2. **Relational Data Model:** Relational Model Terminology: Domains, Attributes, Tuples, Relations, Characteristics of Relations, Relational Constraints: Domain Constraints, Key Constraints, Relational Database Schema, Relational Database Design By ER To Relational Mapping. Introduction to SQL. [11]

3. **Normalization:** Functional Dependencies, Armstrong's Inference Rule, Normal Form up to Boyce Codd Normal Form. [4]

4 **Relational Algebra:** Selection, Projection, Set Theoretic Operations Union, Intersection, Set Difference And Division, Inner, Outer, Left Outer, Right Outer and Full Outer Join. [8]

5. **Transaction Processing And Concurrency Control:** Definition of Transaction, Desirable ACID Properties, Serializable And Non Serializable Transactions, Concurrency, Lost Update, Dirty Read, Concurrency Control Techniques: Locking, 2PL [7]

Text Books:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, 7th Edition, 2015.

Reference Book:

1. Jeffrey A. Hoffer, Mary B. Prescott and Fred R. McFadden, "Modern Database Management", Prentice Hall, 8th Edition, 2006.

2. Avi Silberschatz , Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2011.

CA 16. 204 **Computer Networks** **3-1-0-4**

Total Lectures:40

1	**Introduction:** Computer networks; Network topologies, protocols and standards, Network devices: repeaters, bridges, gateway, Routers; categories of networks- LAN, WAN and MAN.	[7]
2	**OSI and TCP/IP Model:** Layers and their function, OSI reference model, TCP/IP model, Comparison of models.	[5]
3	**Physical layer:** Transmission Media: guided and unguided; Attenuation, Distortion, Noise, Propagation, Switching, ISDN & its service, Multiplexing: Time division & frequency division multiplexing	[8]
4	**Data Link Layer:** Functionality, Design Issue, Error Detection & Correction Codes, MAC, Static & Dynamic Channel Allocation, Introduction to IEEE standards.	[6]
5	**Network Layer:** Routing Algorithms, Flooding, Broadcast & Multicast routing, congestion Control & internetworking, Quality of services	[7]
6.	**Application Layer :** Network Security & Privacy, Data Compression & Cryptography, Electronic Mail, The WWW, Multimedia, Audio, Video, DNS, FTP, HTTP, SMTP, telnet etc.	[7]

Text Book

1. Tanenbaum A. S., "Computer Networks", Prentice-Hall of India, 4th Ed., 2002.
2. Stallings W., "Data and Computer Communications", Prentice-Hall of India, 5th Ed., 2003.

References Books

1. Forouzan B. A., "Data Communications and Networking", Tata McGraw-Hill, 3rd Ed., 2004.
2. Hayes J. F., "Modeling and Analysis of Computer Communication Networks", Khanna Publishers, 1987.

CA 16. 205 **Management Information System** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Elements, characteristics, objectives and importance, relationship between MIS and Computer, role of MIS in the functions of management. [7]

2. **Information Concept:** Classification of information, levels of information, techniques of data collection, quality aspect of information, value of Information. [7]

3. **Decision Making:** Decision making concepts, rationality in decision making, decision support system, MIS as a technique for programmed decisions, structured Vs Un-structured decisions, formal vs. informal systems, model of decision making, methods, MIS and role of decision making. [8]

4. **Manager and Computers:** Database concept, database models, database design, RDBMS, MIS and RDBMS, network topology, LAN, MAN, WAN and data communication. [6]

5. **Development of MIS:** Strategic and project planning for MIS, conceptual system design, detailed design, implementation, evaluation and maintenance of the MIS, pitfalls of MIS. [6]

6. **Applications of MIS:** MIS for marketing, financial, production management, human resource management. [6]

Text Books:

1. Jawadekar,W. S. "Management Information System", Tata McGraw- Hill Publishing Co. Ltd., New Delhi

Reference Books:

1 Murdick, R, G, Ross J E and Clagget, J,R, "Information Systems for Modern Management", PHI, New Delhi

2 Sadagopan, "Management Information System", PHI, New Delhi.

3 Parker, Case Thomas, "Management Information System: Strategies and Action", Tata McGraw- Hill Publishing Co. Ltd., New Delhi

CA 16. 206 **Computer Graphics** **3-1-0-4**

Total Lectures:40

1	**Basic Concepts:** Application Areas of Computer Graphics, Graphical User Interface, RGB Color model, CMY color models, Advantages of Computer Graphics.	[8]
2	**Graphics Hardware:** Random Scan Displays, Raster Scan Display (with Introduction to Flickering, Interlacing, American Standard Video), Color CRT Monitors, Flat Panel Display (Plasma Panel, Liquid Crystal Display, Electroluminescent Display).	[7]
3	**Raster Graphics Algorithms:** Line Drawing Algorithms-DDA, Bresenham's Algorithm, Circle and Ellipse Drawing Algorithms, Filling (Scan-Converting Polygon Filling, Inside Outside Tests Boundary Fill and Area Fill Algorithm). Cohen- Sutherland Algorithm of clipping	[12]
4	**Transformations:** 2-D Transformations (Rotation, Reflection, Shearing, Scaling), Homogeneous Coordinate Representation, and Translation.	[8]
5	**Animation Introduction:** Conventional and Computer-Assisted Animation, Animation languages, methods of controlling Animation, basic rules of Animation.	[5]

Text Books:

1. Zhigang X. and Plastock R.A., “Theory and Problems of Computer Graphics (Schaum's Outline)”, Tata Mc Graw Hill, New Delhi.

Reference Books:

1 Hearn Donald D. and Baker M.Pauline, “Computer Graphics” , Prentice Hall India, New Delhi.

2 Krishnamurthy N, “Introduction to Computer Graphics”, Tata Mc Graw Hill Edition, New Delhi.

CA 16. 207 **C++ Programming** **3-0-0-3**

Total Lectures:40

1. **Object Oriented Programming:** Basic concepts of object–oriented programming, Structured versus object- oriented programming, merits and demerits of object oriented methodology. [5]

2. **Beginning with C++:** Preprocessor directives, Variables, data types, constants, operators, scope resolution operator, memory management operators, decision and loop control structures, arrays, strings, functions. [7]

3. **Classes and Objects:** Class definition, Structure versus class, accessing member functions within a class, data hiding, arrays within a class, static data and member functions, objects, friend functions and friend classes, constant member functions, pointers to members, constructors and destructor. [8]

4. **Overloading and Exception Handling:** Definition, unary operator overloading, binary operators overloading, overloading of new and delete operators, manipulation of string using operators, type conversion, overloading with friend functions, function overloading, error and exception handling. [8]

5. **Inheritance and Overriding:** Derived and base classes, type of inheritance, derived class constructors and destructor, overriding member functions, public and private inheritance, virtual base classes, abstract classes, this pointer, virtual functions and pure virtual functions, static and dynamic bindings. [8]

6. **Introduction of I/O Streams and the Standard Library:** Header files, I/O stream library, stream I/O for objects, file I/O. [4]

Text Books:

1. Lafore Robert, "Object-Oriented Programming in C++", 4th edition, SAMS.
2. Balagurusamy E., "Object Oriented Programming With C++", 6th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Reference Books:

1 Stroustrup Bjarne,"Programming -Principles and Practice Using C++", Addison-Wesley.

2 Schildt Herbert, "C++: The Complete Reference", 4th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

CA 16. 208 **Electronic Commerce** **3-0-0-3**

Total Lectures:40

1. **Electronic Commerce**: Overview and Scope, Traditional Commerce vs. Electronic Commerce, Impact of E-Commerce, Electronic Markets, Internet Commerce, e-commerce in perspective, Application of E Commerce in Direct Marketing and Selling, advantages and disadvantages, and future of E-commerce. [9]

2. **Business strategy in an Electronic Age:** Value Chains, Supply chain, Porter's value chain Model, Inter Organizational value chains, Strategic Business unit chains and industry value chains. [7]

3. **Business to Business E-Commerce**: Inter-organizational Transitions, Credit Transaction Trade Cycle, a variety of transactions. Electronic Data Interchange (EDI): Introduction, Benefits of EDI, EDI Technology, EDI standards, EDI Communication, EDI Implementation, EDI agreement, EDI security. [9]

4. **Electronic Payment System:** Introduction, Online Payment System, Prepaid Electronic Payment System, Post Paid Electronic System, E-Cheques, Credit Cards, Smart Cards, E-Purses, Debit Cards, Legal Risk of E-Payment System. [8]

5. **Securing Network Transaction:** Security Policy, Procedures and Practices, Transaction Security, Cryptography Algorithm, Public Key Algorithm, Authentication Protocol, Digital Signature, E-Mail Security. [7]

Text Books:

1. Whitely David, "E-commerce Strategy, Technology and application", Tata McGraw Hill Publications, New Delhi.

Reference Books:

1 Kalakota ,R. and Whinston, A. B. "Readings in Electronic Commerce", Addison Wesley.
2 Schneider, Gary P. and Perry ,Jame, "Electronic Commerce" Thomson Publication.
3 P.T. Joseph, S.J., "E-Commerce An Indian Perspective", PHI.

CA 16. 209 **Discrete Mathematics** **3-1-0-4**

Total Lectures:40

1. **Progressions:** Arithmetic Progression, Arithmetic mean, Harmonic Progression Harmonic mean, Geometric Progression, Geometric mean. [6]

2. **Set Theory:** Definition of Sets, Subsets, Cardinality of Sets, types of sets: Equal Sets, Universal Sets, Finite and Infinite Sets, proper set, power sets, Operations on Sets: Union, Intersection, Complement of Sets, set difference, Cartesian Product, Venn Diagrams, and Algebra of sets, duality, counting principle. [10]

3. **Relations and Functions:** Definition, types of relation, Ordered Pairs, properties of relation, equivalence relations, partial ordering relation. Function: Domain and Range, Onto, Into, and One to One Function, Composite and Inverse Functions. [8]

4. **Prepositional Calculus:** Propositions, Logical Connectives: conjunction, disjunction and negation, Truth Tables, Tautologies and Contradictions, Conditional and Bi-conditional statements. [8]

5. **Group Theory:** Definition of a group, properties of group, different types of group, subgroup, finite, infinitely, countable and Cyclic Groups. [8]

Text Books:

1. Lipschutz, Seymour and Lipson, Mar c “Discrete mathematics”, Tata Mc Graw-Hill Publications, Second Edition.

Reference Books:

1 Rremblay, J.P. and Manohar, R., “Discrete Mathematical Structures with Applications to Computer Science”, The McGraw Hill Companies.
2 Ross, Kolman Busby, “Discrete Matheamatical Structures”, Prentice Hall International.
3 Vasishtha, A. R., “Abstract Algebra” , KRISHNA Prakashan Media (P) Ltd.

CA 16. 210 **Java Programming** **3-1-0-4**

Total Lecture:40

1. **Basic Concepts:** Importance of Java, Java Byte code, Java and HTML, the Java buzzwords, using blocks of code, lexical issues, Java Class Libraries. [4]
2. **Java Programming:** Constants, Variables, Data Types, Operators, Type Conversion in Expression, Mathematical Functions, Decision Control Structure, Loop Control Structure, Arrays. [8]
3. **Classes:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, the this keyword, garbage collection, the finalize () method, overloading methods, using objects as parameters, returning objects, recursion, introducing access control, understanding static, introducing final, arrays revisited, introducing nested and inner classes, exploring the string class, using command-line arguments, Vector, Wrapper Classes. [5]
4. **I/O and String Handling:** I/O basics, reading console input, writing console output, the PrintWriter class, reading and writing files, string constructors, string length, special string operations, character extraction, string comparison, searching strings, modifying a string, data conversion using valueOf (), changing the case of characters within a string, StringBuffer. [6]
5. **Inheritance:** Inheritance basics, using super, create a multilevel hierarchy, constructors, method overriding, dynamic method dispatch, abstract classes, final with inheritance, object class. [5]
6. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, creating your own exception subclasses, using exceptions. [7]
7. **Applet Programming:** Applet life cycle, Creating executable application, Designing a web page, Applet Tag, Parameter passing in applets, Graphic Class, lines, rectangles, circle and ellipse, polygons. [5]

Text Books

1. Herbertz Shildt ,"Java The Complete Reference,", 7th ed.,TMH, New Delhi
2. Balagurusamy E, "Programming With Java " , TMH, New Delhi

Reference Books

1. Borror A. B., "Object-Oriented Programming with Java-an ultimate Tutorial", Dreamtech Press, 2000.
2. Budd T., "Understanding Object-Oriented Programming with Java", Pearson Education Asia, 2001.
3. Arnold K., Gosling J. and Holmes D., "The Java Programming Language", Addision-Wesley, 3rd ed., 2000.

CA 16.233 Database Management System Laboratory 0-0-4-2

Unit 1: Basic Commands

Testing: Create Table, Insert, Update, Alter, Delete, Where

Queries based on the above elements.

Unit 2: SQL Scalar functions

Testing: UCASE, LCASE, MID, LEN, NOW

Queries based on the above elements.

Unit 3: Aggregate functions

Testing: Max, Min, Sum, Count, Avg , First, Last

Queries based on the above elements.

Unit 4: Clauses

Testing: Distinct, Alias, Order by, Group by, Having

Queries based on the above elements.

Unit 5: Logical Operators

Testing:

OR, AND, Not, Between, Like, All, Any

Queries based on the above elements.

Unit 6: SQL Constraints

Testing: Not NULL, Check, Primary Key, Foreign Key, Cascade delete, Default

Queries based on the above elements.

CA 16. 234 **Internet Laboratory** **0-0-4-2**

UNIT I: Evaluate e-mail software and Web-based e-mail services

Testing: Mail configuration on different mail sites

Programs:

- Main features of e-mail and how it works
- Describe the Thunderbird and Opera e-mail clients
- Describe and use Web-based e-mail services
- Configure and use Outlook Express to send, receive, and print e-mail messages
- Create and maintain an address book in Outlook Express
- Configure and use Hotmail to send, receive, and print e-mail messages
- Create and maintain an address book in Hotmail

UNIT II: Use search engines and directories effectively

Testing: Web search tools **(**google, Google Scholar, DuckDuckGo**,** Metasearch engines**)**

Programs:

- Determine whether a research question is specific or exploratory
- How to formulate an effective Web search strategy to answer research questions
- Uses of Web search engines, Web directories, and Web meta search engines effectively
- Use Boolean logic and filtering techniques to improve your Web searches
- Use advanced search options in Web search engines
- Assess the validity and quality of Web research resources
- Describe the future of Web search tools

UNIT III: Use FTP and other services to transfer and store data

Testing: File Transfer Protocol

Programs:

- Describe what FTP is and how it works
- Demonstrate how to use an FTP client program and Web browser to transfer files
- Demonstrate navigation of an FTP site using a Web browser
- Demonstrate how to compress and decompress files and how to check them for viruses
- Download an FTP client program using a Web browser
- Install and use a compression program
- Trace the connection between your computer and a remote computer

UNIT IV: Important features of electronic commerce

Testing: E-Business

Programs:

- Important sites that conduct electronic commerce
- Basics of electronic commerce
- How companies generate revenues online
- Companies reduce costs and improve operational efficiency using Internet technologies
- New ways of doing business on the Web such as online auctions etc.
- International, legal, and ethical concerns for electronic commerce

CA 16. 235 **C++ Programming Laboratory** **0-0-4-2**

1. Introduction to C++
Testing:
• Data Types & Operators
• Control Statements
• Arrays
Programs:
• Significant number of programmes in order to cover all contents of unit 1 (at least 6)

2. Classes and Object
Testing:
• Class with function printing hello
• Class with default constructor
• Class with parameterized constructor
• Destructor
• Static and constant data
Programs:
• Apt number of programmes preferably based upon real life examples hotel billing, fee submission etc. (at least 6)

3. Inheritance and Polymorphism
Testing:
• Inheritance
• Function Overloading
• Operator overloading
• Overriding
• Comparisons between private, public and protected
• Virtual function and virtual class
• This pointer
• Exception handling
• Abstract class
Programs:
• Minimum 12 programmes to cover all contents of unit 3

4. I/O handling
Testing:
• Reading and writing from/to a file
• Output formatting
Programs:
• Programmes related with basic file operations (at least 5)

CA 16.236 Java Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types & Operators
- Control Statements
- Arrays

Programs

- Apply logic to print different patterns(at least 3)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- Implementing matrix operations
- Searching and Sorting

2. Classes, Object & Inheritance

Testing

- Objects and reference variables
- Constructors and parameterized constructors
- this, static, command line arguments
- Inheritance, overloading and overriding
- super, abstract classes and Dynamic method dispatch

Programs

- Write a program to illustrate super .
- Show method overloading to calculate the area of different shapes.
- Manipulate the above program to illustrate run time polymorphism.

3. I/O and String Handling

Testing

- Reading console input and writing console output
- BufferedReader class and PrintWriter class
- String operations and comparisons

Program

- Write a program to print the last characters of all the strings given from command line
- Change the case of characters within a string.
- Write an applet to print "HELLO"**.**

4. Package, Interfaces and Exception Handling

Testing

- importing packages
- interfaces and multiple inheritance
- exception-handling fundamentals
- built-in exceptions and creating one's own exception subclasses

Programs

- Write and execute a program which is inside a package "MyPacK".
- Write a program which imports a package.
- Write a program in which implements the concept of multiple inheritance.
- Write a program that handles two Exceptions, each at different run.

- Write a program in which an user defined exception is created.

5. Applet

Testing

- Applet Life Cycle
- Applet tag

Programs

- Write an applet to print “HELLO”**.**
- Write an applet to print different shapes.
- Write an applet to which works according to values passed through html page.

CA 16.301 **Web Technology** **3-0-0-3**

Total Lectures: 40

1. **Introduction:** Clients, Servers, and Communication, The Internet Basic Internet Protocols, The World Wide Web, HTTP request message, response message, Web Clients Web Servers. [5]

2. **HTML:** HTML Document, Markup Tags (HTML, HEAD, TITLE, BODY, PRE, LIST, HR, BR), Formatting Tags (MARQUEE, BOLD, ITALICS, SUBSCRIPT), Linking, URL, Relative Path Vs Absolute Path names, Images, Tables, Frames, Form Elements (Text, Buttons, List, Reset, Submit, Radio buttons, Checkbox); DHTML: Cascading Style sheets, Dragging, Dropping, Layers, Div tag. [8]

3. **JavaScript:** Declaration and Expressions, Control Structure and Functions, Variable scope Global Vs Local, Object in Java Script: Properties and Methods, Array Object, Date Object, Math Object, String Object, Events in java Script: Onblur, Onclick, on change, on focus, Design of Interactive forms; [9]

4. **VBScript:** Fundamentals, Variables, String, Constant, Date and Time, Arrays, control Structure, Design making, looping, Sub procedure, Object Methods and events, data validation. [7]

5. **XML:** Overview, Comparison of XML and html, components of XML, XML document, XML declaration, Root element, An empty element, attributes, Markup Delimiters, Element Mark Up, Attribute Mark Up, Naming Rules, Character References, Predefined Entities, Entity References, Cdata Sections, Processing Instructions, Document Type Declaration, Welformed and Valid Document, DTD and Validation, Internal DTD Subset, External DTD, Developing DTD, Elements and Attributes Of DTDs:- Empty Element, Only Element, Mixed Elements, Any Element, Creating a valid document from a DTD. [11]

Text Books:

1. Young M .L, " Internet Millenum Edition" TMH, New Delhi.
2. Jackson Jeffrey C., "Web Technologies -A Computer Science Perspective", Pearson Education, 2006.

Suggested Reading

1. Noel Jerkr, " Techunedia VB Scraper VB Script Interleave course", New Delhi 1998
2. Marlin Webb, "Java Scraper, Instant JavaScript", Tata McGraw-Hill, New Delhi.
3. Eathier Kay and Houser Alan **,** **"**XML programming in 2 ½ days," IDG Books India (P) Ltd

CA 16. 303 **Software Engineering** **3-0-0-3**

Total Lectures: 40

1. **Introduction:** Software Characteristics, Components and Applications, Software Engineering a layered Technology, Software life cycle models, Waterfall, Prototype, Evolutionary and Spiral Models. [8]

2. **Software Project Management:** Basic Concepts, Project Management: Core functions, support functions, Project Integration Management. [8]

3. **Software Project Planning:** Objectives, decomposition techniques: software sizing, problem based estimation, lines of code based estimation, and function point based estimation, process based estimation, Cost Estimation Models:- COCOMO, Risk Management. [8]

4. **Software Design:** Design Principles, Design Concepts:- abstraction, refinement, modularity, software architecture, structured partitioning, information hiding, effective Modular Design:- functional independence, cohesion and coupling, Object Oriented analysis and Design. [8]

5. **Software Testing:** Testing Fundamentals, Design of Test Cases, White box testing, Basis Path testing, Control structure Testing, Black box testing. [8]

Text Books:

1. Pressman R.S., "Software Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference Books:

1 Jalote Pankaj,"An Integrated Approach to Software Engineering", NAROSA.
2 Sommerville, Ian "Software Engineering", Pearson Education
3 Fairely, R.E., "Software Engineering Concepts", McGraw-Hill

CA 16. 304 **Multimedia Technology** **3-0-0-3**

Total Lectures: 40

1. **Overview** - Multimedia - Definitions, Basic properties, Temporal and non-temporal medium, Multimedia applications, Uses of Multimedia, Stages of multimedia project, requirements to make good multimedia, Multimedia skills and training.

[6]

2. **Multimedia-Hardware and Software**: Production Platforms, Hardware Peripherals, Connections, Memory and Storage devices, Media software tools, Multimedia Authoring tools, Production Standards.

[8]

3. **Multimedia building blocks**: Audio, basic sound concepts, music, speech, MIDI versus digital audio, audio file formats, sound for the web, images and graphics-basic concepts, Digital video production and editing techniques, animation-basic fundamentals, Kinematics, morphing , animation s/w tools and techniques, animation for the web.

[10]

4. **Data Compression:** Need of Compression techniques, Difference of lossless/lossy compression techniques. Storage space and coding requirements, classification of coding, compression techniques-JPEG and MPEG.

[9]

5. **Multimedia and Internet:** HTML and web authoring, Multimedia considerations for Internet, Design considerations for web pages ,Web Browsers, Web page makers and editors, Media Communication, Media Consumption, Media games.

[7]

Text Book:

1. Steinmetz R., and Nahrstedt K., Multimedia - Computing, Communications and Applications, Pearson Education Asia, 2nd Ed., 2003.

References Books:

1. Buford J. F. K., Multimedia System, Addison-Wesley, 3rd Ed., 1994.
2. Vaughan T., Multimedia - Making it Work, Tata McGraw-Hill, 3rd Ed., 2002.

Testing:

Flash editor and toolbox.
Frames and key frame concepts
Color schemes

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using shape tween and motion tween.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

concept of layers
Understanding guide ,mask layer.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using symbols (movie clip, graphic and buttons) and library.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation of text morphing.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Flash editor and toolbox.
Frames and key frame concepts
Color schemes

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using shape tween and motion tween.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

concept of layers
Understanding guide ,mask layer.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using symbols (movie clip, graphic and buttons) and library.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation of text morphing.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Markup Tags
Formatting Tags
Frames
Form Elements

Programs:

Design web pages based on above Tags.
Design and formatting a form based on form elements

Testing:

Cascading Style sheets
Dragging
Dropping
Div tag.

Programs:

Based on above CSS formatting on HTML scripts.

Testing:

Java Script Declaration and Expressions
Control Structure and Functions
Java Script: Properties and Methods
Array Object
Date Object
Math Object
String Object
Events in java Script: Onblur, Onclick, on change, on focus.

Programs:

Form validation through JavaScript
Program for Event handling
Working with Date and Time Functions
Program for calculator

Testing:

VBScripts String
Date and Time
Arrays
Control Structure
Looping
Methods and events
Data validation

Programs:

Form validation through VBScript
Program for Event handling
Working with Date and Time Functions

Testing:

XML components
DTD
Creating a Valid Document from a DTD

Programs:

Basic XML Document
Access XML document elements through programs

CA 17. 208 **Electronic Commerce** **3-1-0-4**

Total Lectures:40

1. **Electronic Commerce**: Overview and Scope, Traditional Commerce vs. Electronic Commerce, Impact of E-Commerce, Electronic Markets, Internet Commerce, e-commerce in perspective, Application of E Commerce in Direct Marketing and Selling, advantages and disadvantages, and future of E-commerce. [7]

2. **Business strategy in an Electronic Age:** Value Chains, Supply chain, Porter's value chain Model, Inter Organizational value chains, Strategic Business unit chains and industry value chains. [6]

3. **Business to Business E-Commerce**: Inter-organizational Transitions, Credit Transaction Trade Cycle, a variety of transactions. Electronic Data Interchange (EDI): Introduction, Benefits of EDI, EDI Technology, EDI standards, EDI Communication, EDI Implementation, EDI agreement, EDI security. [7]

4. **Electronic Payment System:** Introduction, Online Payment System, Prepaid Electronic Payment System, Post Paid Electronic System, E-Cheques, Credit Cards, Smart Cards, E-Purses, Debit Cards, Legal Risk of E-Payment System. [8]

5. **Securing Network Transaction:** Security Policy, Procedures and Practices, Transaction Security, Cryptography Algorithm, Public Key Algorithm, Authentication Protocol, Digital Signature, E-Mail Security.

6. **Case Study:** Different case studies of E commerce [5]

CA 17. 362 **Knowledge Management** **3-1-0-4**

Total Lectures: 40

1. **Introduction:** Definition, Evolution, Types, Implication for Knowledge Management [6]

2. **Life Cycle:** Challenges, Difference, Knowledge management system Life Cycle, Comparative Studies Between SDLC and Knowledge Management System Development, Role of Knowledge Developer. [8]

3. **Knowledge Creation and Architecture:** Knowledge Codification, Need of Codification, and Knowledge Tools for Codification, Developer Skills Set. [9]

4. **Knowledge Transfer and Internet:** Internet and Knowledge, E-Business, Ethical and Legal Issues in Knowledge Management. [8]

5. **Executive Information and support Systems**: Business Expert System and AI, OLTO & OLAP; Data Warehousing; Data Marts, Data Warehouse architecture; Tools for data warehousing. [9]

Text Books:

1. Awad, Elias M., "Knowledge Management", TMH, New Delhi

Reference Books:

1 Inmon, W. H., "Building Data Warehousing", Wiley, New Delhi

2 Han, Jiawei, Kamber, Michelinal, "Data Mining Concepts & Techniques", Harcourt India, New Delhi

CA 17. 363 **System Software** **3-1-0-4**

Total Lectures: 40

1. **Overview:** Language processors, data structures for language processors, assemblers, macros and macro processors, compilers, interpreters, linkers and loaders. [5]

2. **Operating System:** Functions of Operating System, Kernel, Shell, Process, Process state diagram, System Calls. [5]

3. **Assemblers:** Design of an assembler ,one pass and two pass Assembler, Databases of Assemblers, table processing [7]

4. **Macro Processors:** Importance of Macro, Macro Definition, Macro call, Macro Expansion, Conditional Macro expansion, Nesting of Macros, Functions of Macro Processor . [8]

5. **Loaders and Linkers:** Function of Loaders, loader schemes - compile and go, general, absolute, subroutine linkages, relocating loaders, direct linking loaders, binders, linking loaders, overlays, dynamic binders. [9]

6. **Compilers :** Types of Compilers, Phases of compiler design, recursion, call and return statements. [6]

Text Books:

1. Donovan J.J., "Systems Programming", New York, Mc-Graw Hill, 1972.

Reference Books:

1 Leland L Beck,"System Software, An Introduction to System Programming", Pearson Education, 13th Indian Reprint, New Delhi, 2003.

2 Dhamdhere, D.M., "Introduction to Systems Software", Tata Mc-Graw Hill 1996.

CA 17. 364 **Artificial Intelligence** **3-1-0-4**

Total Lectures: 40

1. **Overview of A.I.:** Introduction to AI, Importance of AI, AI and its related field, AI techniques.

[4]

2. **Problem space and search**: Defining the problem as a state space search, Production system and its characteristics, Issues in the design of the search problem.

[5]

3. **Heuristic search techniques** : Generate and test, hill climbing, best first search technique, problem reduction, constraint satisfaction

[6]

4. **Game Playing** : Minimax , alpha-beta pruning.

[4]

5. **Predicate logic**: Definition, representation of simple facts in logic, well formed formula, resolution.

[8]

6. **Knowledge representation**: Definition and importance of knowledge, Knowledge representation, Various approaches used in knowledge representation, Issues in knowledge representation.

[8]

7. **Learning:** Introduction learning, Types of learning, Introduction to neural networks.

[5]

Text Book:

1. Rich Elaine and Knight Kevin , Artificial Intelligence, Tata McGraw – Hill, 3rd edition, 2012

Reference Books:

1. Russell Stuart and Norvig Peter, Artificial Intelligence: A Modern Approach, Prentice Hall; 3 edition,2009

2. Patterson D.W., "Introduction to AI and Expert Systems", PHI, 1999

CA 17.365 **Internet Technologies** **3-1-0-4**

Total Lectures: 40

1.	**Introduction:** Layering, TCP/IP Layering, Internet Addresses, The Domain Name System, Client Server Model, Port Numbers, Implementations and Application, Programming interfaces.	05
2.	The Link Layer Ethernet and IEEE 802 Encapsulation Trailer Encapsulation, **SLIP:** Serial Line IP, Compressed SLIP, **PPP**: Point-to-Point Protocol.	04
3.	**IP**: The Internet Protocol, IP Header, IP Routing, Subnet Addressing, Subnet Mask, Special Case IP Addresses.	06
4.	**Introduction to ARP**: Address Resolution Protocol and RARP: Reverse Address Resolution Protocol, ARP Packet Format, Proxy ARP, RARP Packet Format.	07
5.	**ICMP**: Internet Control Message Protocol Introduction, ICMP, Message Types, ICMP Address, Mask Request and Reply , IP Routing, Routing Principles, Introduction to Dynamic Routing; **UDP**: User Datagram Protocol UDP Header, UDP Checksum; **DNS**: The Domain Name System DNS Basics, DNS Message Format, security.	10
6.	**TCP**: Transmission Control Protocol TCP Services, TCP Header TCP Connection, Establishment and Termination, TCP Timeout and Retransmission, Repacketization; Telnet and Rlogin Remote Login Rlogin Protocol, SMTP Protocol; **FTP**: File Transfer Protocol and SMTP: Simple Mail Transfer Protocol.	08

Text Books:

1. Tannenbaum A. S., “Computer Networks”, Prentice-Hall India. New Delhi
2. Forouzan Behrouz A, “Data Communication and Networking”, TMH, New Delhi

Reference Books:

1 Sybex, “Networking Complete”, BPB Publication, New Delhi

2. Stallings Willam, “Data and Computer Communication”, Pearson Education, New Delhi

CA 17. 366 **Information Security** **3-1-0-4**

Total Lectures: 40

1.Introduction: Information, Characteristics of Information, Security Attacks, NSTISSC security model, Concepts of Policies; procedures; Guidelines and Standards. [8]

2.Cryptography: Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, Public key cryptography principles, public key cryptography algorithms, digital signatures, digital Certificates. [10]

3.IP Security: IP Security Overview, Architecture, Authentication Header, Encapsulation Security Payload, Combining Security Association, Key Management, Pretty Good Privacy, S/Mime and Types. [7]

4.Web Security and E-Commerce: Web Security Requirement, SSL and Transport Layer Security, Secure Electronic Transactions, Introduction to E-Commerce, Transactions on E-Commerce, Requirement of Security on E-Commerce. [7]

5. System Security: Recognized Security Threats, Virus, Trojan horse, Worm, Spyware, Adware, Key Logger, Denial of Services, Firewall Design Principles, Trusted Systems, Common criteria for information technology security and evaluation. [8]

Text Book:

1. William Stallings ,"Cryptography and Network Principles and Practice", Fourth Edition, , Pearson.

2. William Stallings, "Network Security Essentials (Applications and Standards)" Pearson.

Reference Books:

1. Forouzan, Mukhopadhyay ,"Cryptography & Network Security", , McGrawHill
2. Godbole "Information Systems Security", , Wiley-India
3. Shah Deven "Information Security Principles and Practice", , Wiley-India

CA 17.367 **Network Security** **3-1-0-4**

Total Lectures: 40

1 **Introduction:** Attacks, Services and Mechanisms, Security Attacks, Security Services, Integrity check, digital Signature, authentication, has algorithms. [3]

2 **Secret Key Cryptography:** Block Encryption, DES rounds, S-Boxes IDEA: Overview, comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB, CBC, OFB, CFB, Multiple encryptions DES. [8]

3 **Hash Functions and Message Digests:** Length of hash, uses, algorithms (MD2, MD4, MD5, SHS) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages. digest computation.) SHS: Overview, padding, stages. [7]

4 **Public key Cryptography:** Algorithms, examples, Modular arithmetic (addition, multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption. Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures [7]

5 **Authentication:** Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs offline guessing, storing. Cryptographic Authentication: passwords as keys, protocols, KDC's Certification Revocation, Interdomain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution, smart cards, biometrics. [6]

6 **Example System:** Kerberos: purpose, authentication, serer and ticket granting server, keys and tickets, use of AS and TGS, replicated servers. Kerberos V4: names, inter-realm authentication, Key version numbers. Kerberos V5: names, realms, delegation, forwarding and proxies, ticket lifetimes, revoking tickets, multiple Realms. [4]

7. **Network Security:** Electronic mail security, IP security, Network management security. Security for electronic commerce: SSL, SET. System Security: Intruders and Viruses, Firewalls, Intrusion Detection. [4]

Text Books:

1. Atul Kahate," Cryptography and Network Security", TMH, New Delhi

2. Kaufman, C., Perlman, R., and Speciner, M., "Network Security, Private Communication in a public world" , PHI.

Reference Books:

1 Stallings, W., "Cryptography and Network Security: Principles and Practice", Prentice Hall.

2. Stallings, W., "Network security Essentials: Applications and standards", Prentice Hall.

3. Behrouz A Forouzan, "Cryptography and Network Security"; McGraw Hill;.

CA 17. 368 **Cyber Law** **3-1-0-4**

Total Lectures:40

1. **Fundamentals of Cyber Law**: Jurisprudence of Cyber Law- Overview of Computer and Web Technology- Introduction to Indian Cyber Law- Overview of General Laws and Procedures in India; Freedom of Expression on the Internet. [10]

2. **E-commerce-Legal Issues:** Electronic Commerce –Digital Signature- Meaning; Creation of Digital Signature; Understanding how digital signatures work, Role in Information Technology; technical issues; legal issues; Crimes relating to digital signature certificates. [10]

3. **Cyber Crimes:** Meaning of Cyber Crimes –Cyber crimes under IPC, Cr.P.C and Indian Evidence Law - Cyber crimes under the Information Technology Act,2000 - Cyber crimes under International Law - Hacking Child Pornography, Cyber Stalking, Denial of service Attack, Virus Dissemination, Software Piracy, Internet Relay Chat (IRC) Crime, Credit Card Fraud, Net Extortion, Phishing etc - Cyber Terrorism - Violation of Privacy on Internet - Data Protection and Privacy ;Concept of Social Networking – Legal Implications of Social Networking [12]

4. **Intellectual Property Issues and Cyberspace : The Indian Perspective;** Overview of Intellectual Property related Legislation-Copyright law & Cyberspace; Trademark law & Cyberspace; Law relating to Semiconductor Layout & Design. [8]

Text Books:

1. Rodney D. Ryder, Guide to Cyber Laws, 2nd Edit, Wadhwa and Company, Nagpur
2. Sharma,Vakul. Information Technology law and Practice. Universal law Publishing,2011
3. Rattan, Jyoti. Cyber law. New Delhi: Bharat law House,2011.

Reference Books:

1 Seth,Kanika. Cyber Law in the Information Technology Act. Nagpur : Lexis Nexis Butterworth Wadhwa,2009
2. Rodney D.Ryder,Guide of Cyber Law,2nd Edition.
3. Faruq Ahmed,Cyber law in India.

CA 17. 369 **E-Business** **3-1-0-4**

Total Lectures:40

1. **Internet as a Business Driver:** Internet, WWW, Benefits of Internet and WWW, Difference between e-Commerce and e-Business, Mobile Internet, Internet Consumers. [8]
2. **Introduction to e-Business Trends:** Trends Driving e-Business, Customer Oriented Trends, e-Service Trends, Organizational Trends, Enterprise Technology Trends and General Technology Trends. [7]
3. **E-Business Models:** Disruptive Technology, e-Business Models, Internet Pricing, e-Cash, Online Retailing, Constructing e-Business ICT Framework. [10]
4. **Leveraging the Web for Marketing:** Business Enhancement, Framework for Web Marketing, Web Usability, Content Management, and Impact of Internet on Marketing. [9]
5. **Online Resources and Deployment:** Meta Search Engines, Boolean Searching on Internet, Best Practice Web Searching, The Invisible Web, [6]

Text Books:

1.Ravi Kalakota, Marcia Robinsion, "E-Business 2.0: Roadmap For Success", 2nd Edition, Pearson.
2.Paul Phillips, "E-Business Strategy", 1st edition, TMH.

Reference Books:

1.Colin Combe, "Introduction to e-Business", 1st Edition, Routledge
2.Azhar Kozami**, "**Business Policy and Strategic Management", 2nd Edition, Tata McGraw Hill.

CA 17. 373 **Software and CASE Tools** **3-1-0-4**

Total Lectures: 40

1. **Software Engineering Fundamentals :** Definition of software product and process, Software Characteristics, Components, Applications, Layered Technologies, Processes and Product, Methods and Tools, Generic View of Software Engineering, Software Crisis and Software development paradigms, [5]

2. **Software Requirements Analysis & Specification:** System specification, Software requirements specification (SRS) standards, Analysis Modeling: Difference between Data and Information, ER Diagram, Dataflow Model, Control Flow Model, Control and Process Specification, Data Dictionary [8]

3. **Software Design:** Software architecture, Modular design - cohesion and coupling, Process-oriented design, Data-oriented design, User-interface design, Real-time software design, introduction to Object Oriented Design. [7]

4. **CASE Tools, Coding and Testing** Computer-aided software engineering, Introduction to CASE, Building Blocks of CASE, Integrated Case Environment, Characteristics of good Programming languages, Introduction to Testing Process, Testing Activities like Unit, Integration & System Testing. [7]

5. **Software Reengineering:** Business Process Reengineering, Reverse Engineering, Software re-engineerin.. [5]

6. **Software Quality and Metrics:** SQA-Software Quality Assurance, Software Reliability, Software quality metrics, SQA plan, ISO 9000 and 9001 Quality Standards. [8]

Text Books:

1. Pressman R.S. , “Software Engineering”, TMH.
2. Rumbaugh James ,Object Oriented Modeling and Design, Prentice Hall- Gale
3. The Unified Modeling Language User Guide - Grady Booch, James Rumbaugh, Ivar Jacobson.

Reference Books:

1 Pankaj Jalote,“An Integrated Approach to Software Engineering”, NAROSA.
2 Designing Flexible Object Oriented systems with UML - Charles Ritcher
3 Fairely, R.E., “Software Engineering Concepts”, McGraw-Hill
4 Object-Oriented Analysis and Design: using UML Mike O'Docherty Wiley Publication

CA 17. 375 **Bioinformatics** **3-1-0-4**

Total Lectures:40

1. **Introduction to Networking:** Definition and scope of networking, Basic network topology, Concept of LAN, MAN and WAN, Introduction to Internet and data transfer protocol (TCPI/P, FTP) [5]

2. **Biological Information Resources:** Introduction to biological data and database management, Biological databases – Protein databanks (Primary and Secondary databank; Sequence and structure databank), Genomic databanks (Sequence and specialized databanks). [5]

3. **Sequence Alignment:** Introduction to biological sequence alignment, Database searching, Algorithm for sequence alignment, Pairwise alignment (Needleman and Wunsch algorithm, Smith-Waterman algorithm), Multiple Sequence Alignment, Concept of Gaps, Gap penalties and scoring matrices. [7]

4. **Tools for Sequence Alignment:** FASTA, BLAST, Variations of BLAST, Alignment scores and statistical significance of database searches. [8]

5. **Genomics:** Genome, Gene structure of prokayotes and eukaryotes, Concept of ORFs, GC-content, Codon Usage, cDNAs and ESTs, Serial analysis of gene expression (Microarrays). [9]

6. **Proteomics:** Introduction to proteome and proteome analysis (2D electrophoresis, Mass spectrophotometry, Protein microarray and X-ray crystallography), Algorithm for modeling protein folding. [6]

7. **Phylogenetics:** Introduction to phylogenetics, Parsimony, Molecular phylogenetics, Methods of phylogenetic tree construction

Text Books:

1. Peruski and Peruski: The Internet and the new Biology: tools for Genomic and Molecular Research, ASM Publishing House, India.

Reference Books:

2 Higgins and Taylor, Bioinformatics, Oxford University Press, US.

CA 17. 377 **Geographical Information System** **3-1-0-4**

Total Lectures: 40

1. **Genesis and Progression:** Basic Concepts, Benefits of Computerization of Information, Users of GIS, Introduction to Real World and Data Model, Geometric Representation of objects, Levels of Measurement, Applications of GIS. [8]

2. **Vector Data Models:** Introduction, Spaghetti Model, Topology Model, Data Compression, Storing Vector Data. [7]

3. **Raster Data Models:** Necessity and Characteristics, Coding and Storage of Raster Data, Compression of Raster Data, Run Length Encoding, Chain Codes, Block Codes, Quad Tree Model, Conversion and Contrast between Vector and Raster Models. [10]

4. **Hardware and Software Requirements for GIS:** Basic Hardware Devices viz Computer, VDU, Quantizers, Printers, Plotters, etc. DBMS, Structure of Databases, Multimedia, WWW. [9]

5. **Basics of Data Collection:** Digitizing Maps, Scanning, Manual Digitizing, Arial Photographs, Photo Interpretation, Remote Sensing, Correction, Surveying. [6]

Text Books:

1. Bernhardsen Tor, "Geographic Information System: An Introduction", 3rd edition, Wiley Publication.
2. Longley Paul, "Geographic Information Systems and Science", 2nd Edition, Wiley Publication.

Reference Books:

1 Bjarne Stroustrup ,"Programming -Principles and Practice Using C++", Addison-Wesley.

2 Herbert Schildt , "C++: The Complete Reference", 4th edition, TMH.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech CS

Total Lectures: 40

CS 509 High Performance Computer Architecture 3-1-0-4

1. Overview: Necessity of high performance, Constraints of conventional architecture, Parallelism in uniprocessor system, Evolution of parallel processors, future trends, Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture, Performance Metrics and Measures, Speedup Performance Laws. [6]

2. Pipeline Architecture: Principles and implementation of Pipelining, Classification of pipelining processors, General pipelining reservation table, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Job sequencing and Collision, Advanced pipelining techniques, loop unrolling techniques, out of order execution, software scheduling, trace scheduling, Predicated execution, Speculative loading, Register Stack Engine, Software pipelining. [8]

3. Vector and Array Processor: Basic vector architecture, Issues in Vector Processing, Vector performance modeling, vectorizers and optimizers, SIMD Computer Organization Masking and Data network mechanism, Inter PE Communication, Interconnection networks of SIMD, Static Vs Dynamic network, cube, hyper cube and Mesh Interconnection network. Parallel Algorithms for Array Processors. [8]

4. Multiprocessor Architecture: Loosely and Tightly coupled multiprocessors, Processor characteristics of multiprocessors, Inter Processor communication network, Time shared bus, Crossbar switch, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP), Processor, Inter Processor Communication and Synchronization. [8]

5. Multithreaded Architecture: Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions. [4]

6. Parallel Programming Techniques: Message passing program development, Synchronous and asynchronous message passing, Message passing parallel programming, Shared Memory Programming, Data Parallel Programming. [6]

Text Books:

1. Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing", McGraw Hill International Edition, 2004.
2. Kai Hwang, "Advanced Computer Architecture", Tata McGraw Hill Edition, 2001.

Reference Book:

1. William Stallings, "Computer Organization and Architecture, Designing for performance" Prentice Hall, Sixth Edition, 2003.1

Total Lectures: 40

CS 511 Adhoc Sensor Networks 3-1-0-4

1. Ad hoc Networks: Introduction and Definitions, Ad hoc Network Applications, Design Challenges. [3]

2. Routing in Mobile Ad hoc Networks: Introduction, Flooding, Proactive Routing, On Demand Routing, Proactive Versus on demand Debate, Location based Routing. [4]

3. Multicasting in Ad hoc Networks: Introduction, Classifications of Protocols, Multicasting Protocols, Broadcasting. Protocol Comparisons, Overarching Issues. [4]

4. Transport layer Protocols in Ad hoc Networks: Introduction, TCP and Ad hoc Networks,Transport Layer for Ad hoc Networks: Overview, Modified TCP, TCP-aware Cross-layered Solutions. Ad hoc Transport Protocol. [5]

5. QoS Issue in Ad hoc Networks: Introduction, Definition of QoS, Medium Access Layer, QoS Routing, Inter- Layer Design Approaches. [4]

6. Security in Mobile Ad hoc Networks: Vulnerabilities of Mobile Ad hoc Networks, Potential Attacks, Attack Prevention Techniques. Intrusion Detection Techniques. [4]

7. Overview of Wireless Sensor Networks (WSNs): Introduction, Constraints and Challenges, Advantages of Sensor Networks, Sensor Network Applications. [2]

8. Routing Protocols: Geographic, Energy-Aware Routing – Unicast Geographic Routing, Routing on a Curve, Energy-Minimizing Broadcast, Energy-Aware Routing to a Region; Attribute-Based Routing – Directed Diffusion, Rumor Routing. [8]

9. Security in WSNs: Introduction: IEEE 802.11b Security Mechanisms, WEP Security Issues, WEP Improvements, Wireless Security Threats and Risks: Types of Security Threats, Physical Security of Wireless Devices, WLAN Attacks. Risk Mitigation and Countermeasures: Basic Countermeasures, AAA Infrastructure Solutions, Additional Enhancements. [6]

Text Books:

1. Prasant Mohapatra and Srihanamurthy, “Ad Hoc Networks Technologies and Protocols”, Springer, Springer International Edition, 2009.
2. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks”, John Wiley & Sons, Inc., Publication, 2007.
3. Zhao, Guibas, “Wireless Sensor Networks” , Elsevier, 2004.

Reference Book:

1. A.Boukereche, “Handbook of Algorithms for Wireless Networking and Mobile Computing”, Chapman and Hall/CRC Computer and Information Science Series, 2007.

Total Lectures: 40

CS 513 Cryptography and Information Security 3-1-0-4

1. Introduction: Elements of Information Security, Category of computer securities, types of attacks and services. [4]

2. Cryptographic Techniques: plain text and Cipher text, Encryption and Decryption, Stenography, Symmetric and Asymmetric key Cryptography, Blowfish, Data encryption standard, (DES), Advanced Encryption Standard(AES) [6]

3. Number Theory: Introduction to ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms. [4]

4. Public key Cryptography: Public Key Cryptography and RSA, Key Management, Diffie-Hellman key Exchange, Elliptic Curve Architecture and Cryptography. [5]

5. Message Authentication and Hash Function: Authentication requirements, authentication functions, MAC, hash functions, MD5, SHA, Digital Signatures: Digital Signatures, authentication protocols, Digital certificates, Kerberos, Certificate authority. [9]

6. Information attacks: Recognizing Security Threats and countermeasure for Phishing, Virus, Trojan Horse, Worms, Spyware, Adware, Key logger, Denial of Service, Spamming, Port Scanning and Password cracking [4]

7. Web and IP Security: Secure Socket Layer(SSL), Secured Hyper Text Transfer Protocol (SHTTP), S/MIME, IP security overview, Authentication Header(AH), Encapsulating Security Payload(ESP), IP key management . [6]

8. Case study: IP spoofing attack, Cyber Laws. [2]

Text Book:

1. William Stallings, "Cryptography and Network Security – Principles and Practices", Prentice-Hall of India, 4/E edition, 2003.

Reference Books:

1. VK Pachghare, "Cryptography & Information Security", PHI, 2009
2. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill, 2003.

CS 517 Adhoc Sensor Networks Laboratory 0-0-2-1

1. Basics of Network Simulation
2. Simulating a Local Area Network
3. Measuring Network Performance
4. Simulation of a Satellite Network
5. Simulating a Wi-Fi Network
6. Simulating a Wi-MAX Network
7. Simulating a Mobile Ad-hoc Network
8. Simulating a Wireless Sensor Network
9. Setting up a Bluetooth Network
10. Setting up a Zig-Bee Network

CS 519 Cryptography and Information Security Lab 0-0-2-1

1. Implementation of Ciphers
a) Play fair
b) Hill cipher

2. Implementation of the concepts from number theory
a) Fermat's & Euler's Theorem
b) Primality testing
c) Chinese Remainder Theorem

3. Implementation of Symmetric key algorithms like AES/ DES

4. Implementation of Asymmetric key Algorithms like RSA/ DSA.

5. Implementing hash code using MD5/SHA. And generate digital signature

6. Generation of Virus.

Total Lectures: 40

CS 530 Network Security 3-1-0-4

1. Introduction to Security in Networks: Characteristics of Networks, Intrusion, Kinds of security breaches, Plan of attack, Points of vulnerability, Methods of defense, Control measures, Effectiveness of controls [6]

2. Sniffers: Passive Sniffing, Active Sniffing, Ethereal tool, Man-in-the-Middle Attacks, Spoofing and Sniffing Attacks, ARP Poisoning and countermeasures. [6]

3. Denial of Service: Denial of Service, Goal of DoS (Denial of Service), different types of attacks and their impacts, securing from these attacks. [10]

4. Secure Sockets: IPsec overview – IP security architecture, IPsec-Internet KeyExchanging (IKE), IKE phases – encoding , Internet security, Threats to privacy , Packet sniffing ,Spoofing - Web security requirements, Real Time communication security, Security Standards–Kerberos.X.509 Authentication Service. [9]

5. Security Protocols: Transport layer protocols – SSL, Electronic mail security – PEM and S/MIME security protocol, Pretty Good Privacy , Web Security, Firewalls design principles , Trusted systems-Electronic payment protocols, Intrusion detection, password management Viruses and related Threats, Virus Counter measures, Virtual Private Networks. [9]

Text Book:

1. William Stallings, "Cryptography and Network Security: Principles and Standards", Prentice Hall India, 3rd Edition, 2003.

Reference Books:

1. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security: Private Communication in a public world", Prentice Hall India, 2nd Edition, 2002.

2. Charles P. Pleeger, "Security in Computing", Pearson Education Asia, 5th Edition, 2001.

Total Lectures: 40

CS 532 Cyber Forensic 3-0-0-3

1. Incident and Incident Response : Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response Phase after detection of an incident. [10]

2. Initial Response and Forensic Duplication: Initial Response & Volatile Data Collection from Windows system – Initial Response & Volatile Data Collection from Unix system - Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic Duplicate/Qualified Forensic Duplicate of a Hard Drive. [10]

3. Storage and Evidence Handling: File Systems-FAT,NTFS - Forensic Analysis of File Systems – Storage Fundamentals-Storage Layer, Hard Drives Evidence Handling-Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure. [10]

4. Network Forensics: Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing - Internet Fraud. [10]

Text Books:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGraw Hill, 2006.
2. Peter Stephenson, “Investigating Computer Crime: A Handbook for Corporate Investigations”, Sept 1999.

Reference Books:

1. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Toolsand Technology", Academic Press, 1st Edition, 2001.
2. Skoudis. E., Perlman. R. Counter Hack: “A Step-by-Step Guide to Computer Attacks and Effective Defenses”, .Prentice Hall Professional Technical Reference. 2001.
3. Norbert Zaenglein, “Disk Detective: Secret You Must Know to Recover Information From a Computer”, Paladin Press, 2000.
4. Bill Nelson, Amelia Philips and Christopher Steuart, “Guide to computer forensics and investigations”, course technology, Cengage Learning; 4thedition, ISBN: 1-435-49883-6, 2009.

Total Lectures: 40

CS 534 Image Information Processing 3-1-0-4

1. **Introduction:** Basics regarding Digital Images, elements of digital image processing systems, different image formats, elements of visible perception ,image model, sampling, quantization, image enhancement, restoration and analysis. [10]
2. **Mathematical Preliminaries and Image Transforms**: Matrix theory, random signals, spectral density function, results from estimation and information theory, Introduction to DFT, 2-DFT, FFT and other transforms such as Walsh, Hadamard, discrete cosine, Haar, slant and KL . [10]
3. **Image Data Compression:** Basic compression techniques such as Huffman coding, arithmetic coding, LZ77, LZ78, Predictive techniques –PCM , DPCM, transform coding theory of images, hybrid coding and vector DPCM, Introduction to speech and video compression, MPEG ,packet video. [10]
4. **Visual Cryptography:** Introduction to information hiding, surveys of different Steganographic and Watermarking techniques, principles of Steganography and water marking techniques, Statistical Steganography- distortion code generation techniques. Detecting, extracting and disabling hidden information, Basic principles , applications, evaluation and benchmarking of water marking systems, Extension from still images to video, Fingerprints classification and analysis. [10]

Text Books:

1. R.C. Gonzalez , "Image Processing" Pearson education 4th edition , 2013.
2. A.K. Jain ,"Fundamentals of Digital Image Processing " PHI 2nd edition , 1995.

Reference Books:

1. Khalid Sayood, "Introduction to Data compression", Morgan Kaufmann Publishers, 2003 reprint.
2. Stefan Katzenbelsser and Fabial A.P. Petitcolas , "Information hiding techniques for Steganography and Digital watermarking " , Artech house publisher , January 2004.
3. Jessica Fridrich , "Steganography in Digital media : Principles ,algorithms and applications ,Cambridge university press,2010.
4. Ingemar Cox,M.Miller,J.Bloom, Jessica Fridrich and T.Kalker,"Digital Watermarking and Steganography", Morgan Kaufmann Publishers,Nov.2007.
5. David Solomon, "Data compression: The Complete Reference", Springer Verlag, 4e, 2007.
6. W.K.Pratt ,"Digital Image Processing",John Willey and Sons,1994 .

Total Lectures: 40

CS 536 Database Security 3-1-0-4

1. Introduction: Introduction to Databases Security, problems in Databases Security Controls. Security Models**:** Introduction, Access Matrix Model, Take-Grant Model, Acten Model, PN Model, Hartson and Hsiao'sModel, Fernandez's Model, Bussolati and Martella's Model for Distributed databases. [7]

2. Advanced Models: Bell and La Padula's Model, Biba's Model, Dion's Model, Sea View Model Jajodia and Sandhu's Model, The Lattice Model for the Flow Control. [6]

3. Security Mechanisms: User Identification/Authentication, Memory Protection, Resource Protection Control Flow Mechanisms, Evaluation Criteria [6]

4. Security Software Design: A Methodological Approach to Security Software Design, Secure Operating System Design, Secure DBMS Design, Security Packages, Database Security Design. [7]

5. Statistical Database Protection and Intrusion Detection System: Statistics Concepts and Definitions, Types of Attacks, Inference Controls evaluation, Criteria for Control, Comparison, IDES System, RETISS System, ASES System. [7]

6. New Generation Database Systems Protection Models: Model for the Protection of Frame Based Systems, Object Oriented Systems, SORION Model for Object-Oriented Databases. Orion Model, Jajodia and Kogan's Model. [7]

Text Books:

1. Database Security and Auditing, Hassan A. Afyouni, India Edition, CENGAGE Learning, 2009.

2. Database Security, Castano, Second edition, Pearson Education.

Reference Book:

1. Database security, Alfred Basta, Melissa Zgola, CENGAGE learning.

Total Lectures: 52

CS 563 Advances in Distributed Computing **4-0-0-4**

1. **Introduction:** Distributed Systems, Cluster Computing, Supercomputing, Cloud Computing. [6]
2. **Synchronous networks:** Leader election in synchronous ring networks. Leader election in rings. Basic computational tasks in general synchronous networks: leader election. [6]
3. **Fault-tolerant Systems:** Consensus, Link failures: the two generals problem. Process failures (stopping, Byzantine). Algorithms for agreement with stopping and Byzantine failures. Exponential information gathering. [6]
4. **Asynchronous distributed computing**: Formal modeling of asynchronous systems using interacting state machines (I/O automata). Proving correctness of distributed algorithms. [6]
5. **Non-fault-tolerant Systems:** Algorithms for asynchronous networks. Leader election. [4]
6. **Synchronizers**. Synchronizer applications. Synchronous vs asynchronous distributed systems. [6]
7. **Time, clocks and the ordering of events**: State-machine simulation. Vector timestamps. Stable property detection. Distributed termination. Global snapshots. Deadlock detection [6]
8. **Asynchronous shared-memory systems**: The mutual exclusion problem. Mutual exclusion algorithms. Bounds on shared memory for mutual exclusion. Resource allocation. The Dining Philosophers problem. [6]
9. **Locking:** Locking algorithms, optimistic algorithms, lock-free algorithms, lazy algorithms, Load scheduling and balancing techniques. [6]

Text Books:

1. Lynch, Nancy, "Distributed Algorithms", Burlington, MA: Morgan Kaufmann, 1996. ISBN: 9781558603486.
2. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems, Concept and Design", 3rd Edition, Pearson Education, 2005.
3. Mukesh Singhal, Niranjan G. Shivaratri, Niranjan Shivaratri, "Advanced Concepts in Operating Systems", TMH, 1994.
4. Sunita Mahajan, Seema Shah, "Distributed Computing", Oxford University Press,2010.

Reference Books:

1. Sukumar Ghosh, "Distributed Systems: An Algorithmic Approach", Chapman &Hall / CRC, 2007.
2. Pradeep K. Sinha, "Distributed Operating Systems: Concepts and Design", PHI, 2007.
3. Randy Chow, Theodore Johnson, "Distributed Operating Systems and Algorithm Analysis",

Total Lectures: 52

CS 565 Advanced Compiler Construction 4-0-0-4

1. **Advanced Issues in Elementary topics:** Compiler, phases and passes, finite state machines, regular expressions and their applications to lexical analysis, implementation of lexical analyzer using LEX, CFG, bottom-up and top-down parsers, implementation of parsers using YACC. [10]

2. **Symbol Table Structure**: Storage classes, visibility and lifetime. Symbol attributes and symbol table entries, local symbol table management, and global symbol table structure, storage binding and symbolic registers. [6]

3. **Intermediate Representations**: Issues in designing intermediate languages, High level, medium level, low level and multi-level intermediate languages. Representing all intermediate languages in informal compiler algorithm notation (ICAN). [8]

4. **Code Optimization**: Introduction, early optimization, redundancy elimination. Loop optimization: Induction variable optimizations, bounds checking elimination.Procedure optimization: Tail-call optimization and Tail-recursion optimization, procedure integration, In-line expansion, leaf routine optimization and shrink wrapping. [8]

5. **Register Allocation**: Register allocation and assignment, local methods, graph coloring, priority based graph coloring. Code Scheduling: Instruction Scheduling, Speculative loads and boosting, speculative scheduling, trace scheduling, percolation scheduling. [8]

6. **Interprocedural Analysis and Optimization**: Call graph, interprocedural data flow analysis, constant propagation, alias analysis, optimizations and register allocation. [7]

7. **Automatic Code Generators**: Syntax directed technique, semantic directed parsing, tree pattern matching and dynamic programming. [5]

Text Book:

1. Steven S. Muchnik, “Advanced Compiler Design Implementation”, Morgan Kauffman publishers, 2005.

Reference Books:

1. Alfred Aho, Monica Lam, Ravi Sethi, Jeffrey Ullman, “Compilers: Principles, Techniques, and Tools”, Second edition, Addison-Wesley, 2006.

2. Fisher, Faraboschi, Young, “Embedded Computing - A VLIW Approach to Architecture, Compilers, and Tools”, Morgan Kaufmann, 2005.

Total Lectures: 52

CS 567 BioInformatics 4-0-0-4

1. Introduction to Bioinformatics: Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics Problems and Applications of Bioinformatics. [6]

2. Bioinformatics Databases: Introduction, Nucleotide sequence database - Protein sequence databases, Sequence motif databases, Protein structure databases, other relevant databases. [6]

3. Data storage and retrieval and Interoperability: Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search.The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts.General Introduction to XML, UMLS, CORBA, PYTHON. [13]

4. Sequence Alignments and Visualization: Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example),Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization. [12]

5. Bioinformatics Softwares: Clustal V, Clustal W 1.7, RasMol, Oligo, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip. [5]

6. Semantic Web Techniques: Bridging databases, browsing space of information, life sciences identifiers, RDF data representation. [5]

7. Bioinformatics and Distributed Computing: Java Distributed computing platform, DPRml, DSEARCH. [5]

Text Books:

1. Dan E. Krane ,"Fundamental Concepts of Bioinformatics", third edition, Pearson Education, 2009.
2. Claverie, J.M. and Notredame C. ," Bioinformatics for Dummies", Wiley Editor , January 2003.

Reference Book:

1. ShaliniSuri, "Bioinformatics", APH Publishing Corporation, 2006.

Total Lectures: 52

CS 569 Advanced Computer Graphics 4-0-0-4

1. **Animation:** Introduction of computer Animation, Principles of Animation, Key framing , Kino-dynamics Planning- motion blending, skinning-skeleton animation, rigid skinning ,linear skinning, dual skinning, physics modeling-Physics-based animation, rigid body systems, articulated rigid bodies, forward and inverse dynamics. [14]

2. **Rendering:** Basic concepts of graphics models-illumination& reflection models Shading-Scanning polygons, Gourad and Phong shading ,texture mapping- bump & environmental maps , mipmaps , shading languages-vertex shedders and fragment shedders. [12]

3. **Modeling:** Representation, Using homogeneous Coordinate systems, Modeling process, terrain-representation, methods , fault formation & weather, plants modeling , animals modeling. [12]

4. **Surface Representation:** 3 dimensional object representation –polygon representations, implicit representation , Beziers ,B-splines-basis function, knot insertion, conversion , rational B-splines (NURBS)-properties and examples , evaluators, subdivision surfaces-coarse mesh and subdivision rule,types of subdivisions , Voxels . [14]

Text Book:

1. Peter Shirley, Stephen Robert Marschner, "Fundamentals of Computer Graphics" , A K Peters Limited, 2009.

Reference Books:

1. Shreiner Dave, "Opengl Programming Guide: The Official Guide To Learning Opengl", Version 2.1, 6/E , Pearson Education India, 2008.
2. Francis S. Hill, Jr., Stephen M. Kelley , "Computer Graphics: Using OpenGL" , Pearson Prentice Hall, 2008
3. James D.Foley, Andries van Dam, Steven K. Feiner, John F. Hughes , "Computer Graphics ,Principles & Practice", 3rd Edition, Pearson Prentice Hall, 2013.
4. Edward Angel, "Interactive Computer Graphics a top-Down Approach using openGL", 5th Edition Pearson Prentice Hall, 2008.

Total Lectures: 52

CS 571 Advances in Algorithm Design 4-0-0-4

1. Pattern matching algorithms: Finite automata and regular expression, recognition of regular expression patterns, recognition of substrings, Two – way deterministic pushdown automata, position trees and substring identifiers. [11]

2. Computability theory: Turing machines, variants of Turing machines, Hilbert's problem, decidable languages, the halting problem, Un-decidable problems from language theory, mapping reducibility, the recursion theorem, decidability of logical theories, Turing reducibility, definition of information. [11]

3. Fast Fourier Transform and Polynomials: Representation of polynomials, the DFT and FFT algorithms, efficient FFT implementation, the FFT using bit operations, products of polynomials, the Schonhage – Strassen integer multiplication algorithm. [11]

4. Randomized Algorithm and Parallel Algorithm: Monte-Carlo algorithm, Las-Vegas algorithm, Game tree evaluation, De-randomization. Models for parallel computation basic techniques; Parallel matrix algorithms: matrix-vector multiplication, matrix multiplication, triangular system solution, sorting networks-parallel merging networks, zero –one principle. [8]

5. Complexity theory: Time complexity, the classes P, NP, NP complete and NP hard, Hierarchy theorems, Relativization, Circuit Complexity, approximation algorithms, probabilistic algorithms, circuit complexity, alteration, interactive proof systems, parallel computation, cryptography. [11]

Text Book:

1. Aho Alfred V., Hopcraft John E., Ullman Jefferey D. "The design and analysis of computer algorithms" Pearson education, tenth impression 2012.

Reference Books:

1. Cormen Thomas H. "Introduction to algorithms" PHI, Third edition – 2012.

2. MICHAEL SIPSER Sipser Michael, "Introduction to the theory of computation" Thomson press, Third edition 2012.

3. Brassard G. Fundamental of Algorithmcs, Prentice-Hall of India, 2003.

4. Horowitz E. Computer Algorithms, Galgotia Publications, 2002.

Total Lectures: 52

CS 572 Web Services Security 4-0-0-4

1. Introduction to web Service Technologies: Introduction to web services, Security for Web Services and Security Goals, Need of security and Privacy in web services, applications of web service security, SOA and Web Services Principles, Web Services Architecture, Web Services Technologies and Standards, SOAP, Web Services Description Language (WSDL). [10]

2. Web Service Threats Vulnerabilities, and Countermeasures: Threats and Vulnerabilities, Threats Modelling, Vulnerability Categorizations and Catalogs, Threats and Vulnerabilities Metrics. [10]

3. Standards for Web Service Security: The Concept of Standard Web Services Security, Standards Framework, An Overview of Current Standards, XML Data Security ,Security Assertions Markup Language (SAML), SOAP Message Security, Key and Trust Management standards, Standards for Policy Specification, Access Control Policy Standards, Implementations of Web Services Security Standards**.** [12]

4. Digital Identity Management and Trust Negotiation: Overview of Digital Identity Management, Overview of Existing Proposals Liberty Alliance, WS-Federation, Comparison of Liberty Alliance and WS-Framework, Other Digital Identity Management Initiatives, Discussion on Security of Identity Management Systems, Business Processes. [10]

5. Access Control for Web Services: Approaches to Enforce Access Control for Web Services, WS-AC: An Adaptive Access Control Model for Stateless, Web Services, The WS-AC Model, WS-AC Identity Attribute Negotiation, WS-AC Parameter Negotiation. [10]

Reference Book:

1. Elisa Bertino, Lorenzo D. Martino, Federica Paci, Anna C. Squicciarini, Security for Web Services and Service Oriented Architectures, Springer Science (2009).

Total Lectures: 52

CS 574 Mobile and Wireless Security 4-0-0-4

1. **Wireless Technologies:** Introduction to Wireless technologies- Wireless data networks-Personal Area Networks -Transmission Media – WLAN standards - Securing WLANS - Countermeasures - WEP (Wired Equivalence Protocol). [10]

2. **Multiple Access Techniques and Wireless Networking**: Introduction- FDMA, TDMA, Spread Spectrum Multiple Access: Space Division Multiple Access- Packet Radio, Introduction To Wireless Networks- Differences Between Wireless And Fixed Telephone Networks, Development Of Wireless Networks, Traffic Routing In Wireless Networks Integrated Services Digital Network (ISDN), Protocols For Network Access. [12]

3. **Wireless Threats**: Kinds of security breaches – Eavesdropping, Communication Jamming, RF interference, Covert wireless channels, DOS attack, Spoofing, Theft of services, Traffic Analysis, Cryptographic threats, Wireless security Standards. [10]

4. **Security in Data Networks**: Wireless Device Security Issues - CDPD security (Cellular Digital Packet Data), GPRS security (General Packet Radio Service), GSM (Global System for Mobile Communication) security, IP security. [10]

5. **Wireless Transport Layer Security**: Secure Socket Layer - Wireless Transport Layer Security - WAP Security Architecture - WAP Gateway. [10]

Reference Books:

1. Nichols and Lekka, “Wireless Security-Models, Threats and Solutions”, Tata McGraw – Hill, New Delhi, 2006.
2. Merritt Maxim and David Pollino,”Wireless Security”, Osborne/McGraw Hill, New Delhi, 2005.
3. William Stallings, “Cryptography and Network Security - Principles and practices, Prentice Hall, New Delhi, 2006.

Total Lectures: 52

CS 576 Information Security Policies 4-0-0-4

1. Cyber Security and its problem-Intervention Strategies: Redundancy, Diversity and Autarchy. Private ordering solutions, Regulation and Jurisdiction for global Cyber security, Copy Right-source of risks, Pirates, Internet Infringement, Fair Use, postings, criminal liability, First Amendments, Data Losing. [13]

2. Copy Right-Source of risks: Pirates, Internet Infringement, air Use, postings, Criminal Liability, First Amendments, Losing Data, Trademarks, Defamation, Privacy-Common Law Privacy, Constitutional law, Federal Statutes, Anonymity, Technology expanding privacy rights. [13]

3. Duty of care &criminal liability: procedural issues, Electronic Contracts & Digital Signatures, Misappropriation of information, Civil Rights, Tax, Evidence. Information security policies and procedures : Corporate policies-Tier 1,Tier 2 and Tier 3 policies, Process management planning and preparation developing policies-asset classification policy developing standards. [13]

4. Information security: fundamentals-Employee responsibilities- information classification-Information handling- Tools of information security- Information processing-secure program Administration. Organizational and Human Security: Adoption of Information Security Management Standards, Human Factors in Security- Role of information security professionals [13]

Reference Books:

1. Jonathan Rosenoer, Cyber Law: The law of the Internet, Springer, 1997
2. Mark F Grady, Fransesco Parisi Thomas R. Peltier, The Law and Economics of Cyber Security, Cambridge University Press, 2005.
3. Kenneth J. Knapp, "Cyber Security and Global Information Assurance: Threat Analysis and Response Solutions", IGI Global, 2009.
4. Thomas R Peltier, Justin Peltier and John blackley,"Information Security Fundamentals", 2nd Edition.

Total Lectures: 52

CS 578 Operating System and Mobile Application Security 4-0-0-4

1. Introduction to android: An open platform for mobile development, android applications, and android SDK features, developing for android, developing for mobile devices, android development tools. Introducing the application manifest, using the manifest editor, the android application lifecycle, externalizing resources, fundamental android UI design, introducing views and layouts, creating new views and menus. [10]

2. Intents, broadcast receiver, adapters and the Internet: Introducing Internet and adapters, using internet resources, introducing dialogs, Data storage, retrieval and sharing techniques for saving data, saving simple application data and loading files, databases in android. [10]

3. Maps, Geocoding and Location based services: setting up the emulator with test providers, Selecting the location provider, finding your location, using proximity alerts, using the geocoder, creating map based activities and mapping earthquakes example Advance Android development paranoid android, using AIDL to support IPC for services, using internet services, building rich user interfaces. [10]

4. Mobile Web Architecture, Standards and Tools: Mobile Internet Access, Mobile Web browser Evolution, Mobile Web Standards and development time, WAP and WAP Standards, XHTML, WML and WML Script, Mobile Web Development Approaches, Content Adaption and Adaption Strategies, How to recognize end user device, Device Detection in PHP, Tools Available for mobile web development, Conversion Engines, Emulators, Mobile Web Checkers, Dynamic content**.** [11]

5. Mobile Application Development Management & Security Mobilized Enterprise Web Architectures, User To Mobile Client Security Issues, Mobile Client Security Issues, Client Server Communications Security Issues, Existing Web Architectures and Back End Systems Security Issues, Project Management, Requirements, Design, Code Development and Integration, Integration and System Testing, Deployment and Release Management, Re Evaluation and Reiteration, Operations and Maintenance. [11]

Reference Books

1. Reto Meier, Professional Android Application Development, John Wiley and Sons, 2010.
2. Rick Rogers, John Lombardo, Zigurd Mednieks, G. Blake Meike, Android Application Development Programming with the Google SDK, O'Reilly, 2009.
3. Valentino Lee; Heather Schneider; Robbie Schell , Mobile Applications Architecture, Design, and Development, Prentice Hall April 16, 2004.

Total Lectures: 52

CS 580 Biometric Security 4-0-0-4

1. Overview: Introduction, benefits of biometrics over traditional authentication systems, benefits of biometrics in identification systems, selecting a biometric for a system, Key biometric terms and processes, biometric matching methods, Accuracy in biometric systems. [11]

2. Physiological Biometric Technologies: Leading technologies: Finger-scan, Facial-scan, Iris-scan, Voice-scan, components, working principles, competing technologies, strengths and weaknesses. Other physiological biometrics: Hand-scan, Retina-scan, components, working principles, competing technologies, strengths and weaknesses, automated fingerprint identification systems. [11]

3. Behavioral Biometric Technologies: Handprint Biometrics, DNA Biometrics, signature and handwriting technology, Technical description, classification, keyboard / keystroke dynamics, Voice, data acquisition, feature extraction, characteristics, strengths, weaknesses, deployment. [10]

4. Multi Biometrics: Multi biometrics and multi factor biometrics - two-factor authentication with passwords - tickets and tokens – executive decision - implementation plan. [10]

5. Biometric Applications: Categorizing biometric applications – application areas: criminal and citizen identification, surveillance, PC/network access, e-commerce and retail/ATM, costs to deploy, other issues in deployment. [10]

Reference Book:

1. Samir Nanavathi, Michel Thieme, and Raj Nanavathi, "Biometrics -Identity verification in a network", Wiley Eastern, 2002.
2. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley Eastern Publications, 2005.
3. John Berger," Biometrics for Network Security", Prentice Hall, 2004.

Total Lectures: 40

MA 531 Advanced Computational Mathematics 3-0-0-3

1. Calculus of Finite Differences and Interpolation: Finite differences and difference operators, Construction of difference tables, Interpolation and extrapolation with equal intervals (Newton- Gregory forward, backward, Stirling and Bessel's formula), Interpolation and extrapolation with unequal intervals (Newton's divided difference and Lagrange's formula). [08]

2. Numerical Differentiation and Integration: Numerical differentiation with equal and unequal intervals, numerical integration (newton-Cotes quadrature formula, Trapezoidal, Simpson's 1/3, Simpson's 3/8, Weddle's and Romberg rules), Double and triple integration using Trapezoidal and Simpson's rules. [07]

3. Numerical Solution of Simultaneous Equations: Gauss elimination method (Partial Pivoting), Jacobie's iteration method, Gauss Jordan method, Gauss Siedel iteration method. [4]

4. Numerical Solution of Algebraic and Transcendental Equations: Bisection method, Regular falsi method (method of false position), Newton Raphson method and its applications, Graeffe's root squaring method with error analysis.

[4]

5. Numerical Solution of Ordinary and Partial Differential Equations: Numerical solution of ordinary differential equations of first order and first degree using Picard's, Taylor series, Euler, Euler's modified, Runge-Kutta method of fourth order and Milne's Predictor -Corrector method.
Classification of partial differential equations (elliptic, parabolic, and hyperbolic). Finite difference approximations to partial derivatives. Jacobi and Gauss Siedel method, Crank - Nicolson method, Solution of Laplace and Poisons equations. [10]

6. Linear Algebra: Review of group, ring and field , Vector Spaces, Subspaces, Linearly dependent and independent, Basis, Dimensions, Isomorphism, Linear transformations and their matrix representations , Rank, Inverse of Matrices, Cauchy- Schwarz inequality, Eigenvalue, Eigenvectors. [07]

Text Books:

1. M.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, 2012.
2. B.S. Grewal, Numerical Methods, BPB publication, 2012.
3. Introduction to Linear Algebra with applications by Jim Defranza and Daniel Gagliardi, TMH, Year 2013.

Reference Books:

1. Numerical Mathematics Analysis by James B. Scarborough.
2. Introduction Methods of Numerical Analysis by S.S. Shastry.
3. Applied Numerical methods with MATLAB by Steven C Chapra, TMH.
4. Introduction of Numerical Analysis by Forberg.
5. V. Rajaraman Computer oriented numerical methods 3rd edition PHI – 2012
6. Linear Algebra and Its applications by David C. Lay, Addison- Wisley(An imprint of Pearson education).

MA 533 Advanced Computational Mathematics Laboratory 0-0-2-1

Implement the following in C/C++/MATLAB:

(1) Newton-Gregory's formulae for forward and backward interpolation.
(2) Stirling formula.
(3) Bessel's formula.
(4) Newton's divided difference formula.
(5)Lagrange's formula.
(6) Numerical differentiation.
(7) Numerical integration: Newton –Cotes quadrature formula..
(8) Trapezoidal rule.
(9) Simpson rules.
(10) Romberg rules.
(11) Solution of differential equations by Euler's method modified Euler's method.
(12) Runge-Kutta method.
(13) Milne's Predictor-Corrector method.
(14) Bisection method
(15) Regula Falsi method
(16) Newton – Raphson method.
(17) Graeffe's root squaring method.
(18) Gauss elimination method (with partial pivoting).
(19) Eigen values and eigen vectors.
(20) Solution of partial differential equations.

RM 17.101 **Research Methodology** **2-0-0-2**

1. **Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches,Research Process,Validity and Reliability in Research. [2]

2.**ProblemFormulation:**Identification, Selection and Formulation of a Research Problem, Criteria ofagood Research Problem, Reviewof Literature, Research Gaps. [4]

3.**Research Design:**Research Framework, Meaning &Significance of Research Designs, Features of a good Research Design, Types of Research Design. [4]

4.**Dataforresearch:**TypesofData,Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis.[4]

5. **Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [8]

6. **ReportWriting:**Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [4]

TextBooks:

1. R.Pannershelvam, "ResearchMethodology" PrenticeHall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"ResearchMethodology: MethodsandTechniques",New Age International (p) Limited,Publishers New Delhi, 4ndedition,2018.

References –

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013.
4. Dr.A.K.Phophalia, “Modern Research Methodology: New Trends and Techniques” Paradise Publishers Jaipur, 1st edition, 2012.
5. Pankaj Madan, “Research Methodology”, Global Vision Publishing House, New Delhi, 2nd edition, 2016.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech VLSI

Total Lecture: 40

EC 502 FPGA ARCHITECTURE & APPLICATIONS 3-1-0-4
(Elective I)

1	**PROGRAMMABLE LOGIC:** ROM, PLA, PAL, PLD, PGA – Features, Programming and Applications using Complex Programmable Logic Devices.	6
2	**FPGA:** Field Programmable Gate Arrays – Logic Blocks, Routing Architecture, Design Flow, Technology Mapping for FPGAs.	4
3	**FINITE STATE MACHINES (FSM):** Top Down Design – State Transition Table, State Assignments for FPGAs. Problem of Initial State Assignment for One Hot Encoding. Derivations of State Machine Charges.	8
4	**REALIZATION OF STATE MACHINE:** Charts with a PAL. Alternative Realization for State Machine Chart using Microprogramming. Linked State Machines. One – Hot State Machine, Perimeters for State Machines – Basic Concepts, Properties.	8
5	**FSM ARCHITECTURES AND SYSTEMS LEVEL DESIGN:** Architectures Centered Around Non-Registered PLDs. State Machine Designs Centered Around Shift Registers. One – Hot Design Method. Use of ASMs in One – Hot Design. K Application of One – Hot Method. System Level Design – Controller, Data Path and Functional Partition.	10
6	**DIGITAL FRONT END DIGITAL DESIGN TOOLS FOR FPGAS & ASICS:** Using EDA Tool ("FPGA Advantage") – Design Flow Using FPGAs of Parallel Adder Cell, Sequential Circuits, Multiplexers.	4

Text Books:

1 P.K.Chan & S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall, 1994.

2 S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Publicatgions,1994.

3 J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley & Sons, Newyork, 1995.

Reference Books:

1 S.Brown, R.Francis, J.Rose, Z.Vransic, Field Programmable Gate Array, Kluwer Pubin, 1992.

Total Lecture: 40

EC 504 **ASIC DESIGN** **3-1-0-4**

(Elective II)

1	**ASIC DESIGN STYLES:** Introduction – categories-Gate arrays-Standard cells-Cell based ASICs-Mixed mode and analogue ASICs – PLDs.	4
2	**ASICs – PROGRAMMABLE LOGIC DEVICES:** Overview – PAL –based PLDs: Structures; PAL Characteristics – FPGAs: Introduction, selected families – design outline.	6
3	**ASICs –DESIGN ISSUES:** Design methodologies and design tools – design for testability – economies.	6
4	**ASICs CHARACTERISTICS AND PERFORMANCE**: design styles, gate arrays, standard cell -based ASICs, Mixed mode and analogue ASICs.	6
5	**ASICs-DESIGN TECHNIQUES:** Overview- Design flow and methodology- Hardware Description languages-simulation and checking-commercial design tools.	6
6	**LOGIC SYNTHESIS, SIMULATION AND TESTING:** Verilog and logic synthesis –VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation- automatic test pattern generation.	6
7	**ASIC CONSTRUCTION:** Floor planning, placement and routing system partition.	2
8	**FPGA PARTITIONING**: Partitioning Methods-Floor Planning- Placement-Physical Design Flow-Global Routing-Detailed Routing –Special Routing-Circuit Extraction-DRC.	4

Text Books:

1 L.J.Herbst, "Integrated circuit engineering", OXFORD SCIENCE Publications, 1996.

2 M.J.S.Smith, "Application - Specific integrated circuits", Addison-Wesley Longman Inc 1997.

3 **Himanshu Bhatnagar, "Advanced ASIC Chip Synthesis: Using Synopsys Design Compiler, Physical Compiler, and PrimeTime", Kluwer Academic Publishers.**

Reference Books:

1 Michael John Sebastian Smith, "Application specific integrated circuits", Addison-Wesley.

Total Lectures 40

EC 541 Semiconductor Device Models for Circuit Simulation 3-1-0-4

1. Principle of circuit simulation and its objectives. [4]

2. Introductions to SPICE- DC, small signal, large signal, high frequency, noise models of diodes and measurement of diode model parameters. [6]

3. DC, small signal, high frequency and noise models of bipolar junction transistors, extraction of bipolar junction transistor model parameters. [6]

4. DC, small signal, high frequency and noise model of MOSFETs. [5]

5. Devices scaling, short and narrow channel MOSFETs. [5]

6. MOSFET channel mobility model, level-1 and level-2 large signal MOSFET Models. [4]

7. Extraction of MOSFET model parameters. [5]

8. JFET and MESFETs, extraction of JFET and MESFET model parameters. [5]

Text Books:

1. Dasgupta N., and Dasgupta A., Semiconductor Devices - Modeling and Technology, Prentice-Hall of India, 2004.
2. Ben G. Streetman, Sanjay Banerjee, "Solid State Electronic Devices", Prentice Hall.
3. Adir Bar-Lev, "Semiconductors and electronic devices", Prentice-Hall International.

Total Lectures 40

EC 542 Analog VLSI Design 3-1-0-4

1. Basic consideration in analog VLSI design. [4]

2. MOS current sources, current mirrors, out buffers and voltage reference circuits. [6]

3. CMOS amplifier. [7]

4. Noise in CMOS amplifier. [3]

5. CMOS comparators. [6]

6. Mixed signal circuits. [6]

7. MOS circuit components. [4]

8. Switched capacitor filters realization by MOS technology. [4]

Text Books:

1. Razavi B., Design of Analog CMOS Integrated Circuits, McGraw-Hill, New York, 2001.
2. D. Johns and K. *Martin*, "*Analog Integrated Circuit Design*", *John* Wiley & Sons.
3. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design", Oxford university press.

Total Lectures 40

EC 543 VLSI Fabrication Technology 3-1-0-4

1. Crystal growth and Epitaxy [3]
2. Diffusion and Ion-implantation [4]
3. Oxidation Processes [3]
4. Film Deposition Techniques [4]
5. Etching and Cleaning [4]
6. Lithographic Processes [5]
7. Metal Deposition and Interconnect Formation [2]
8. Process Integration : Bipolar and MOS (NMOS & CMOS) [7]
9. Packaging [3]
10. Testing [3]
11. Reliability and Yield [2]

Text Books:

1. Gandhi S. K., VLSI Fabrication Principles – Silicon and Gallium Arsenide, John Wiley & Sons, 2nd Ed., 2003.
2. A.I.C.T.E, Design and Fabrication Technology, A.I.C.T.E, Bangalore, 2001.
3. *S. M. Sze*, "*VLSI Technology"*, Second Edition, McGraw-Hill.

Total Lectures 40

EC 544 VLSI Systems and Subsystems 3-1-0-4

1. System specification using HDL. [6]
2. General VLSI Components. [7]
3. Arithmetic circuits in CMOS VLSI. [5]
4. Memories and Programmable logic. [7]
5. System level physical design. [7]
6. VLSI clocking and system design. [6]
7. Reliability and testing of VLSI circuits [2]

Text Books:

1. Hill F. J., and Peterson G. R., Computer Aided Logical Design with Emphasis on VLSI, John Wiley & Sons, 4th Ed., 1993.
2. Wolf W., Modern VLSI Design- System-On-Chip Design, Pearson Education Asia, 3rd Ed., 2002.
3. John P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons.

Total Lectures 40

EC 545 Elements of Digital VLSI Design 3-1-0-4

1.	CMOS Technology & Device Scaling	[6]
2.	Stick Diagram, Layout and Full Custom Mask Design	[4]
3.	MOS inverters : Static and Dynamic Characteristics	[4]
4.	Inverter Delay and Power Dissipation	[5]
5.	Interconnect delay	[2]
6.	Combinational MOS Logic Circuits	[4]
7.	Sequential MOS Logic Circuits	[4]
8.	Dynamic Logic Circuits	[3]
9.	Low power VLSI Circuits	[4]
10.	Introduction to BiCMOS Circuits	[2]
11.	Introduction to FPGA and ASICS	[2]

Text Books:

1. Weste N. H., Principles of CMOS VLSI Design, Pearson Education Asia, 2nd Ed., 2001.
2. Kang S., CMOS Digital Integrated Circuits Analysis and Design, Tata McGraw-Hill, 3rd Ed., 2003.
3. Baker J. R., CMOS - Circuit Design, Layout and Simulation, Prentice-Hall of India, 2000.

Total Lectures 40

EC 546 **Mixed-Signal Systems (Elective III)** **3-1-0-4**

1.	Introduction to mixed-signal systems.	[2]
2.	Continuous time and sampled data signal processing.	[5]
3.	Static and dynamic logic, OTA-C circuits.	[6]
4.	Switched current techniques.	[3]
5.	Switched capacitor techniques.	[3]
6.	Converters and Delta-sigma modulators.	[4]
7.	Filter design strategies.	[6]
8.	Image processing.	[7]
9.	Silicon compilers.	[3]

Text Books:

1. Christoph G., Languages for System Specification - Selected Contributions on UML, SystemC, System Verilog, Mixed-Signal Systems, and Property Specifications from FDL'03, Springer Publisher, 1996.
2. Nishath K. V., Simulation Techniques and Solutions for Mixed-signal Coupling in Integrated Circuits, Springer Publisher, 1994.
3. Baker R. J., CMOS Mixed-Signal Circuit Design, Prentice-Hall of India, 2001.

Total Lecture: 40

EC 548 **VLSI Physical Design and Design Automation (Elective II)** **3-1-0-4**

1.	Basic VLSI design methodologies.	[3]
2.	Algorithmic graph theory and computational complexity.	[4]
3.	Tractable and intractable problems.	[3]
4.	Combinatorial optimization.	[4]
5.	Layout compaction.	[3]
6.	Placement and partitioning.	[4]
7.	Floor planning.	[3]
8.	Routing.	[3]
9.	Simulation.	[4]
10.	Logic synthesis and verification.	[4]
11.	High-level synthesis.	[5]

Text Books:

1. Sarrafzadeh M., and Wong C. K., An Introduction to VLSI Physical Design, McGraw-Hill, New York, 1996.
2. Geiger R. L., Allen P. E., and Strader N. R., VLSI Design Techniques for Analog and Digital Circuits, McGraw-Hill, New York, 1990.
3. Naveed Sherwani, "Algorithms for VLSI Physical Design Automation", Springer International Edition.

Total Lectures 40

EC 550 Embedded System Design 3-1-0-4

1. **Introduction to Embedded System & Design Concepts:** Introduction & examples of embedded system, Concept of embedded system design , design challenges, processor technology & IC technology, Embedded processor & general purpose processor, trades-offs, development phase of embedded system & use of software tools for development of embedded system . [4]

2. **Embedded Processor Architecture/Microcontrollers:** Role of processor selection in embedded system, overviews of 8-bits/16-bits/32-bits microcontrollers, 8051 microcontroller: Architecture, basic assembly language programming concepts, instruction sets, addressing modes, logical operations, arithmetic operations, branching instructions, Boolean instructions, subroutines, timing subroutine, serial data communication & interrupt process, assembly language programming examples [8]

3. **Interfacing, programming & real-time applications:** Memory & I/O interfacing, Timer & counter operation & Programming, Serial communication,& interrupt handling, LCD & keyboard interfacing, DS 12887 RTC interfacing, interfacing ADC/DAC, real world interfacing & applications. [12]

4. **Embedded software Architecture & Development:** Challenges & issues in an embedded software development, real-time programming language & embedded OS, Embedded software architecture: Round-Robin, Round-Robin with interrupt, RTOS architecture, tasks & tasks states, priority based scheduling, Semaphore & shared data, timer function, memory management, encapsulating semaphore & queue, hard real-time scheduling consideration, saving memory space & power. Embedded software development process & tools, implementation aspects of embedded systems, validation & debugging of embedded system. [10]

5. **Networks for Embedded system:** 12C two wire busses, the can bus, SHARC link ports, Ethernet, Myrinet, IEEE 1451.1 & IEEE 1451.2 plugs & play standards, embedded TCP/IP. [6]

Text Books:

1. Dreamtech Software Team, Programming for Embedded Systems, Wiley Publishing, Inc., 2003.
2. Mazidi and Mazidi, "The 8051 Microcontroller And Embedded Systems Using Assembly And C", Pearson Education India.
3. David E. Simon, "An Embedded Software Primer", Addison-Wesley Professional.

Total Lectures 40

EC 553 **DESIGN OF DIGITAL SYSTEMS** **3-1-0-4**
(Elective I)

Introductory concepts: Number System and floating-point numbers, Combinational logic circuits, Flip-Flops and related devices, Digital Arithmetic operations and circuits, counters and registers. [5]

Integrated Circuit Logic family: Evolution of TTL, IIL (merged structure), CML logic, 10K and 100K series of ECL, Stacked ECL, EFL. [7]

Evolution of nMOS logic: Passive load, saturated load, linear load, dynamic behaviour, Gates realization. [5]

CMOS logic families: static and dynamic behaviour, IC interfacing, TTL driving CMOS and vice-versa, different types of circuit realization. [5]

MSI Logic Circuits: Derived logic building blocks such Decoders/ drivers, Encoders, Multiplexers, De-multiplexers, Magnitude Comparators, applications. [5]

MESFET, MESFET Inverter, DCFL, supper buffer FET logic, BFL [8]

Memory Devices: General memory operations, Programmable logic devices, Semi-conductor memories, SRAM, DRAM, FAMOS, FLOTOX. [5]

Text Books:

1. R. J. Tocci : "Digital System: Principles & Applications" – PHI
2. Manufacturers IC – Data Sheet.
3. Leo Chartrand, "Advanced Digital Systems: Experiments and Concepts with CPLDs", Cengage Learning.

Reference Books:

1. John F. Wakerly, "Digital Design: Principles and Practices", Prentice Hall.

Total Lectures 40

EC 556 **Low Power VLSI Technology (Elective III)** **3-1-0-4**

1.	Introduction to low power VLSI technology.	[2]
2.	Voltage scaling and power-delay tradeoff.	[5]
3.	Threshold voltage scaling.	[4]
4.	Multi-threshold CMOS.	[4]
5.	Variable threshold CMOS.	[3]
6.	Estimation and optimization of switching activity.	[5]
7.	Reduction of switched capacitance.	[2]
8.	Adiabatic logic circuits.	[4]
9.	Low-power memories.	[4]
10.	DC-DC converters.	[3]
11.	Low-power architecture.	[4]

Text Books:

1. Weste N. H., Principles of CMOS VLSI Design, Pearsons Education Asia, 2nd Ed., 2001.
2. Geiger R. L., VLSI Design Techniques for Analog and Digital Circuits, McGraw-Hill, New York, 1990.
3. Yeo K., Rofail S. S., and Goh W., CMOS/BiCMOS ULSI Low Voltage, Low Power, Pearsons Education Asia, 2003.

Total Lectures 40

MA 509 Advanced Mathematics 3-1-0-4

1. Computer based numerical methods:
   Methods for numerical solution of algebraic and transcendental equations: Direct methods e.g. Bisection method, Regula-Falsi method; Iterative method e.g. Newton-Raphson method.
   Methods for the solution of simultaneous linear equations: Direct methods e.g. Gauss elimination method; Iterative method e.g. Gauss-Seidel method, Jacobi method
   Finite difference table for equal and unequal intervals in the independent variable values. Newton's forward and backward interpolation formula; Newton's interpolation formula for divided differences. Numerical differentiation. Numerical Integration methods: Simpson's rules, Trapezoidal rule and Romberg's method.
   Numerical solution of ordinary differential equations: Euler method, Modified Euler method and Runge-Kutta methods.
   Numerical solution of elliptic and parabolic differential equations using finite difference approach.
   [20]

2. Statistics and Probability:
   Concept of random variable, total and conditional probability, Bayes' theorem,probability distributions and probability density functions, moments and moment generating functions. Some theoretical probability distributions such as binomial, Poisson, normal, uniform, exponential, rectangular, χ^2, t, F.Sampling theory, sampling distributions and sampling techniques.Estimation theory, Point and Interval estimation of mean and variance of data. Testing of hypotheses. Simple and Composite hypothesis. Correlation and Regression. Multiple and Partial correlation and regression. Concepts of stochastic processes with special reference to Monte Carlo methods. [20]

Text Books

1. Shastri S.S., Introductory Method of Numerical Analysis, Prentice-Hall of India, 3rd Ed., 2002.
2. Trivedi K.S., Probability and Statistics with Reliability Queuing and Computer Science Application, Prentice-Hall of India, 2002.

Reference Book

1. Dass H.K., Advanced Engineering Mathematics, S. Chand and Company Ltd., 1999.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

MCA

CA 507 **Information Systems** **3-0-0-3**

Total Lectures: 40

1. **Information:**Concepts, Information: a quality product, Classification of information, Methods of data and Information collection, Value of information, General model of a human as a information processor, Summary of information concepts and their implications, organization and information, MIS and Information concepts. [8]

2. **Information Systems, Organizations, management and Strategy:** Organisations and Information Systems, how information system impact organizations and business firms, Type of Information System, Managerial Challenges of Information Technology. Components of information System, Information System Activities. [8]

3. **Information Systems for Functional Areas:** Information for financial, Marketing, Inventory control, Production function, Personnel function, Cases related to information, requirement for above functional areas. [8]
4. **Computer Concepts & Peripherals:** Need of computer Literacy, Use and Definition of Computer, Generation of Computer, Classification of Computer, Peripherals: Input, output and storage technologies. [7]

5. **Computer System & System Software:** Brief history of Computer Hardware, Type of Computer System, Microcomputer System, Mainframe Computer System, System Software: Definition, operating system, programming language, web languages and services, Programming software. [9]

Text Book:

1. Steven Alter "Information Systems the foundation of E-Business", 4th Edition Person education, 2010.
2. Brien James A. O'and MarakasGeorge M., "Management Information System" 9th Edition, Tata McGraw Hill Education Private Limited, 2010.

Reference Book:

1. RajaramanV. "Analysis and Design of Information System", Prentice-Hall of India, 3rd Edition, 1996.
2. BasandraSuresh K. "Management Information System", Wheeler Publication, 2003.

CA 508 **Theory of Computation** **3-1-0-4**

Total Lectures:40

1. **Finite Automata and Regular Expression:** Finite State Systems, Basic definitions, Regular Languages and Regular Expressions, Finite Automata, Kleen theorem, Arden's theorem, Mealy and Moore Machine and their Conversion, Pumping Lemma for Regular Sets, Decision Algorithms, Myhill-Nerode theorem and Minimization of finite automata. [12]

2. **Context-Free Grammars:** Context-Free Grammars, Union, Concatenation of CFGs, Derivation Trees, Simplification of Context-Free Grammars, Chomsky Normal Form, Greibach Normal Form, Ambiguous Grammar, Inherently Ambiguous Context-Free Languages. [9]

3. **Context-Free Languages and Pushdown Automata:** Pushdown Automata and Context Free Languages, Pumping Lemma for CFL, Closure Properties of CFL and Decision Algorithms for CFL. [6]

4. **Turing Machine:** Turing Machine Model, Techniques for Turing Machine Construction, Turing Machines as Language Acceptor, Combining Turing Machines, Properties of Recursive And Recursively Enumerable Languages and Universal Turing Machine. [8]

5. **Chomsky Hierarchy of Languages:** Regular Grammars, Unrestricted Grammars and Turing Machines, Context-Sensitive Grammars and Linear Bounded Automata. [5]

Text Books:

1. Martin John C. "Introduction to languages and the theory of computation", 4th edition, McGraw-Hill, 2003
2 Peter linz , "An introduction to Formal Languages and Automata" , Narosa Publishing House, sixth edition, 2010.

Reference Books:

1 Hopcroft John E., Motwani Rajeev and Jeffery Ullman *D.* , "Introduction to Automata Theory, Languages, and Computation", 3rd edition, Narosa Publishing House, 2006.

2. Sipser Michael, "Introduction to Theory of Computation", 1st edition, Cengage Learning, 2012.

CA 509 **C Programming** **3-0-0-3**

Total Lectures:40

1. **Introduction:**Brief History, Library& Linking, Compilation & Execution, Data Types, Operator and Expression Identifier, Keyword and Token, Constant, Data Declaration and Definition, Operators and Expression, Precedence & Associability of Operators. [7]

2. **Control and Loop Statement:** Introduction, Selection Statements, If, The Conditional Expression, switch, Iteration Statements: for loop, while loop, do-while loop, Jump, Goto label, break and continue, exit() function. [7]

3. **Array, Function and String:** Definition, declaration and Types of Array, Operation and application of array, Brief introduction on string header files and applications of strings. Function, argument passing, scope of variable, call by reference and call by value, recursion, passing array to function. [5]

4. **Structure and Union:** Definition, Declaration and Initialization, Accessing Structure members, Arrays of Structure, Passing Structure to function, Structure to Pointer, Union. [6]

5. **Pointers:** Definition, declaration, Pointer to Pointer, NULL Pointer, De-referencing Pointer, Pointer Arithmetic , array to pointer (1-D array ,2-D array), pointer array, function to pointer. [6]

6. **File handling:** Introduction, Defining and Opening a File in read and writes mode, Closing a file and ending of file, Enumerated data types, Error Handling During I/O Operation, Random Access to Files, Command Line Arguments. [5]

7. **Storage Classes & Preprocessor:** Introduction,Storage Classes. Preprocessor Directive, Macro. [4]

Text Books:

1. Scheldt Herbert, “C The Complete Reference” Tata McGraw hill 6th edition,2010.

2. Kernighan & Ritchie, “C Programming Language” Prentice Hall Second Edition, 1988.

Reference Books:

1 Kanetkar Y.P., “Let us C Solutions” 10th edition, BPB publication, 2010.

2. Balaguruswamy E., “Programming in ANSI C “5th Edition Tata McGraw-Hill Education, 2004.

CA 510 **C++ Programming** **3-0-0-3**

Total Lectures:40

1. **Introduction**: Overview of oops, Differences between OOP and Procedure Oriented programming, Structure of a C/C++ program, Differences between C/C++, Data Types in C++, Identifier and Keywords, Constants,C++ Operators, Type Conversion,Variable declaration, statements, Expressions, Features of iostream.h,Input andOutput, Conditional Expression,Loop statements, Jump statements. [7]

2. **Data Abstraction and Polymorphism:**Class Definition, Controlling access to other functions, Memory Allocation, Different Types of Constructors, Destructor,Dynamic Creation and Destruction of Objects.Overloading functions and operators, Overloading New and Delete operators. [7]

3. **Inheritance:**Definition, DerivedClasses, Syntax of Derived Classes, Base Class, Types of Inheritance, Overloading Inherited Member Functions ,Virtual Base Class. [5]

4. V**irtual functions and polymorphism:** Static and Dynamic bindings,virtual functions, dynamic binding through virtual functions,virtual function call mechanism, implications of polymorphic use of classes , virtual destructors , calling virtual functions in a base class constructor. [6]

5. **I/O and Templates:** Standard I/O Using C functions, stream I/O in C++, formatted I/O, File I/O, generic Classes in C++, Necessity of Templates , generic classes using Macros, class templates, Function Templates, Advantages of Templates. [8]

6. **Exception and File Handling:** Benefits of exception handling, troubles with standard C functions , exception handling mechanism in C++, hierarchy of file stream classes, opening and closing files, file modes, testing for errors,file pointers and their manipulations, ASCII & Binary files, sequential and random access files. [7]

Text Books:

1. Schildt Herbert, C++: The Complete Reference ,4th edition, Tata Mcgraw Hills, 2003.

2. Balagurusamy E., Object Oriented Programming With C++,4thedition, Tata Mcgraw Hills, 2013

Reference Books:

CA 511 **Digital Electronics** **3-1-0-4**

Total Lectures: 40

1 **Number Systems and Codes:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic. [2]

2 **Introduction to Boolean Algebra:** Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [2]

3 **Logic Gates:** Diode and transistor as a switch, basic logic gates, derived logic gates, block diagrams and truth tables, logic diagrams from Boolean expression and vice versa, converting logic diagram to universal logic, positive logic, negative logic and mixed logic. [5]

4 **Simplification of Boolean Functions:** K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method. [5]

5 **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]

6 **Sequential Circuits:** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters. [10]

7 **Logic Families:** Logic gate characteristics (propagation delay, speed, noise margin, fan-in, fan-out, power dissipation), standard logic families (RTL, DCTL, TTL, ECL, MOS) [5]

8 **Programmable Logic:** Introduction to programmable logic array (PLA), programmable array logic (PAL). [1]

Text Books:

1. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Delhi, 4th Edition, 2009.
2. Floyd, T. L. and Jain, R.P., "Digital Fundamental", Pearson Education, Delhi, 8th Edition, 2009.
3. Tocci, R. J., Widmer, N. and Moss, G., "Digital System: Principles and Applications", Pearson Education, Delhi, 10th Edition, 2007.

Reference Books:

1. Puri, V. K., "Digital Electronics: Circuits and Systems", Tata McGraw-Hill, Patel Nagar, New Delhi, 4th Edition, 2001.
2. Karim, M.A. and Chen. X., "Digital Design: Basic Concepts and Principles", CRC Press Taylor & Francis Group, Printed in India by Saurabh Printers, 2nd Indian reprint, 2010.
3. Jain, R. P., "Modern Digital Electronics", Tata McGraw-Hill, Patel Nagar, New Delhi, 4th edition,1999.

CA 512 Systems Analysis and Design **3-0-0-3**

Total Lectures= 40

1. **System Concepts:** Definition, characteristics and elements, Types of system, problems in system development, principles of system building, system engineering [5]

2. **Information Systems**: Information, components and types of information system, computer based information systems. [4]

3. **System Models**: System Development Life Cycle (SDLC), Prototype, Prototype tools and strategy. [5]

4. **Systems Analysis** : Role of systems Analyst, system planning , information gathering tools for determining information requirements, cost/benefit analysis. [6]

5. **Feasibility Study** : System performance constraints, specific system objectives, steps in feasibility analysis, feasibility report. [3]

6. **Structured Analysis** : Definition, Tools of Structured Analysis: data flow diagram, decision tree and decision table. [5]

7. **System Design**: Process and stages in design, input/output and form design, control design, design of database interactions. [6]

8. **System implementation**: System testing and quality assurance, implementation and system maintenance, hardware and software selection, system security and recovery. [6]

Text Books:

1. Awad, Elis M. , " Systems Analysis and Design", Galgotia Publications Pvt. Lid, New Delhi, 1997.
2. Senn, James A., "Analysis & Design of Information ", McGraw Hill Education (india) Pvt. Ltd., New Delhi, 2005.

Reference Books:

1. Goyal, Arunesh , " Systems Analysis and Design", PHI Learning Pvt. Ltd., New Delhi, 2011.
2. Hoffer, J. A., George, J. F. and Valacich, J. S., " Modern Systems Analysis & Design", Pearson Education(Singapore) Pvt. Ltd., Delhi,2005.

CA 514 **Operating system** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Overview, Evolution,Types, operating system functions and characteristics. [3]

2. **Process Management:** The process concept, operating system services for process management, scheduling algorithms and multiple processor scheduling. [5]

3. **Memory Management:** Storage allocation methods, paging, segmentation, virtual memory concept, demand paging, page replacement algorithms and trashing. [5]

4. **Input /Output and File Systems:** Hardware organization, device scheduling policies, Functions of file systems, file access and allocationmethods, directory systems, structured organizations, directory and file protection mechanisms and implementation issues. device dependent and device independent software. [7]

5. **Deadlocks:** Characterization, prevention and avoidance, deadlock detection and recovery and practical consideration. [5]

6. **Process Synchronization:** Critical section problem, semaphores, classical process co-ordination problems and their solutions, inter process communication and message-passing mechanisms. client-server modeling, RPC, threads. [6]

7. **Protection & Security:** Goals of Protection, Principles of Protection. Domain of protection Access Matrix, Implementation of Access Matrix. Access control, Revocation of Access Rights. Capability- Based systems, Language - Based Protection, Security problem, program threats, system and network threats cryptography as a security tool, user authentication, implementing security defenses, fire walling to protect systems [9]

Text Books:

1. Silberschatz A., and Galvin P.B., Operating System Concepts, John Wiley &Sons, 6th Edition, 2005.
2. Tanenbaum A.S., Modern Operating Systems, Pearson Education Asia, 4th Edition, 200

Reference Books:

1 Stallings W., Operating Systems, Pearson Education Asia, 5thEdition, 2008.
2 Tanenbaum A.S. and Woodhull A. S., Operating Systems- Design and Implementation, Pearson Education Asia, 2nd Edition, 2009.

CA 515 Mathematical Foundation of Computers **3-1-0-4**

Total Lectures:40

1. **Matrix Theory :** Introduction to the matrix theory, types of matrices, inverse of matrices, rank of matrices, solving system of linear equations, Eigen values and Eigen vectors, Sparse matrix, diagonalization and triangulization of matrices. [16]

2. **Three -dimensional geometry and Vector calculus:** Basic concepts of three-dimensional geometry (viz. direction cosines and direction ratios), equation of a plane and of a straight line. Basic concepts of vectors, gradient, divergence and curl of a vector. [8]

3. **Calculus:** Introduction of differential and integral calculus, derivatives of various types of functions, basic idea of differential equations, solutions of ordinary differential equations with constant coefficients. [10]

4. **Complex Algebra:** Introduction to the complex algebra, complex numbers, geometrical representation of complex numbers: Argand diagram, De-Moirvre's theorem. [6]

Text Books:

1. Ramana B. V. , " Higher Engineering Mathematics", Tata McGraw – Hill Publishing Company Ltd., P 1390, 2nd edition, 2001

2. Babu Ram, "Engineering Mathematics", Pearson, New Delhi, 2010.

3. Narayan Shanti , "Analytical Solid Geometry", S Chand & Company, New Delhi,1988.

Reference Books:

1. Grewal B. S. and Grewal J. S. , "Higher Engineering Mathematics" , Khanna Publishers, New Delhi, P. 1390, 40th edition,2004

2. Kreyszig Errwin, "Engineering Mathematics", John Wiley& Sons, New York, , p. 1639, 9th Edition,1998.

CA 516 **Data Structures** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Data Structure definition, Requirement of different Data Structures, Abstract Data Type, Analysis of Algorithm. [3]
2. **Linear Data Structure:** One and Two-dimensional Arrays, Array Representation, Selection Sort, Bubble Sort, Quick Sort, Heap Sort and Merge Sort,Sequential Search, Binary Search. **L**inked List and itsrepresentations, Operations on Linked List, Types of Linked List, Stack and its representation, Operations on Stack, Queue and its representation, Operations on Queue, Applications of these data structures. [15]
3. **Tree :** Binary Tree and its travesals (Breadth-First, Depth-First), Expression Trees (Infix, Prefix, Postfix Traversals), Binary Search Trees, Heaps,AVL Tree. [12]
4. **Graph:** Matrix Representation, List representation and applications, Minimum Spanning Tree finding algorithms, Shortest Path finding algorithms. [5]
5. **Hashing Techniques:** Hash Function, Address Calculation Techniques, Common Hashing Functions, Collision Resolution, Linear Probing, Double Hashing, Bucket Hashing, Deletion and Rehashing. [5]

Text Books:

1. Horowitz and Sahani, “Fundamental of data structures”,Galgotia Publication,1998.
2. Lipschutz, “Data Structures Schaum’s Outline Series”, Tata Mcgraw Hills,2006.

Reference Books:

1 TenenbaumAaron M., YedidyahLangsam and Moshe J. Augenstein “Data Structures Using C and C++” , PHI,2009.
2. Kruse R. etal, “Data Structures and Program Design in C”, Pearson Education,2007.

CA 517 **Business Accounting** **3-0-0-3**

Total Lectures: 40

1. **Fundamentals of Accounting:** Meaning, Scope and objective of accounting, Accounting principles, Accounting concepts and conventions, Double entry system. [5]

2. **Financial Accounting:** Rules for Journalisation, Posting in ledger, Trial balance, Preparation of financial statement: Trading account, Profit and loss account, Balance sheet;Analysis of financial statement. [10]

3. **Management Accounting:** Concept andobjectives of Management Accounting, Ratio Analysis: Objectives, Advantages and limitations,Types of ratios; Funds flow analysis and Cash flow analysis, Capital budgeting. [10]

4. **Cost Accounting:** Concept and principles, Classification and elements of cost, Techniques of Cost Accounting: Marginal costing, Standard costing, Budgetary Control -Types of budgets, Preparation of budgets; Working capital. [12]

5. **Computerized Accounting**: Uses of Microsoft Excel in accounting, analysis of balance sheet with excel Tally software-application. [3]

Text Books:

1. Bhattacharya A. K, Financial accounting, Prentice Hall of India, 3rd edition, 2006.

2. Khan M.Y. and Jain P.K., Management Accounting, Tata McGraw-Hill Education,2006

3.SaxenaV.K. &VashistC.D., Advanced Cost and Management Accounting , Sultan Chand and Sons,2002.

Reference Books:

1. Jain S.P &NarangK. L, Financial Accounting, Kalyani Publications, 2013.

2.Kulkarni.Mahesh, Management Accounting, Career Publications, 2008.

3.PatankarSanjay, Management Accounting, NiraliPrakashan, 2010.

4. MaheshwariS. N., Management Accounting and Financial Control, S. Chand & Company, 1996.

5 Gupta S.P., Management Accounting, SahityaBhawan, 2nd Edition, 2000.

CA 518 Discrete Mathematics and Probability Theory **3-1-0-4**

Total Lectures = 40

1. **Set Theory:** Sets, Venn-diagrams, algebra of sets, finger sets, binary relations and equivalence relations [6]

2. **Probability Theory:**Fundamentals:Addition and multiplication of probability, Bayes theorem, Binomial, Poisson and normal distribution. [9]

4. **Graph Theory**: Introduction, graph, undirected graph, simple, multiple graph and pseudo graph, walk, path, cycle and connectivity, sub-graph, types of graph, isomorphic graph and representation of graph in computer memory. [10]

5. **Mathematical Logic:**Prepositional calculus, basic logical operations, statements generated by set conditional statements, converse inverse and contraposition statements. [8]

6. **Boolean Algebra:** Basic theorems on Boolean algebra, duality principle, Boolean functions and Boolean expressions. [7]

Text Books:

1. Rosen Kenneth H, "Discrete Mathematics & its applications with Combinatorics and Graph Theory", TMH,2012.

2. Palaniammal S., "Probability & Random Processes", PHI Learning Pvt. Ltd,2000.

3. DeoNarsingh, "Graph Theory with Applications to Engineering and Computer Science", PHI, 1979.

Reference Books:

1. Hines William W., Montgomery D. C. and Goldman David M., "Probability and Statistics in Engineering", Wiley, 2003.

2. Chart rand G. and Zhang P., "Introduction to Graph Theory", TMH, 2006.

3. Kolman B., Busby R. C. and Rass S., "Discrete Mathematical Structures", Prentice – Hall of India Pvt. Ltd, 2013.

CA 525 **Digital Electronics Laboratory** **0-0-4-2**

1 To study the use of General Purpose Digital Trainer and familiarization with the digital IC Data-Books.

2 To study AND, OR. NOT, NAND, NOR, EX-OR gates and their specified experiments.

3 To set up a 4-bit Binary Counter (74LS93) to demonstrate its sequence of Counting.

4 To study the characteristics curve of TTL and CMOS logic gates.

5 To design and test 4-bit Adder and Subtractor circuits.

6 To compare the magnitude of two 4-bit Binary Numbers A and B.

7 Design a combinational circuit with 4 inputs and 4-outputs that converts a 4-bit Gray Code to an equivalent 4-bit Binary number.

8 Design and implement a BCD to Seven Segment Decoder / Driver.

9 To design and implement a 2 to 1 multiplexer.

10 To design and implement a 1:2 & 1:4 de multiplexer.

11 To investigate the operation of various flip flops SR, JK, T and D using gates and FF ICs.

12 To study the following application of shift register using IC 74LS164 and 74LS194 (Shift Right Logic, Shift Left Logic, Parallel Load).

13 Design and test arithmetic and logic circuit using combinational circuit (logic circuit, multiplexer and 4-bit binary adder/ full adder. (Already covered in experiment no.6, 10 &11)

14 Design and test a 4-bit Up Down binary counter. (Already covered in experiment no.3)

NOTE: All experiments are to be performed on either physical apparatuses or on digital electronics simulator like Virtual Bread Board etc.

CA 527 C Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types & Operators
- Control Statements
- Arrays
- Strings

Programs

- Apply logic to print different patterns(at least 5)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- Implementing matrix operations
- Searching and Sorting
- String Manipulations
- Program to understand the decision making constructs and find the roots of a quadratic equation
- Program to understand the implementation of library function

2. Functions

Testing

- Function & Function Calling
- Storage Classes

Programs

- Function Declaration and Definition
- Function call by value and call by reference
- Illustration of storage classes

3. Pointers, Structure and Union

Testing

- Pointer
- Structure
- Union

Programs

- Declaring and initializing pointers
- Accessing a variable through its pointer
- To Implement and use user defined type structures
- Creating a new data type Date with the help of structure
- To understand the use of pointers in arrays
- To learn dynamic memory allocation and deallocation
- To implement list and pointer to list

4. File Handling

Testing

- FILE

Programs

- program to Create a File & Store Information
- program to illustrate Reading of Data from a File and to delete or replace a specific Line from a Text File
- program to Create Employee Record and Update it

CA 528 **C++ Programming Lab** **0-0-4-2**

1. Introduction to C++

Testing:
• Data Types & Operators
• Control Statements
• Arrays

Programs:

- Apply logic to print different patterns (atleast 3)
- Find average, minimum and maximum of an array elements.
- To print Fibonacci series.
- Multiplication of two matrices
- Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

2. Classes and Object

Testing:
• Class with function printing hello World
• Class with default constructor
• Class with parameterized constructor
• Destructor
• Static and constant data

Programs:

- To demonstrate classes and different types of constructors.
- Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

3. Inheritance and Polymorphism

Testing:
• Inheritance
• Function Overloading
• Operator overloading
• Overriding
• Comparisons between private, public and protected
• Virtual function and [pure]virtual class
• This pointer
• Exception handling
• Abstract class

CA 529 **Data Structures Laboratory** **0-0-4-2**

Arrays Testing:

- Array declaration and initialization
- Addition & multiplication
- Deletion of elements.

Programs:

1. To implement the array concepts for matrix applications.
2. To implement the 1-D, 2-D and 3-D array concepts for data storage and retrieval.
3. Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

Linked List Testing:

- Insertion
- Deletion
- Traversing
- Searching

Programs:

1. To implement various operations over the linked list.
2. To implement variations of linked list e.g. Circular linked list.
3. Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

Stack Testing:

- Array implementation
- Linked list implementation
- Push and Pop

Programs:

1. To implement various operations over the stack.
2. To demonstrate applications of stack e.g. infix to prefix conversion.

Queue Testing:

- Array implementation
- Linked list implementation
- Insertion
- Deletion

CA 603 **Design and Analysis of Algorithms** **3-1-0-4**

Total Lectures:40

1. **Analysis of Algorithms:** Asymptotic notation, proof by induction, solving recurrences, the Master Theorem, analysis of algorithms for time and space complexity, worst case, average case and amortized case analysis. [10]
2. **Algorithm Methodologies:** Recursion, divide and conquer algorithms, greedy algorithms, dynamic programming, backtracking and branch-and-bound with examples, applications and analysis. [12]
3. **Graph Algorithms:** Basic graph search methods (BFS, DFS), spanning trees, Prim, Kruskal algorithms, path finding and shortest path algorithms, topological sorting, bipartite graphs. [10]
4. **Infeasibility:** P and NP classes, NP hard problems, parallel algorithms-principles, models and analysis and applications**.** [8]

Text Books:

1. Cormen T. H., Leiserson C. E., Rivest R. L., and Stein C., "Introduction to Algorithms", Prentice-Hall of India, 2nd ed,2002.
2. Horowitz E., "Computer Algorithms", Galgotia Publications,2008.

Reference Book:

1. Aho A.V., Design and Analysis of Computer Algorithms, Pearson Education Asia, 2000.
2. Brassard G., "Fundamentals of Algorithmics", Prentice-Hall of India,2003.

CA 605 Computer Communication Networks 3-1-0-4

Total Lectures: 40

1. **Introduction:** Layered architecture, OSI, TCP/IP. [5]
2. **Physical Layer:** Transmission media, physical layer protocol, switching techniques. [6]
3. **Data Link Layer:** Design issues- framing, error control and flow chart, stop and wait protocol, sliding window protocol, and performance analysis. [7]
4. **Medium Access Sub Layer:** P-ALOHA, S-ALOHA, CSMA, reservation scheme, CSMA/CD, Ethernet, Token Ring, Token Bus, DQDB, FDDI. [6]
5. **Network Layer:** Rotating algorithms, congestion control, internetworking, IP Layer, X.25, ISDN, etc. [6]
6. **Transport Layer:** Quality of service, connection management, flow control and buffering, multiplexing, crash recovery, ICP. [5]
7. **Application Layer:** Network security, electronic mail, SNMP, DNS, etc. [5]

Text Books:

1. Tanenbaum A. S., "Computer Networks", Prentice-Hall of India, 4th ed.,2003.
2. Stallings W., "Data and Computer Communications", Prentice-Hall of India, 6th ed.,2003

References Books:

1. Forouzan B. A., "Data Communications and Networking", Tata McGraw-Hill, 3rd ed.,2006,
2. Hayes J. F., "Modeling and Analysis of Computer Communication Networks", Khanna Publishers.,2003

CA 606 **Cryptography and Network Security** **3-1-0-4**

Total Lectures:40

1. **Introduction**: Attacks, Services and Mechanisms, Security Attacks, Security Services, Integrity check, digital Signature, authentication. [3]

2. **Secret Key Cryptography:** Block Encryption, DES rounds, S-Boxes IDEA: Overview, comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB, CBC, OFB, CFB, Multiple encryptions DES. [6]

3. **Hash Functions And Message Digests:** Length of hash, uses, algorithms (MD2, MD4, MD5, SHS) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages, digest computation.) SHS: Overview, padding, stages. [7]

4. **Public Key Cryptography:** Algorithms, examples, Modular arithmetic (addition, multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption. Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures. [9]

5. **Authentication:** Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs offline guessing, storing. Cryptographic Authentication: passwords as keys, protocols, KDC's Certification Revocation, Interdomain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution, smart cards, biometrics. [8]

6**. Network Security:** Electronic mail security, IP security, Network management security. SSL, SET Intruders and Viruses, Firewalls, Intrusion Detection. [7]

Text Books:

1. Kaufman, c., Perlman, R., and Speciner, M., "Network Security, Private Communication in a public world", 2nd ed., Prentice Hall PTR,2002.

2. Stallings, W., "Cryptography and Network Security: Principles and Practice", 3rd ed., Prentice Hall PTR,1994.

Reference Books:

1. Stallings, W. "Network security Essentials: Applications and standards", Prentice Hall,2006.

2. Behrouz A Forouzan. "Cryptography and Network Security"; McGraw Hill.,2007.

CA 607 **Database Management Systems** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Databases and database users, database system concepts and architecture, data modeling using the Entity-Relationship (ER) model, Enhanced Entity Relationship model. [7]

2. **Relational Data Model:** Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model. [7]

3. **Structured Query Language (SQL):** SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views. [4]

4. **Database Design:** Functional dependencies and normalization of relational databases, First Normal Form (1NF), 2NF, 3NF, Boyce-Codd normal form (BCNF), multivalued dependency, 4NF. [8]

5. **Transaction Processing:** Introduction, properties, recoverability, serializability. Concurrency control techniques: Two phase locking protocol, Database recovery techniques: Recovery concepts, recovery techniques based on deferred and immediate update. [7]

6. **Object and Object-Relational Databases:** Concepts for object databases, object database standards and design, object relational systems. [7]

Text books:

1. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Management Systems, 5th Edition, Pearson Education,2008.
2. Raghu Ramakrishnan, Database Management Systems, 3rd Edition, TMH,2002.

Referenc books:

1. G.W. Hansen, and J.V. Hansen, Database Management and Design, 2nd Edition, PHI,1999.
2. Korth and Schilberschatz, Database System Concepts, 4th Edition, TMH,2006.
3. C.J. Date, Database Systems, 2nd Edition, TMH,2003.

CA 608 **Management Information Systems** **3-0-0-3**

Total Lectures:40

1. **Organization:** Hierarchy in the organization structure, information flows, concentration of authority, characteristics of managers, problem solving by managers. [5]
2. **Information Needs and Sources of Managers:** Activities of the organization, managerial activities, planning, types of management decisions and information needs, types of information needed, sources of information. [5]
3. **Basics of Management Information Systems**: Overview of information system, MIS concepts, definition, role and impact of MIS, process of management, organization structure and behaviors, decision making, information concepts, levels of information systems, system concepts, types of system, system development model. [10]
4. **Development of Management Information Systems:** Information requirements determination tools, development and implementation of MIS, choice of information technology. [6]
5. **Application of Management Information Systems:** Applications in manufacturing sector-personnel management, financial management, production management, material management, marketing management, applications in service sector, Decision support system. [8]
6. **Special Topics:** Technology of information system, business process reengineering, electronic business technology. [6]

Text Books:

1. Jawadekar W. S., Management Information Systems, McGraw-Hill, New York, 2nd ed,2002.
2. Basandra, S. K., Management Information Systems, Wheeler Publishing, New Delhi,1997.

Reference Books:

1. O' Brien, J. A., Management Information Systems, Galgotia Publications,2003.
2. Post, G. V., and Anderson D. L., Management Information Systems, Tata McGraw – Hill,2006.
3. Davis G. B., and Olson M. H., Management Information Systems, Tata McGraw-Hill,1985.

CA 609 **Java Programming** **3-0-0-3**

Total Lectures: 40

1. **The Genesis of Java:** The importance of Java to Internet, Java's magic-the byte code, the Java buzzwords, the continuing revolution, Java and HTML, using blocks of code, lexical issues, the Java class libraries. [4]

2. **Data Types, Variable, and Arrays:** Java as a strongly typed language, the simple types, integers, floating-point types, characters, Booleans, a closer look at literals, variables, type conversion and casting, automatic type promotion in expressions, arrays, a few works about string, a note to C/C++ programmers about pointers, operators-arithmetic operators, the bitwise operators, relational operators, Boolean logical operators, the assignment operator, the ? operator, operator precedence, using parentheses, control statements-Java selection statements, iteration statements, jump statements. [8]

3. **Classes:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, the this keyword, garbage collection, the finalize () method, a stack class, overloading methods, using objects as parameters, a closer look at argument passing, returning objects, recursion, introducing access control, understanding static, introducing final, arrays revisited, introducing nested and inner classes, exploring the string class, using command-line arguments. [9]

4. **Inheritance:** Inheritance basics, using super, creating a multilevel hierarchy, when constructors are called, method overriding, dynamic method dispatch, using abstract classes, using final with inheritance, the object class, Multithreading. [6]

5. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, creating your own exception subclasses, using exceptions. [7]

7. **I/O, Applets, and String Handling:** I/O basics, reading console input, writing console output, the Print Writer class, reading and writing files, applet fundamentals, the transient and volatile modifiers, string constructors, string length, special string operations, character extraction, operations on string. [6]

Text Books :

1. Schildt Herbert "Java: The Complete Reference" McGraw Hill Education; 9 edition,2014.

Reference Books:

1. Budo Timothy "Understanding Object-Oriented Programming with JAVA" . Pearson,1999.
2. Balagurusamy E " Programming with JAVA, A Primer" Tata Mcgraw Hill,2006.

CA 610 **Mobile Computing** **3-0-0-3**

Total Lectures:40

1**. Introduction,**issues in mobile computing, overview of wireless telephony: cellular concept, GSM: air-interface, channel structure, location management: HLR-VLR, hierarchical, handoffs, channel allocation in cellular systems, CDMA, GPRS. [8]

2. **Wireless Networking,**Wireless LAN Overview: MAC issues, IEEE 802.11, Blue Tooth, Wireless multiple access protocols, TCP over wireless, Wireless applications, data broadcasting, Mobile IP, WAP: Architecture, protocol stack, application environment, applications. [8]

3. **Data Management Issues**, data replication for mobile computers, adaptive clustering for mobile wireless networks, File system, Disconnected operations. [8]

4. **Mobile Agents computing**, security and fault tolerance, transaction processing in mobile computing environment. [8]

5**. Ad Hoc Networks**, localization, MAC issues, Routing protocols, global state routing (GSR), Destination sequenced distance vector routing (DSDV), Dynamic source routing (DSR), Ad Hoc on demand distance vector routing (AODV), Temporary ordered routing algorithm (TORA), QoS in Ad Hoc Networks, applications. [8]

Text Books:

1. Schiller J., “Mobile Communications”, Addison Wesley,2003.

2. Mehrotra A. , “GSM System Engineering”,1997.

3. Heijden M. V. D., M. Taylor, “Understanding WAP”, Artech House,2000.

Reference Books:

1. Perkins Charles, “Mobile IP”, Addison Wesley,1994.

2. Perkins Charles, “Ad hoc Networks”, Addison Wesley,2001.

CA 621 Database Management Systems Laboratory 0-0-4-2

1. **Creating Tables in SQL**

   Testing
   - Create command
   - Update commands
   - Insertion of records
   - Deletion of records
   - Primary Key
   - Foreign Key

   Programs
   - A Database Schema should be created with at least five relations.

2. **Populating records in relations**

   Testing
   - Entity integrity constraint
   - Referential Integrity constraint
   - Domain constraint

   Program
   - Populate the records with the above mentioned constraints for the 5 relations in the schema designed in 1.

3. **Views**

   Testing
   - Creation
   - Deletion
   - Modification

   Program
   - Create 5 meaningful views for the designed database.

4. **PL/SQL**

   Testing
   - Structures
   - Control Statements
   - Variables
   - cursors

CA 623 Computer Communication Networks Laboratory 0-0-4-2

Assignments are based on the course contents of CA 605 Computer Communication Networks.

CA 625 Java Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types and Operators
- Control Statements
- Arrays

Programs

- Apply logic to print different patterns(at least 3)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- 3 application programs based on above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.

2. Classes, Object and Inheritance

Testing

- Objects and reference variables
- Constructors and parameterized constructors
- this, static, command line arguments
- Inheritance, overloading and overriding
- super, abstract classes and Dynamic method dispatch

Programs

- Write a program to illustrate super .
- Show method overloading to calculate the area of different shapes.
- Manipulate the above program to illustrate run time polymorphism.
- application programs based on above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.

3. Package, Interfaces and Exception Handling

Testing

- importing packages
- interfaces and multiple inheritance
- exception-handling fundamentals
- built-in exceptions and creating one's own exception subclasses

Programs

- Write and execute a program which is inside a package "MyPacK".
- Write a program which imports a package.

CA 626 Software Engineering Lab 0-0-4-2

1. Design a software process model for a project based on SRS.

   Testing
   - Waterfall model
   - Prototyping model
   - Iterative model
   - Spiral model etc.

   Design SRS for 5 different projects and use CASE tool to select the model.

2. Software project estimation.

   Testing
   - Effort estimation
   - Development time estimation
   - Schedule estimation
   - Cost estimation

   Design 5 different projects and use CASE tool to estimate the effort, schedule, and cost required to develop a software product.

3. Develop data flow diagrams.

   Testing
   - Context diagrams
   - Level 1/2/3 diagrams
   - Balancing DFDs
   - Synchronous/asynchronous operations

   Draw DFDs for 5 different projects using CASE tool.

4. Develop software code as per coding standards.

   Testing
   - Reading Data
   - Data processing
   - Data storage
   - Data display

   Write code for a complete project that has these features.

5. Black box and white box testing.

CA 628 Mobile Application Development Laboratory 0-0-4-2

1. What is Android? o Setting up development environment o Dalvik Virtual Machine & .apk file extension o Fundamentals: a. Basic Building blocks - Activities,Services,Broadcast Receivers & Content providers b. UI Components - Views & notifications c. Components for communication -Intents & Intent Filters o Android API levels (versions & version names)
2. Emulator-Android Virtual Device o Launching emulator o Editing emulator settings o Emulator shortcuts o Logcat usage o Introduction to DDMS o Second App:- (switching between activities) Develop an app for demonstrating the communication between Intents
3. Basic UI design o Form widgets o Text Fields o Layouts o [dip, dp, sip, sp] versus px, Menu o Option menu o Context menu o Sub menu o menu from xml o menu via code
4. : Intents (in detail) o Explicit Intents o Implicit intents o Examples
5. Styles & Themes o styles.xml o drawable resources for shapes, gradients (selectors) o style attribute in layout file o Applying themes via code and manifest file
6. SQLite Programming o SQLiteOpenHelper o SQLiteDatabse o Cursor o Reading and updating Contacts o Reading bookmarks o
7. Notifications o Broadcast Receivers o Services and notifications o Toast o Alarms

CA 629 Computer Organization and Architecture 3-0-0-3

Total Lectures: 40

1. **Principles of Computer Organisation:** Software hardware interaction layers in computer architecture, central processing unit, machine language instructions, addressing modes, instruction types, instruction set selection, instruction cycle and execution cycle. [10]

2. **Processor and ALU Design:** Number system, computer arithmetic and ALU design, control unit, data path and control path design, microprogramming versus hardware control, RISC Vs CISC, pipelining in CPU design, superscalar processors. [10]

3. **Memory Organisation:** Memory subsystem, storage technologies, memory array organization, memory hierarchy interleaving, cache and virtual memories and architectural aids to implement these. [10]

4. **Input-Output Organisation:** Input-output devices and characteristics, input-output programming, bus interface, data transfer techniques, I/O interrupts, and channels. [10]

Text Books:

1. Mano M. M., "Computer System Architecture", Prentice-Hall of India, 3rd ed.1992.
2. Hayes J. P., "Computer Architecture and Organization", McGraw- Hill, New York, 3rd ed.,1988.

Reference Books:

1. Hwang K., "Advanced Computer Architecture: Parallelism, Scalability and Programmability", McGraw-Hill, New York.,1993.
2. Carter N., "Computer Architecture", Tata McGraw-Hill,2002.

CA 630 **Advanced DBMS** **3-1-0-4**

Total Lectures:40

1. **Parallel and Distributed Databases:** Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing – Three Tier Client Server ArchitectureCase Studies. [10]

2. **Object and Object Relational Databases:** Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance – Complex Objects – Object Database Standards, Languages and Design: ODMG Model – ODL – OQL – Object Relational and Extended – Relational Systems : Object Relational featuresinSQL/Oracle – Case Studies. [8]

3. XML Databases: XML Databases: XML Data Model – DTD - XML Schema - XML Querying – Web Databases – JDBC – Information Retrieval – Data Warehousing – Data Mining. [7]

4. Mobile Databases: Mobile Databases: Location and Handoff Management - Effect of Mobility on Data Management - Location Dependent Data Distribution - Mobile Transaction Models - Concurrency Control - Transaction Commit Protocols- Mobile Database Recovery Schemes. [7]

5. Multimedia Databases: Multidimensional Data Structures – Image Databases – Text/Document Databases- Video Databases – Audio Databases – Multimedia Database Design. [8]

Text Books:

1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Fifth Edition, Pearson Education/Addison Wesley,2010.

2. Thomas Cannolly and Carolyn Begg, “ Database Systems, A Practical Approach to Design, Implementation and Management”, Third Edition, Pearson Education,2009.

Reference Books:

1. Henry F Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, Fifth Edition, McGraw Hill,2005.

2. C.J.Date, A.Kannan and S.Swamynathan,”An Introduction to Database Systems”, Eighth Edition, Pearson Education,2006.

CA 631 **Real Time Systems** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Issues in Real Time Computing, Structure of a Real Time System. Task Classes, Performance Measures for Real Time Systems, Estimating Program Run times. Task Assignment and Scheduling -Classical Uniprocessor scheduling algorithms, UniProcessor scheduling of IRIS Tasks, Task Assignment,Mode Changes, and Fault Tolerant Scheduling. [8]

2. **Programming Language and Tools:** Desired Language characteristics, Data Typing, Control structures,Facilitating Hierarchical Decomposition, Packages, Run-time (Exception) Error handling, Overloading andGenerics, Multitasking, Low Level programming, Task scheduling, Timing Specifications, Programming Environments, Run-time Support. [8]

3. **Real time Databases**: Basic Definition, Real time Vs General Purpose Databases, Main Memory Databases,Transaction priorities, Transaction Aborts, Concurrency Control Issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time systems. [8]

4. **Real-Time Communication**: Communications Media, Network Topologies Protocols, Fault TolerantRouting. Fault Tolerance Techniques - Fault Types, Fault Detection. Fault Error containment Redundancy,Data Diversity, Reversal Checks, Integrated Failure handling. [8]

5. **Reliability Evaluation Techniques**: Obtaining Parameter Values, Reliability Models for HardwareRedundancy, Software Error models. Clock Synchronization - Clock, A Nonfault-Tolerant SynchronizationAlgorithm, Impact of Faults, Fault Tolerant Synchronization in Hardware, Fault Tolerant Synchronization in Software. [8]

Text Books:

1. C.M. Krishna, Kang G. Shin, “Real-Time Systems”, McGraw-Hill International Editions,1997.

1. Stuart Bennett, “Real Time Computer Control-An Introduction”,Second edition Perntice Hall PTR,1994.

Reference Books:

1. Peter D. Lawrence, “Real time Micro Computer System Design – An Introduction”, McGraw Hill,1988.
2. S.T. Allworth and R.N. Zobel, “Introduction to real time software design”, Macmillan, II Edition,1987.

CA 632 **Software Project Management** **3-1-0-4**

Total Lectures:40

1.**Introduction To Software Project Management :**Project Definition – Contract Management – Activities Covered By Software Project Management – Overview Of Project Planning – Stepwise Project Planning. [6]

2. **Project Evaluation :** Strategic Assessment – Technical Assessment – Cost Benefit Analysis – Cash Flow Forecasting – Cost Benefit Evaluation Techniques – Risk Evaluation. [6]

3. **Activity Planning:** Objectives – Project Schedule – Sequencing and Scheduling Activities – Network Planning Models – Forward Pass – Backward Pass – Activity Float – Shortening Project Duration – Activity on Arrow Networks – Risk Management – Nature Of Risk – Types Of Risk – Managing Risk – Hazard Identification – Hazard Analysis – Risk Planning And Control. [9]

4. **Monitoring And Control:** Creating Framework – Collecting The Data – Visualizing Progress – Cost Monitoring – Earned Value – Priortizing Monitoring – Getting Project Back To Target – Change Control – Managing Contracts – Introduction – Types Of Contract – Stages In Contract Placement – Typical Terms Of A Contract – Contract Management – Acceptance. [9]

5. **Managing People And Organizing Teams:** Introduction – Understanding Behavior – Organizational Behaviour: A Background – Selecting The Right Person For The Job – Instruction In The Best Methods – Motivation – The Oldman – Hackman Job Characteristics Model – Working In Groups – Becoming A Team –Decision Making – Leadership – Organizational Structures – Stress –Health And Safety – Case Studies. [10]

Text Books:

1. Bob Hughes, Mikecotterell, “Software Project Management”, Third Edition, Tata McGraw Hill,2011.

2. Ramesh, Gopalaswamy, "Managing Global Projects", Tata McGraw Hill,2001.

Reference Books:

1. Jalote, “Software Project Management in Practice”, Pearson Education,2002.

2. Royce, “Software Project Management”, Pearson Education,2005.

CA 633 **M -Commerce** **3-1-0-4**

Total Lectures:40

1. **Electronic Commerce:** Introduction, e-commerce marketplace, Focus on portals, Location of trading in the marketplace, Commercial arrangement for transactions , auctions business models for e-commerce, Revenue models, E-commerce versus E-business. [6]

2. **Mobile Commerce:** Overview, Infrastructure, Types of Mobile Commerce Services, Technologies of Wireless Business, Benefits and Limitations, Support, Mobile Marketing and Advertisement, Non Internet Applications in M–Commerce. [6]

3. **Mobile Commerce Technology:** Framework of Mobile Commerce,NTT Docomo‘s I– Mode, Wireless Devices for Mobile Commerce, Classification of Framework for Mobile Location Based Services, Wireless Personal and Local Area Networks, The Impact of Technology in Mobile Communications Networks. [7]

4. **Mobile Commerce Theory and Applications:** The Ecology of Mobile Commerce, Wireless Application Protocol, Mobile Business Services, Mobile Portal, Factors affecting the Adoption of Mobile Gaming Services, Mobile Data Technologies and Small Business Adoption and Diffusion. [5]

5. **Business– to– Business Mobile E-Commerce:** Enterprise Enablement, Email and Messaging, Field Force Automation, maintenance and management, Remote IT Support Customer Retention, B2C Services, Warehouse automation security. [6]

Text Books:

1. Chaffey Dave, “E-Business and E-Commerce Management”, Pearson Education, Third Edition, 2009,.

2. Mennecke Brian E., Strader Troy J., “Mobile Commerce: Technology, Theory andApplications”, Idea Group Inc., IRM press,2003.

Reference Books:

1. Louis P. J., “M-Commerce Crash Course”, McGraw- Hill,2001.

2. May Paul, “Mobile Commerce: Opportunities, Applications, and Technologies of Wireless Business” Cambridge University Press,2001.

3. Papazoglou Michael P., Ribbers Peter M.A., “e-business organizational and Technical foundation”,Wiley India,2009.

4. Dr.Pandey , Shukla Saurabh “E-commerce and Mobile commerce Technologies” , Sultanchand ,2011.

CA 634 **Software Engineering** **3-0-0-3**

Total Lectures:40

1. **Introduction To Software Engineering:** Software crisis, Software engineering Approach and Challenges, Software development process models with comparison: Waterfall, Rapid prototyping, Timeboxing and Spiral Models, and Automation through software environments. [8]
2. **Planning The Software Project:** Cost Estimation, Planning Schedule, Staffing, Project Monitoring, Quality Assurance and Risk Management. [8]
3. **Structured Analysis:** Initial Investigation, Feasibility study, Traditional and modern methods of requirement determination, SRS, Structuring the requirements: Process modeling, logic modeling, conceptual data modeling, Metrics. Validation VS verification [8]
4. **Design Fundamentals:** Function and Object Oriented Design concepts, Verification and Metrics. Coding and Maintenance: Coding Process, Metrics, Testing fundamentals, Types of Testing, Metrics, Types of Maintenance. [8]
5. **Software Re-Engineering:** Source Code Translation, Program Restructuring, Data Re-Engineering, Reverse Engineering. [8]

Text Books:

1. Sommerville Ian, “Software Engineering”, Addison Wesley, 6th ed,1995.
2. Hoffer, George, Valacich, “Modern System Analysis and Design” Pearson Education, 3rd ed,2012.

Reference Books:

1. Pressman S. Roger, “Software Engineering”, Tata McGraw-Hill,2009.
2. JalotePankaj, “An integrated Approach to Software”, Engineering, Narosa Publishing House,2014.

CA 642 **Digital Image Processing** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Background, Digital Image Representation, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System. Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry. [8]
2. **Image Transforms:** Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two-Dimensional Fourier Transform, Other Separable Image Transforms. [8]
3. **Image Enhancement :** Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background, Smoothing Filters, Sharpening Filters, Lowpass Filtering, Highpass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. [8]
4. **Image Restoring:** Degradations Model - Definitions, Degradation Model for Continuous Functions, Diagonalization of Circulant and Block-Circulant Matrices, Circulant Matrices, Block Circulant Matrices, Effects of Diagonalization on the Degradation Model, Algebraic Approach to Restoration, Unconstrained Restoration, Constrained Restoration, Inverse Filtering – Formulation, Removal of Blur Caused by Uniform Linear Motion, Restoration in the Spatial Domain, Geometric Transformation. [8]

5. **Image Compression:** Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria. Image Compression Models,The Channel Encoder and Decoder. Elements of Information Theory Measuring Information, The Information Channel, Fundamental Coding Theorems, Using Information Theory. Error-Free Compression. Lossy Compression. [8]

Text Book:

1. Rafael. C. Gonzalez & Richard E.Woods., “Digital Image Processing”, 2/e Pearson Education, New Delhi.2009.

Reference Books:

1. W.K.Pratt., “Digital Image Processing” ,3/e Edn., John Wiley and sons, Inc,2001.

2. M. Sonkaet.al “Image Processing, Analysis and Machine Vision”, 2/e, Thomson, Learning, India Edition,1998.

CA 644 **Artificial Intelligence** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Overview of artificial intelligence (AI) and AI techniques. [3]
2. **Problem Solving:** Searching, state space formulation, depth first & breadth first searches and intelligent searching. [7]
3. **Production Systems:** Design, implementation & limit factors and case studies. [7]
4. **Game Playing:** Minimax and Alpha-beta pruning. [6]
5. **Knowledge and Reasoning:** Propositional & first order topic, semantic networks, inference and logical reasoning systems. [6]
6. **Knowledge Representation:** CD, frames & scripts, learning and neural networks. [6]
7. **Advanced Topics:** Expert system, natural language processing, PROLOG. [5]

Text Books:

1. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 2nd ed,2008.
2. Bratko I., PROLOG Programming for Artificial Intelligence, 3rd ed,2001.

Reference Books:

1. Russell S., and Norvig P., Artificial Intelligence – A Modern Approach, Prentice-Hall of India, 2nd ed,2009.
2. Patterson D. W., Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall of India,1990.

CA 646 **Parallel Processing** **3-1-0-4**

Total Lectures:40

1. **Parallel Processing:** Introduction, data and control parallelism, (concurrency, scalability, speedup, Amolahl's Law), PRAM model of parallel computation, parallel algorithm design. [8]
2. **Multiprocessors and Multicomputers:** Processor organization, shared memory and message passing systems, message passing interface programming with respect to PARAM 10000. [9]
3. **Array Processing:** SIMD array processing, communications, SIMD interconnection networks, algorithms for array processing. [8]
4. **Applications:** Parallel algorithms for matrix multiplication, fast Fourier transform, linear systems, sorting, numerical integration, and optimization. [7]
5. **Parallel Programming Languages:** C, C++ and high performance FORTRAN. [8]

Text Books:

1. Hwang K., "Advanced Computer Architecture", Tata McGraw-Hill,2003.
2. Quinn M. J., "Parallel Computing", Tata McGraw-Hill, 2nd ed,2002.

Reference Books:

1. Hwang K. and Briggs F. A., "Computer Architecture and Parallel Processing", McGraw-Hill, New York.,1984.
2. Sinha P. K., "Distributed Operating System", Prentice-Hall of India,1997.

CA 648 **Service Oriented Architecture** **3-1-0-4**

Total Lectures:40

1. **Roots of SOA**: Characteristics of SOA - Comparing SOA to client-server and distributed internet architectures – Anatomy of SOA- How components in an SOA interrelate - Principles of service orientation. [5]

2. **Web Services**: Service descriptions – Messaging with SOAP –Message exchange Patterns – Coordination –Atomic Transactions – Business activities – Orchestration – Choreography - Service layer abstraction –Application Service Layer – Business Service Layer – Orchestration Service Layer [9]

3**. Service Oriented Analysis**: Business-centric SOA – Deriving business services- service modeling - Service Oriented Design – WSDL basics – SOAP basics – SOA composition guidelines – Entity-centric business service design – Application service design – Task- centric business service design [9]

4. **SOA Platform Basics**: SOA support in J2EE – Java API for XML-based web services (JAX-WS) - Java architecture for XML binding (JAXB) – Java API for XML Registries (JAXR) - Java API for XML based RPC (JAX-RPC)- Web Services Interoperability Technologies (WSIT) - SOA support in .NET – Common Language Runtime - ASP.NETweb forms – ASP.NET web services – Web Services Enhancements (WSE) [10]

5.WS-BPEL Basics: WS-Coordination overview - WS-Choreography, WS-Policy, WS-Security. [7]

Text Books:

1. Thomas Erl, "Service-Oriented Architecture: Concepts, Technology, and Design", Pearson Education,2005.

Reference Books:

1. Thomas Erl, "SOA Principles of Service Design" The Prentice Hall,2007.
2. Newcomer, Lomow, "Understanding SOA with Web Services", Pearson Education,2005.
3. Sandeep Chatterjee, James Webber, "Developing Enterprise Web Services, An Architect's Guide", Prentice Hall Professional, 2004.

CA 709 **Distributed Systems** **3-1-0-4**

Total Lectures:40

1. **Characterization of Distributed Systems:** Definition, distributed systems- Internet, intranet, mobile, ubiquitous computing, resource sharing and World Wide Web challenges- heterogeneity, openness, security scalability failure handling concurrency and transparency. [4]
2. **System Models:** Architecture models- software layers, system architecture, variations on client-server model, interfaces and objects, design requirement for distributed architectures, fundamental models-interaction models, failure model and security model. [5]

3. **Distributed Object and Remote Invocation:** Introduction to remote method invocation (RMI) and interface in distributed systems, communication between distributed objects- objects model, distributed objects, distributed objects model and design issues for RMI, implementation of RMI and distributed garbage collection, remote procedures call and sun RPC case study, events and notifications-participants, JINI distributed event specification, Java RMI case study, building client and server programs, design and implementation of Java RMI. [10]

4. **Time and Global State:** Clocks, events and process states, synchronizing physical clocks- synchronization in a synchronous system, Cristian method for synchronizing clocks, Berkley algorithm and network time protocol, global state and consistent cuts. [5]

5. **Distributed Shared Memory:** Introduction, message passing versus DSM, implementation approaches to DSM, design and implementation issues-structure and synchronization model. [5]
6. **Processes and Processors in Distributed Systems:**Threads, system models, processor allocation, scheduling, fault tolerance. [5]

7. **Distributed File System:** Design, implementation, trends in distributed file system. [6]

Text Books:

1. Coulouris G., "Distributed System Concepts and Design", Pearson Education Asia, 3rd edition, 2003
2. Tannenbaum A. S., "Distributed Operating Systems", Pearson Education Asia,2001.

Reference Books:

1. Sinha P. K., "Distributed Operating Systems", Prentice-Hall of India, 2001.
2. Valduriez O., "Principles of Distributed Database Systems", Pearson Education Asia, 2nd edition, 2002.

CA 711 **Data Mining and Warehousing** **3-0-0-3**

Total Lectures:40

1. **Overview:** Concept of data mining and warehousing, data warehouse roles and structures, cost of warehousing data, roots of data mining, approaches to data exploration and data mining, foundations of data mining, web warehousing, web-warehousing for business applications and consumers, introduction to knowledge management, data warehouses and knowledge bases. [6]

2. **Data Warehouse:** Theory of data warehousing, barriers to successful data warehousing, bad data warehousing approaches, stores, warehouse and marts, data warehouse architecture, data about data - metadata, metadata extraction, implementing the data warehouse, data warehouse technologies. [4]

3. **Data Mining and Data Visualization:** Data mining, OLAP, techniques used to mine the data, market basket analysis, current limitations and challenges to DM, data visualization. [5]

4. **Designing and Building the Data Warehouse:** Theenterprise model approach of data mining design, data warehouse project plan, analysis and design tools, data warehouse architecture, specification and development**.** [5]

5. **Web-Based Query and Reporting:** Delivering information over the web, query and reporting tools and business value, architectural approaches to delivering query capabilities over the web. [3]

6. **Web Based Statistical Analysis and Data Mining:** Analytical tools, business value from analytical tools, humble spreadsheet, statistical products overview – statistical analysis applications, correlation analysis, regression analysis, data discovery tools. [6]

7. **Future of Data Mining and Data Warehousing:** Future of data warehousing, trends in data warehousing, future of data mining, using data mining to protect privacy, trends affecting the future of data mining, future of data visualization. [3]

Text Books:

1. Marakas G. M., “Modern Data Warehousing, Mining and Visualisation”, Pearson Education Asia, 2003.
2. Mattison R., “Web Warehousing and Knowledge Management”, Tata McGraw-Hill,2002.
3. Anahory S., and Murray D., “Data Warehousing in the Real World”, Pearson Education Asia,2002.

CA 715 **Computer Graphics** **3-1-0-4**

Total Lecture:40

1. **Overview:** Display devices – Video, refresh CRT, raster scan, random scan, color CRT, monitors raster scan systems, video controller, raster scan display processor, input devices – trackball and space ball, joy-sticks, digitizers, scanners, touch panels, light pen. [4]
2. **Scan Conversion:** Primitive drawing – DDA and Bresenham algorithm for line, circle, ellipse, general curves, filling – scan line polygon fill algorithm, inside-outside tests, flood-fill, boundary-fill, attributes – area fill attributes, line and text attributes. [8]
3. **Two-Dimensional and Three-Dimensional Transformations:** Basic transformations, matrix representation and homogeneous co-ordinates, composite transformation, reflection, shear transformation. [8]
4. **Three-Dimensional Object Representations:** Polygon surfaces, polygon tables, plane equations, polygon meshes, curved lines and surfaces, quadric surfaces, spheres, curves, spline representations and spline specifications, Bezier and B-spline curves. [8]
5. **Clipping and Viewing:** Line clipping – Cohen Suther Land, Liang-Barsky, polygon clipping – Suther Land – Hodgman, Weiter-Atherton, projection and its transformation – parallel and perspective, vanishing points. [8]
6. **Visibility:** Classification and detection algorithm, back face detection, depth – buffer, scan line, depth sorting and BSP tree, ray casting method and curved surfaces. [4]

Text Books:

1. Hearn D. and Baker P. M., "Computer Graphics", Prentice-Hall of India, 2nd edition, 2004.
2. Newman W., and Sproul R. F., "Principles of Interactive Computer Graphics", McGraw-Hill, New York, 2nd ed, 1992.

Reference Books:

1. Foley J. D., and Van D. A., "Fundamentals of Interactive Graphics", Addison-Wesley, 2nd ed, 1983.
2. Roger D. F., "Procedural Elements for Computer Graphics", McGraw-Hill, New York, 2nd edition, 1985
3. Harrington S., "Computer Graphic", McGraw-Hill, New York, 2nd editon, 1995
4. Xiang Z., and Plastock R., "Theory and Problems of Computer Graphics", McGraw-Hill, New York, 2nd edition, 2000.

CA 725 COMPUTER GRAPHICS LABORATORY 0-0-4-2

1. **Introduction to computer graphics & graphics systems**

   Testing
   - Demonstration of graphics display devices, IO devices.
   - Initialization of graphic in 'C'.
   - Use of graphics primitives – line, circle, rectangle, arc, etc.

   Programs
   - Graphics programs are to be written for the above graphics primitives with color and moving effect (E.g. bus, hut, fish, kite etc).

2. **Scan conversion**

   Testing
   - Line drawing algorithms (DDA, Bresenham, mid-point).
   - Circle generation algorithm (Bresenham, mid-point)
   - Ellipse generation algorithm
   - Filling algorithm (boundary fill, flood fill, scan line polygon fill)

   Program
   - Graphics programs are to be written for each of the above algorithms.

3. **2D & 3D transformation**

   Testing
   - Translation
   - Rotation
   - Scaling
   - Reflection
   - Shearing

   Program
   - Graphics programs are to be written for each of the above algorithms for different axis.

4. **2D viewing & clipping**

   Testing
   - Line clipping algorithm (Cohen Sutherland, Liang Barsky)
   - Polygon clipping (Sutherland Hodgeman, Weiler and Atherton)

   Program
   - Graphics programs are to be written for each of the above algorithms.

CS 218 Computer Organization and Architecture 3-1-0-4

Total Lectures:40

1. **Basic Structure of Computers:** Functional units, basic operational concepts, bus structures, software performance, memory locations and addresses, memory operations, instruction and instruction sequencing, addressing modes, assembly language, basic I/O operations. [8]

2. **Arithmetic Unit:** Addition and subtraction of unsigned and signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication and fast multiplication, integer division, floating-point numbers and operations. [8]

3. **Processing Unit:** Fundamental concepts, execution of a complete instruction, multiple bus organization, hardwired control, microprogrammed control, parallel processing, pipelining, basic concepts of hazards, data and instruction hazards, data path and control hazard consideration. [10]

4. **Memory System:** Basic concepts, semiconductor RAMs, ROMs: speed, size and cost, cache memories, performance consideration, virtual memory, memory management requirements, secondary storage. [8]

5. **I/O Organization:** Accessing I/O devices, interrupts, direct memory access, buses, interface circuits, standard I/O interfaces (PCI, SCSI, USB). [6]

Text Books:

1. Hamacher Carl, Vranesic Zvonko and Zaky Safwat, "Computer Organization", , McGraw-Hill, 5th Edition, 2002.
2. Stallings William, "Computer Organization and Architecture-Designing for Performance", Pearson Education, 8th Edition, 2011.

Reference Books:

1. Mano Morris, "Computer System Architecture", Pearson Education, 3rd Edition, 2007.
2. Hayes John P., "Computer Architecture and Organization", McGraw Hill, 3rd Edition, 1998.
3. Patterson David A. and Hennessy John L., "Computer Organization and Design: The hardware / software interface", Morgan Kaufmann, 2nd Edition, 2002.

CT 509 **Basic Communication Skills** **3-0-0-3**

Total Lectures:40

1. **Spoken English:** Basic sentence types, Tenses (Present, Past, Future), Modals (can, could, shall, should, will, would, may, might, must, ought to, need), Determiners, Question Tags, Phrasal verbs. [8]

2. **Reading and Writing:** Reading Comprehension**:** Efficient reading and note taking, Proof Reading, Précis Writing, Report Writing, Theme (paragraph) Writing, Resume Writing, composing an email. [5]

3. **Advance Communication:** Definition and purpose, Art of Communication, Quizzes, exercise and incidents for practice. [6]

4. **Group Discussion:** Definition, importance, process, points to be borne in mind while participating, Do's and Don'ts in GD, Practice. [6]

5. **Interview skills:** Definition, process, types and preparation (physical, mental), Preparation for FAQ, Dos and Don'ts, Practice. [6]

6. **Communication issues:** Choice of words, sentence formation, essentials of effective communication, barriers to communication. [3]

7. **Different Notions and Concepts:** Request, order, condition, purpose, suggestion, wishes, obligation, possibility, concession. [3]

8 **Phonetics:** Phonology and morphology, body language, pronunciation. [3]

Text Books:

1. Hornby A.S.: "A Guide to Patterns and Usage", Oxford University Press, Delhi,1975.
2. Leech Geoffery: "English Grammar for today", Longman, Delhi,2009.
3. Tonguk R.K, Kumar S.K; "An English Miscellany", Oxford University Press, New Delhi,1999.

Mody University of Science & Technology
Lakshmangarh (Sikar)

College of Engineering & Technology

Department of Nuclear Science & Technology (NST)

Detailed Syllabus for

M. Tech. (Nuclear Science & Technology)

NU- 501 Quantum Mechanics and Electrodynamics 3-1-0-4

Quantum Mechanics

1. Origin of quantum theory and related experiments, wave-particle duality, wave function and its Born interpretation, uncertainty principle, Schrodinger equation, wave functions, wave packets, probability amplitudes, solutions to Schrodinger equation in one dimensions; Barrier penetration, Potential wells, Simple harmonic oscillator, Schrodinger equation in three dimensions.

[7]

2. Formalism of quantum mechanics; Liner vector space, Function spaces, Hilbert space formalism, inner product and probability, completeness of Eigen functions, delta functions, Bra & Ket notation, matrix representation of an operator, change of basis, unitary transformations.

[6]

3. General treatment of angular momentum, spin, identical particles; SHM problem by operator method; Pauli exclusion principle; Scattering theory; some calculations, Perturbation theory, WKB approximation.

[7]

Electrodynamics

4. Coulomb law and electrostatics, Laplace and Poisson equations, Maxwell's equations, partial polarization, Lorentz force, Poynting theorem. Scalar and vector potentials, Gauge transformations and gauge invariance.

[5]

5. Special theory of relativity, four vectors, Field tensor, Relativistic formulation of electrodynamics, Maxwell equations in covariant form

[4]

6. Relativistic charged particle in an electromagnetic field, Motion in uniform electric and magnetic fields and combinations of E and B fields, Non uniform static magnetic field

[4]

7. Green's function for wave equation (relativistic), Radiation from localized moving charges, Multi pole expansion, dipole and quadrupole radiation, Radiation from accelerated charge

[4]

8. Power radiated by point charge, Larmor's formula, Angular distribution of power, Bremsstrahlung and synchrotron radiation, Dispersion theory, Radiative reaction, Radiative damping

[5]

Text Books:

1. Griffiths D. J., Introduction to Quantum Mechanics, 2nd edition, Pearson, 2009.
2. Griffiths D. J., Introduction to Electrodynamics, 3rd edition, Prentice Hall India, 1999.
3. Ghatak A. K. & Lokanathan S., Quantum Mechanics: Theory and Applications, 5th edition, Macmillan India, 2004.

Reference Books:

1. Schiff L. I., Quantum Mechanics, 3rd edition, Tata McGraw-Hill, 2010.
2. Zettili N., Quantum Mechanics: Concepts & Applications, 2nd edition, Wiley, 2009.
3. Jackson J. D. Classical Electrodynamics, 3rd edition, Wiley, 1998.
4. Lifshitz E. M. & Landau L. D., Quantum Electrodynamics (Course of Theoretical Physics), 2nd edition, Pergamon Press, 1981.

NU- 503 **Nuclear Physics** **3-1-0-4**

1. Basic concepts of general properties of nuclei: Charge, Masses and relative abundances, mass defect, size and shape, binding energy, angular momentum, magnetic dipole moments and electric quadrupole moments, Parity, Nuclear radius, Radioactivity, units of radiation, Aplha, Beta and Gamma decay.

[8]

2. Nuclear forces: The Deutron, Nucleon- Nucleon scattering, p-p and n-n interactions, properties of nuclear force, phase shift analysis, Measurement of nuclear parameters, Mossbaur effect

[8]

3. Nuclear models: Liquid drop model, Fermi gas model, Shell model, Collective model, Compound nucleus and Statistical model

[8]

4. Nuclear reactions: Types of reactions and conservation laws, Reaction dynamics, Scattering and reaction cross sections, the Q of Nuclear reaction, Nuclear fission, Nuclear fusion

[8]

5. Elementary particle physics, Hadrons and leptons, their masses, spin parity decay structure, quarks and gluons, Charge conjugation, The CPT theorem and applications of symmetry arguments to particle reactions, symmetries, weak interactions

[**8**]

Text Books:

1. Krane K. S., Introductory Nuclear Physics, John Wiley, 1987.
2. Roy R. R. & Nigam B. P., Nuclear Physics; Theory and Experiments, 1st edition, New Age International, 1967.
3. Burcham W. E. & Jobes M., Nuclear and particle Physics, 2nd edition, John Wiley, 1995.

Reference Books:

1. Wong & Samuel S. M., Introductory Nuclear Physics, 2nd edition, John Wiley, 1999.
2. Cohen B. L., Concepts of Nuclear Physics, Tata McGraw-Hill edition, 2008.

NU 505 **Reactor Physics** **3-1-0-4**

Nuclear Fission; Delayed Neutrons; Reactor Types, Neutron Slowing-down and Thermalization, Critical Reactor; Multigroup Transport and Diffusion Equations for a Critical Reactor [12]

Reactor Calculations and Homogenization, Multigroup Constants, Group Constants in Resonance Region [8]

Perturbation & Variational Methods; Nodal and Finite-Element Transport Theory Methods; Integral Transport Theory [8]

Non-critical Reactors; Point Reactor Kinetics Equations; Solution of Kinetics Equations; Determination of Kinetics Parameters; Feedback; Xenon Oscillations; Fuel Depletion; Spatial Effects. [12]

Text Books:

1. P. F. Zweifel, *Reactor Physics*, McGraw-Hill, New York (1973).
2. Rudi J.J. Stamm'ler and M. J. Abbate, *Methods of Steady-State Reactor Physics in Nuclear Design*, Academic Pr (1983)
3. K. Sriram and Y. R. Waghmare, Introduction to Nuclear Science and Technology, South Asia Book (1990)
4. S.Garg, F. Ahmed and L.S.Kothari, *Physics of Nuclear Reactors*, Tata McGraw Hill, New Delhi (1986).

NU 520 Nuclear Power Plant Operation and Control 3-1-0-4

1. Applications of Reactor Physics for operation, Function of Delayed Neutron Monitoring System and method of identifying failed fuel, Neutron Flux Monitoring, Steady State operation of reactor [6]

2. Subcritical multiplication and reactor startup- Reactor operation without feedback- Analytic solution of reactor kinetics, Dynamic period , Reactor operation with feedback effects- Achievement of feedback effects, Shutdown margin [6]

3. Energy release and deposition, Heat generation parameters, Neutron flux distributions and power profiles in reactor cores, Power peaking factors, Heat generation in the structure, Reactor shutdown [6]

4. Temperature coefficients of reactivity, reactivity feedback, Loss-of-cooling accidents, Reactivity insertion accidents, Containment pressurization process, Response of a PWR pressurizer to load changes, Nuclear Power Plant control [6]

5. Review of fundamentals: Laplace transforms, frequency response and stability analysis, process identification, Advanced control techniques: Feed forward control, ratio control, cascade control, Computer process control: z-transforms, digital signal conditioning, system identification, stability analysis, classical control algorithms (PID etc.), Introduction to Model predictive and adaptive control schemes [8]

6. Sensors for pressure, flow, leak, level, temperature and composition, valve dynamics, neutronic instrumentation, reactor protection instrumentation, process instrumentation [8]

BOOKs

1. Lamarsh, John. Introduction to Nuclear Engineering. 3rd ed. Englewood Cliffs, NJ: Prentice Hall, 2001
2. Reactor Control Engineering by J M Harrer, Van Nostrand, (1963)
3. Control of Nuclear Reactors and Power Plants, by M. A. Schulz , McGraw-Hill Co., New York (1961)

Suggested Readings:

1. D R Coughanowr, Process Systems Analysis and Control, McGrawHill, 1991**.**
2. G Stephanopoulos, *Chemical Process Control*, Prentice Hall, 1985.
3. S Glasstone and A Sesonske, *Nuclear Reactor Engineering*, Vonostrand, 1981

NU- 522 Radiation Physics Instruments and Shielding 3-1-0-4

1. Atomic and Nuclear Structure, Natural and Artificial Radiation, Units and Measurement, Laws of Decay, Properties of Different Types of Radiation, Production of Radionuclides, Interactions of Charged Particles and Photons, Biological Effects of Ionizing Radiation, Radiation Protection Standards and Their Implementation [**10**]

2. Radiation detectors: Gas-filled ionization detectors-Ionization chambers, proportional counters and GM counters, Pulse height spectra and energy resolution, Semi-conductor detectors – Working of a p-n junction detector, partially and totally depleted detectors, surface barrier detectors, Lithium drifted Silicon detectors (Si(Li)), high-purity Germanium(HPGe) gamma detectors, Particle identification and time of flight technique, Scintillation detectors- scintillation mechanism in inorganic crystal scintillators and organic scintillators, Pulse height spectrum using a monoenergetic gamma ray source, Production and detection of neutrons-typical neutron sources, He proportional counters, fission counters. [**10**]

3. Radiation Instrumentation, Portable Survey Instruments, Use of radiation Survey Instruments, Scintillation Counters Radiation Shielding, Shielding Materials for Different Types of Radiation, Requirement for Shielding, Acceptable Radiation Levels for Various Areas, Merits and Demerits of Shielding Material, Criterion for Selecting Shielding Material [**10**]

4. Protection against Radiation Exposure, External radiation protection, Internal radiation protection, Calculation of Radiation Dose, Field, Man-rem and Duration of Work, Biological and Genetic Effects. [**10**]

Books:

1. Knoll G. F., *Radiation Detection and Measurement*, 3rd Edition, John Wiley and Sons (2000)
2. Martin A. A. & Samuel A. H., Introduction to Radiation Protection, 5th edition, Oxford university Press, (2006)
3. Cember H., Introduction to Health Physics, 3rd edition, McGraw-Hill, (1996)

Suggested Readings:

1. Turner J. E., Atoms, Radiation, and Radiation Protection, 3rd edition, Wiley, 1995.
2. Kapoor S. S. and Ramamurthy V. S., *Nuclear Radiation Detectors*, Wiley Eastern Limited, New Delhi (1986).

NU 523 Simulations in Nuclear Engineering 1-0-6-4

Physical simulation- advantage and limitations, Transport phenomena – concept of physical domain and computational domain- assumptions and limitations in numerical solutions [3]

Introduction to Finite difference Techniques, Finite Element Techniques, Finite Volume Techniques [3]

Basics about Monte Carlo Simulation, Algorithms for Monte carlo simulations [4]

Computational methods to analyze nuclear reactor systems described by various differentials, integral and integro-differential equations, Typical problem studies related with radionuclide decay chain, spatial dependence of radiation diffusion, transient heat diffusion [30]

Text Books:

1. Law, A. M. and Kelton, W. D., Simulation, Modeling & Analysis", 3rd Edition, Tata Mc Graw Hill , New Delhi-2003
2. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom, "The Finite Element Method for Engineers".
3. Banks, J, Carson J. S. H. and Nelson, B. L. " Discrete Event System simulations", 2nd edition , PHI, New Jersey, 1999
4. Elmer E Lewis and warren F Miller Jr., Computational methods of Neutron Transport, Wiley – Inter science, 1993

Reference Books:

1. Hector Guerrero Excel Data Analysis: Modeling and Simulation.
2. James; Biersack, J.P.; Ziegler, M.D. Ziegler, "SRIM - The Stopping and Range of Ions in Matter"
3. COMSOL Multiphysics manuals

NU 524 **Physics and Technology of Nuclear Fusion** **3-1-0-4**

1. Plasma- the fourth state of matter, Debye shielding, Collective behavior, Plasma frequency, Plasma Sheath, Plasma in nature and Laboratory, Industrial applications of plasma **[6]**
2. Basic plasma processes, Ionization and Recombination, Coulomb collision, Radiations from plasmas, Plasma Transport processes **[5]**
3. Motion of charged particles in electric and magnetic fields, Adiabatic invariance, Introduction to kinetic theory, Boltzmann equation, Vlasov plasma model, Fluid model from kinetic model, MHD equation, Plasma equilibrium and stability analysis **[6]**
4. Waves and instabilities in plasma **[5]**
5. Plasma generation using DC, RF and microwave power, Plasma diagnostics- Langmuir probe and Spectroscopy **[5]**
6. Energy crisis and role of fusion, Lawson criterion, Ignition criterion and burn physics, Plasma confinement approaches, Open and closed magnetic systems, alternate confinement concepts **[7]**
7. Fusion technology: Plasma heating, First wall sputtering and cooling, Diverter, Blanket physics, Fusion materials **[6]**

Books:

1. Introduction to Plasma Physics, F. F. Chen, 2nd edition, Plenum Press, (1984)
2. Physics of High Temperature Plasma, G. Schmidt , 2nd edition Burlington, MA: Academic Press (1979)
3. Fusion Research, Thomas J Dolan, Pergamon Press, 1982

Suggested Readings:

4. Industrial Plasma Engineering, Vol.1, Principles, J. R. Roth, Institute of Physics, 2001
5. Fusion Plasma Physics, Weston M Stacy, Wiley-VCH, 2001
6. Plasma physics and Fusion Energy, J. P. Freidberg, Cambridge University Press, 2007

NU 525 **Nuclear Power Engineering – I** **3-1-0-4**

Principles of the conversion of nuclear energy to useful power, Over view of various types of nuclear power plants that have been designed, built and operated, Economics of nuclear vs. other types of power plants. Economics of nuclear power plants, accounting for capital costs, fuel costs and O&M (operations and maintenance) costs, as well as environmental aspects - sustainability, proliferation, safety [6]

Neutron induced reactions-Reaction mechanism-microscopic cross sections-variation of cross section with neutron energy-resonances-1/v law, Nuclear fission-fission products-prompt & delayed neutrons-energy balance per fission-mechanism of fission-fissile and fertile materials[6]

Introduction of Nuclear reactor plant design, Reactor Assembly, Coolant Channels, Moderator and Auxiliary Systems, Primary heat Transport and Auxiliaries, Special Safety Systems and Reactor Shield cooling systems, Detailed features of pressurized water reactor components, including steam generators, Pressurisers and chemical-shim control systems. [12]
Problems related to features of gas-cooled reactor cycles and components, and compare/contrast those features with those of conventional LWRs. Difference in neutron spectrum and fuel type between a fast reactor and a LWR affect fast reactor physics and performance. [8]
Advanced future types of nuclear power plants that are in the design or developing stages. Reactor designs of power plants, their energy conversion principles, cycles and load-following characteristicsCompare and contrast the relative merits of different types of power plants. [8]

Text Books:

1. S. Glasstone & A. Sessoske, Vol I & II, CBS Publishers & Distributors, New Delhi (2009)

2. M. M. El-Wakil, *Nuclear Energy Conversion,* American Nuclear Society; Revised edition (1982)

3. John R. Lamarsh and Anthony J. Baratta, *Introduction to Nuclear Engineering*, 3rd Edition, Prentice Hall (2001).

NU-526 Nuclear Power Engineering-II

Chain reaction-classical four factor formula-eta vs. energy curve-conversion & breeding ratios-thermal and fast reactors.- Neutron lifetime-Conversion & breeding though eta vs. energy curve, Macroscopic cross-section, mean free path, neutron flux ,neutron current, beam attenuation-dependence of flux on space, energy, direction and time- simplified model, Neutron balance equation-rigorous Boltzmann and simplified diffusion equation through Fick's law. Multiplying and non-multiplying media

[10]

Boiling Water Reactors : **[10]**
Reactor Internals and Their Functions, Emergency Safeguard Systems, Reactor Safety, Containment System, Spent Fuel Management

Pressurized Water Reactor: **[10]**
Reactor Internals and Their Functions, Emergency Safeguard System, Reactor Safety, Containment System, Spent Fuel Management

Application of Reactor Physics for Operation **[5]**
Design Basis of Reactor Regulation and Protection System **[5]**

NU 528 **Reactor Thermal Hydraulics** **3-1-0-4**

1. Introduction – Different Reactor Types, Introduction – Types of Fuels and Steam Generators [**3**]
2. Conservation Equations, Heat Transfer – Basics, Basic Modes of Heat Transfer, Conduction Heat Transfer Equations [**4**]
3. Thermal Conductivity, Capacity and Diffusivity 1-D Steady-State Heat Conduction without Heat Generation – Plane Wall, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Hollow Cylinder, Sphere, Series-Composite Slab, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Series-Parallel Composite Slab, Composite Cylinder, Heat Flow Through Composite Structures Critical Thickness of Insulation Variable Thermal Conductivity, Conduction Heat Transfer with Internal Heat Generation Conduction Heat Transfer in Multidimensional Systems [**11**]
4. Transient Heat Transfer, Convective Heat Transfer, Heat Transfer Coefficient with Phase Change Thermosyphon cooling, Dimensional Analysis, Radiation Heat Transfer, Pressure Drop Analysis, Pressure Drop Analysis [**10**]
5. Fuel, Clad and Coolant Temperatures, Sub channel Analysis of Rod Bundle Fuels, Sub channel Analysis of Rod Bundle Fuels, Hotspot and Hot channel Factors, Coolant Channel Orificing, Introduction to Two-phase Flow and Basic Relations, Two-phase Flow and Boiling, Reactor Thermal Hydraulics Critical Heat Flux [**12**]

Books:

1. El-Wakil, M. M., Nuclear Heat Transport, McGraw Hill Book Co., New York (1985)
2. Glasstone S. & Sessonske A., Nuclear Reactor Engineering, Vol I and Vol II CBS Publishers & Distributors, New Delhi (2009)
3. Lahey R. T. and Moody F. J., The Thermal-Hydraulics of Boiling Water Nuclear Reactor, 2nd Edition, (1993)

Suggested Readings:

1. Todreas N. E. and Kazimi M., Nuclear Systems Volume I: Thermal Hydraulics Fundamentals, Taylor & Francis Pubs. 2nd Edition, (1989)

List of Nuclear Laboratory Experiments

1. To verify inverse square law using an α- source (^{241}Am) and p-i-n detector
2. Attenuation of α-particles in air and determination of thickness of mylar foil using α-source
3. Characteristic and dead time of a GM Counter, counting statistics using a GM counter
4. To determine the linear and mass attenuation coefficient of lead/ aluminium/ copper using ^{60}Co source (micro- curie) with GM setup
5. Determination of half life of ^{116}In using a GM counter
6. Determination of end point energy of β – particles by absorption method using a GM counter
7. Determination of gamma energy by using a scintillation detector
8. Determination of energy resolution of a Si- surface barrier detector with an ^{241}Am alpha source
9. Determination of the photo peak efficiency of a NaI (Tl) scintillation detector as a function of gamma ray energy.
10. Study of γ-γ directional correlation using a ^{60}Co source and a pair of scintillation Detectors
11. Study of angular distribution of Compton scattered gamma rays using scintillation spectrometer and deduction of total scattering cross section.
12. Determination of rest mass of electron by measuring the energy of Compton scattered gamma rays using a scintillation spectrometer.
13. Measurement of resolving time of a fast-slow coincidence set-up and determination of true-to- chance ratio.
14. Measurement of energy of β-particles using a β–ray spectrometer

NU 532 **Plasma Laboratory** **0-0-2**

List of Plasma Experiments

1. Glow discharge characteristic- Paschen curve
2. Density and electron temperature measurement using Langmuir probes in the glow discharge.
3. To study the conditions of striations in Plasma
4. Plasma confinement studies using magnetic field
5. Dielectric barrier discharge- plasma generation at atmospheric pressure
6. Ion acoustic wave propagation in plasma

Third Semester

NU- 603 Fast Breeder Reactors and Nuclear Engineering Materials 2-1-0-3

1. Fast breeder Reactor : Breeding requirements and fast reactors, Fast reactor system features, Oxide fuels in fast reactors, Carbide/Nitride fuels in fast reactors, Metal fuel development (emphasis on U-Pu-Zr) **[4]**

2. Fast reactor physics, Four-group flux and adjoint flux distributions, Reactivity and stability, System response to accident initiators **[3]**

3. Fast reactor thermal hydraulics: sodium heat transfer, Natural circulation in fast reactors, SGTR mitigation. **[3]**

4. Nuclear Materials and Processing: Nuclear fuels: Metallic, ceramic (Oxides, MOX and Carbide fuels)- fabrication, properties and applications, Reactor Core Materials: Zircalloys, Zr-Nb alloy--- fabrication, properties and applications in reactors, Heavy water: production process, purification and applications **[10]**

5. Fuel Chemistry, Solid Fission Products, Swelling and Fission Gas Bubbles, Fission Gas Release, Corrosion in Nuclear Reactors, Plant Life Extension **[5]**

6. Nuclear waste; types - liquid waste - solid waste - aerial effulent -disposal of fuel or wastes; waste categories – low - level waste - intermediate level waste - high level waste. Basics about Nuclear Waste treatment, PUREX, Waste forms for long-term storage **[5]**

Books:

1. Waltar A. E. and Reynolds A.B., Fast Breeder Reactors, Pergamon Press, New York (1981).
2. Bendict M., Pigford T. and Levi H., Nuclear Chemical Engineering,
3. Wilson P. D., Nuclear Fuel Cycle: From ore to wastes, Oxford Press, 1996

Suggested Readings:

1. Callister D., Fundamentals of Material Science & Engineering, Wiley
2. Raghvan V., Physical Metallurgy: Principles & Practices,
3. Gupta C. K., Materials in Nuclear Applications

NU-605 Nuclear Plant Safety & Regulatory Frame work 2-1-0-3

1. Nuclear power plant safety requirements, Basic concepts in safety and reliability, Loss of coolant accident, Conceptual design of safety systems, Risk and reliability analysis of systems, Operational safety procedures, Manrem budgeting and control, Surface contamination and control

[15]

2. Role of Atomic Energy Regulatory Board (AERB) and Department of Atomic Energy (DAE), Legislation, rules and regulations for safe electricity generation, Legislation for regulation and its effective implementation for nuclear power plants, Role of Central and State Electricity Regulatory Commissions, Applicable AERB Safety Codes, Guides and Technical Specifications, Surveillance requirements and systems, Comparison with the regulatory framework of conventional industry

[15]

Books:

1. Lewis E. E., Nuclear Power Reactor Safety, E. E. Lewis, Wiley-Inter science publication, 1977
2. M. Rosen, Regulatory Codes and Guides issued by the International Atomic Energy Agency (IAEA), (1985)

Suggested Readings:

1. Mishra K. B., Reliability Analysis and Prediction, Elsevier Publications, (1992)
2. Haldar A. and Mahadevan S., Probability, Reliability and Statistical Methods, John Wiley & Sons (2000)
3. Codes and Guides issued by the Atomic Energy Regulatory Board) (AERB), (1982), Niyamak Bhavan, Anushaktinagar, India

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Course structure for

PhD

CS 702 **Advances in Computer Science and Engineering** **Total Lectures: 52**
4-0-0-4

Prerequisite(s): Knowledge of core subjects of computer science and engineering.

Objective(s): To strengthen the knowledge of core subjects of computer science and engineering.
To provide research orientation to the students and latest developments in core areas.

1. **Digital Computer Organization and Architecture:** Boolean algebra, Combinational and sequential circuits. Minimization, Number representations and computer arithmetic (fixed and floating point), Machine instructions and addressing modes, ALU, data-path and control unit, Instruction pipelining, memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode). [10]
2. **Data Structures and Algorithms:** Arrays, stacks, queues, linked lists, trees, binary search, trees, binary heaps, graphs, recursion, searching, sorting, hashing, asymptotic worst case time and space complexity, algorithm design techniques: greedy, dynamic programming and divide-and-conquer, graph search, minimum spanning trees, shortest paths, programming in C. [10]
3. **Theory of computer science and compiler design:** Regular expressions and finite automata, context-free grammars and push-down automata, regular and context-free languages, pumping lemma, Turing machines and undecidability, compiler design: lexical analysis, parsing, syntax-directed translation, runtime environments, intermediate code generation. [10]
4. **Operating System:** Processes, threads, inter-process communication, concurrency and synchronization, deadlock, CPU scheduling, memory management and virtual memory, file systems. [6]
5. **Databases:** ER-model, relational model: relational algebra, tuple calculus, SQL, Integrity constraints, normal forms, file organization, indexing (e.g., B and B+ trees), transactions and concurrency control. [6]
6. **Computer Networks:** Concept of layering. LAN technologies (Ethernet), flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state), TCP/UDP and sockets, congestion control, Application layer protocols (DNS, SMTP, POP, FTP, HTTP), basics of Wi-Fi, network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls. [10]

Outcome(s): This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles of computing to the analysis of computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to maintain life-long learning and continue to be motivated to learn new subjects.

Reference Books:

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd edition, 2008.
2. Thomas H. Cormen, "Introduction to Algorithms", PHI, 3rd edition, 2012.
3. John E. Hopcroft, Rajeev Motwani, J D Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson, 3rd edition.
4. A V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques and Tools", Pearson, 2nd edition, 2014.
5. Galvin, Silberschatz, Gagne, "Operating System Concepts", Wiley India, 9th edition, 2015.
6. Navathe, "Fundamentals of Database Systems", Addison Wesley, 5th edition, 2007.
7. Tanenbaum, "Computer Networks", PHI, 4th edition, 2002

EC702 Advances in Electronics & Communication Engineering **Total Lectures:52**

3-1-0-4

Objective: The course focuses on the basic theory and techniques used in the area of digital signal processing, VLSI design, Microwave Engineering, Antenna & Wave Propagation and Digital Data communication. It also offers a profound understanding of the design, analysis and applications of some complex circuits and devices with the help of computer aided simulation and synthesis tool for hardware design.

Prerequisite:
Basic understanding of core engineering courses given in the syllabus, is required.

VLSI Design Technology

MOS modeling and performance parameters, Design aspects: Review of MOS transistor models , Concept of Scaling and deep submicron VLSI design, Low Power VLSI design, Issues related to high speed VLSI Design (CMOS technology), New trends in Digital VLSI design, Example of Mixed VLSI Design, Advanced Testing and Verification Approaches, Wafer cleaning processes and wet chemical etching techniques. Introduction to hardware description languages (VHDL), logic, circuit and layout verification. MEMS **[10]**

Microwave & Radar Engineering

Maxwell's Equation, Wave Equation and Boundary conditions, Transmission lines, Microwave Passive Components, Measurements of Wavelength, Frequency, Impedance, SWR etc., Q of Cavity, Microwave Linear Beam Tubes, Reflex Klystron. Traveling Wave Tube, Transferred Electron Devices, Principle of operation of Radar, Radar equation, CW and Frequency Modulated Radar, MTI and Pulse Doppler Radar **[12]**

Antenna & Wave Propagation

Introduction of Antenna & its parameters. Reciprocity theorem, Review of microwave antennas- Parabolic Reflector, Cassegrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication. Frequency- independent antennas, Scattering and diffraction. Internal-equation methods, current distribution: Self and mutual impedances. **[10]**

Digital Data Communications

Local Area networks:- token ring, Ethernet, Traditional, Fast and GIGA bit Ethernet, FDDI, DIGITAL MULTIPLEXING :- TDM , T1 carrier , CCITT , CODECS, COMBO CHIPS , North American Hierarchy , Line Encoding , T-carrier , Frame Synchronization Inter Leaving Statistical TDM FDM , Hierarchy ,Wave Division Multiplexing . **[10]**

Signal Processing

Multi-rate Digital Signal Processing: Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion. Linear Prediction And Optimum Linear Filters: Forward and backward linear prediction; Properties of the linear prediction – error filters; Applications of linear prediction., Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters. Power Spectral Estimation: Principle and traditional methods of spectral estimation; Modern methods of parametric estimation; Applications of spectral analysis,. **[10]**

Course Outcomes:

This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles to the analysis of electrical and computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to electrical and computer engineering problems.
4. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
5. Ability to be competitive in the engineering job market.

Text books

1. R.E Collin, "Antennas & Radio Wave Propagation", Mc-Graw Hill
2. D M Pozar,"Microwave Engineering", JohnWilley & Sons
3. Proakis, Rader, Ling, and Nikias, Advanced digital signal processing, Macmillan, 1992
4. John P. Uyemura : Introduction to VLSI Circuits and Systems, John Wiley & Sons,Inc, 2002
5. Electronic communication systems, fundamentals through advanced - W. TOMASI, Pearson 4th Edition.
6. Introduction to Radar, M. I. Skolnik, McGraw Hill.

Reference books

1. Annapurna das & Sisir K das, Microwave Engineering Tata Mcgraw Hill.
2. Data communication and networking - B.A. Forouzen
3. Kin. Lu. Wong, "Compact and Broadband Microstrip Antenna", John Wiley & Sons
4. S. Stergiopoulos (editor), "Advanced Signal Processing Handbook: Theory and Implementation for Radar, Sonar, and Medical Imaging Real-Time Systems", CRC Press LLC, 2001.
5. Neil Weste and David Harris, "CMOS VLSI Design ", 4thEd., Addison Wesley, 2011.

EE 702 **Advances in Electrical Engineering** **Total Lectures: 52**

4-0-0-4

Objective: To provide an exposure on the basic principles and techniques used in the area of ultra-capacitor, control systems and its sliding modes control, Smart Grid, Renewable Energy Integration. It also offers a profound understanding of the design, analysis and applications of Smart Grid, Renewable Energy integration with the help of computer aided simulation and synthesis tools / ETAP Software.

Pre-requisite: Basic understanding of core engineering courses given in the syllabus is required.

1. **Ultra- Capacitor:** Introduction, History, Basic principles of Ultracapacitors, Principles and energy storage mechanism, EC vs. Aluminum (Al) electrolytic capacitors, Capacitors vs. batteries, Benefits and limitations of Ultracapacitors, Ultracapacitor vs. Flywheels, Applications, Cell voltage, Comparison with battery or other energy storage devices, Cost of EC capacitors, Electrochemical Double Layer Capacitor: basic construction, Components of Ultracapacitor, EC capacitor sizes, Future of energy storage industry, Uninterruptible power supply and backup power. [8]
2. **Applications & Future Scenario of Ultra- Capacitor:** Modern day applications of Ultra capacitor, Future application growth, New material developments, Cost reduction, Ultra capacitor may overtake batteries, Market trends, ultra capacitors in the grid, Vehicular applications, Ultra capacitors in wind turbines, Water Desalination/Purification, New Ultra capacitor work at constant voltage, Electrochemical flow Ultra capacitor, Micro Ultra capacitor, Ultra capacitor for resistance welding. [8]
3. **Advanced control systems :** Introduction, Intuitive theory of sliding mode control, Sliding Surface, sliding mode, concept of equivalent control, sliding mode equations, sliding mode observer/differentiator, second order sliding mode. [7]
4. **Classical sliding modes:** Introduction, state feedback sliding mode control: Regular form, Eigen valve placement, quadratic minimization. State feedback control laws design: Single input system, multi-input system, unmatched uncertainty, output tracking with integral action. Output based hyper plane design, control law development. Integral sliding mode control: Problem formulations, control design objective, ISM control design. [8]
5. **Smart Grid:** Introduction, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, The Environmental Impacts of Smart Grid, Technologies Required for Smart Grid. [8]
6. **Renewable Energy Integration:** Introduction, Solar Energy, Wind Energy, Distributed Energy Resources Integration Challenges, Forecasting and Scheduling, Impacts of Renewable Energy into the Grid. [8]
7. **Smart Meter:** Details Description of Smart Meter, Benefits of Smart Meter, Technical Configurations of Smart Meter, Components of Smart Meter Network in Distribution System, Characteristics, Communication Protocols. [5]

Course Outcomes: This course helps our students to apply the knowledge of advanced principles, state of -the-art design techniques, software tools, and research methods for solving challenges of Smart Grid, Renewable Energy Integration and ultra capacitor.

Text Books:

1. R. P. Deshpande, "Ultra -capacitors: Future of Energy Storage", Mc-Graw Hill Education.
2. C-Edwards & S.K. Spurgeon, "Sliding mode control: Theory & Application", Taylor & Francis, 1998.

3. Shawkat Ali A. B. M., Smart Grids Opportunities, Developments and Trends, Springer-Verlag, London , 2013

Reference Books:

1. B. E. Conway, "Electrochemical Super capacitors: Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum Publishers (1999)
2. Utkin V.I., "Sliding modes in control & optimization", Springer-verlay, 1992.
3. Momoh James., Smart Grid Fundamentals of Design and Analysis, John Wiley &Sons, Inc., Hoboken, New Jersey, 2012

ET 901 **Research Methodology** **4-0-0-4**

1. **Introduction:** meaning of research, objectives, motivation for research, types of research, research approaches, research process, validity and reliability in research. [02]

2. **Problem formulation:** identification, selection & formulation of a research problem, objectives of formulation, criteria of a good research problem, review of literature. [03]

3. **Research design:** research framework, meaning & significance of research designs, features of a good research design, types of research design. [04]

4. Data for research: types of data, sources of data, methods of collecting data, data presentation techniques. Methods of data analysis. [10]
*Use of SPSS and MATLAB tools for data analysis.

5. **Mathematical background for research:** approaches to probability, probability distributions; binomial, Poisson, uniform, exponential and normal distributions. Review of basic statistical measures; measures of central tendency, measures of variation. Sampling methods, correlation analysis, simple regression, multiple regression, time series analysis, cluster analysis, clustering techniques. Queuing theory; introduction, simple Markovian queuing models. [10]

6. **Algorithmic Research:** introduction, types of algorithmic research problems, types of solution procedures, steps of development of algorithm. [04]

7. **Simulation:** introduction, need for simulation, simulation analysis of a case study. [03]

8. **Thesis writing:** format; general format of cover page, dedication, certificate, declaration, acknowledgement, abstract, list of contents, list of figures, list of tables, appendices, and references. Contents of thesis; background to research, literature review, problem statement, objectives of research, rationale for the study, motivation to the study, methods, definitions, research models, research design & analysis, results, findings, implications, contributions, significance of research, future directions, and conclusion. [04]
*Practical classes to be taken.

Reference Books.

1. Mr. R. Pannershelvam, "Research Methodology", Prentice Hall India, 2006.
2. Mr. C. R. Kothari, "Research Methodology : Methods and Techniques", Second edition, New Age International Publishers, 2006.
3. Mr. Ranjit Kumar, “Research Methodology: A step by step guide for beginners” , Second edition, Pearson, 2006

Outcome(s): *This course supports the achievement of the following outcomes*

- *Current trends in the rapidly evolving field*
- *The intellectual and philosophical framework necessary to explore wide spectrum of research in mechanical engineering.*
- *To contribute to expanding the frontiers of knowledge and to provide research training.*
- *Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, and research methods for solving engineering problems*

Text Books:

1. Timoschenko S.P. and Goodier J.N, "Theory of elasticity" McGraw-Hill Publishers
2. Dally and Riley, "Experimental stress analysis", McGraw-Hill Publishers
3. B.H. Amstead, Philip F, Ostwald and Myron L, "Manufacturing Processes" Begeman, John Wiley and sons, eighth edition.
4. Sunil Chopra & Peter Meindl, "Supply Chain Management: Strategy, Planning & Operation", Pearson Education Asia
5. Rao S. S, "Engineering Optimization- Theory and Practice", New Age International
6. Nag P. K, "Basic and Applied thermodynamics", TMH, Latest Edition
7. William M. Kays, Michael E. Crawford, "Convective Heat Transfer"**,** McGraw-Hill Publishers.

Reference Books:

1. Boresi & Sidebottom, "Advanced Mechanics of materials", Wiley International.
2. Garg and Venkitakrishnan, "Enterprise Resource Planning: Concepts and Practice", 2nd Ed, PHI
3. G.F. Benidict, "Advanced Manufacturing Processes",Marcel Deker Publisher.
4. Van Wylen G.H. & Sonntag R.E, "Fundamentals of Classical Thermodynamics", John Wiley & Sons.

NT-702 Advances in Nanoscience and Technology Total 52 lectures
3-1-0-4

Objective: The course focuses on the basic theory and techniques used in the area of nano Science & Technology. The paper covers important areas and gives profound understanding about nano world, synthesis of nano materials, various characterization techniques for nano materials and applications of nano Science & technology in the area of modern electronics, medical sciences and environmental sciences. It may guide and help the student in deciding about the research area in which he/ she may like to contribute further.

Pre-requisite:
Basic understanding of core science and engineering courses given in the syllabus

Course Outcomes:

This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles to the analysis of nano science & technological problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems
3. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to nano science & technology problems.
4. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
5. Ability to be competitive in the innovative research areas and relevant job market.

Syllabus details

1. Nano World : [12]

Introduction, History of nanomaterials, what is nano? Beginning of Nanoscience, Moore,s law, Nanoscience: The multidisciplinary science, Different types of nanomaterials, Properties of nanomaterials, Zero dimensional, one-dimensional and two dimensional nanostructures-clusters of metals and semiconductors, nanwires, Size dependent properties-size dependent absorption spectra-phonons in nanostructures, seeing nano-objects

2. Synthesis of Nanomaterials: [16]

Physical Methods: Top-down and bottom-up approach, Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxial, Chemical vapour deposition method and other variants, Electro deposition.

Chemical Methods: Chemical reduction method, Sol- gel, Micelles and microemulsions, Solvothermal synthesis, hydrothermal methods, photochemical synthesis, electrochemical synthesis, Thermolysis routes, Sonochemical routes, Liquid-liquid interface, Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, template synthesis, organic block copolymers, porous silicon, and Pulsed electrochemical deposition. Nanoporous Materials, Silicon, Zeolites, mesoporous materials, nanomembranes and carbon nanotubes, AgX photography, smart sunglasses, and transparent conducting oxides, molecular sieves, nanosponges.

Biological Methods of Synthesis: Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis

3. Characterization Techniques : [12]

X-ray diffraction, Scanning Probe Microscopy, SEM, TEM, Optical microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurements, Magnetic and electrical measurements. Lithographic Techniques: AFM based nanolithography and nanomanipulation, E beam lithography and SEM based nanolithography and nanomanipulation, Ion beam lithography, oxidation and metallization. Mask and its application. Deep UV lithography, X-ray based lithography

4. Applications of Nanomaterials: [12]

Electronic Applications:

Applications of nano for IC chips, STM based lithography-Molecular electronics- LEDs- Memories – CNT and Graphene based Electronic devices - transistor based sensors and its general applications- Applications of Nanomaterials in Space

Applications of Nanomagnetic materials

Nanomagnetism- Bionanomagnetism- type of magnet materials –tag and drag drug delivery – hyperthermia- hypothermia-MRI

Environmental Applications:

Bioremediation- removal of bacteria and microbes- sensors for DNA- Proteins, and Biological applications – self assembly systems- tissue culture- nanopharma

Text Books:

1. Nanoworld: An introduction to Nanoscience and technology – C N R Rao
2. A Textbook of Nanoscience and Technology: T. Pradeep
3. Nano: The Essentials-T. Pradeep
4. Introduction to Nanotechnology, Wiley, Charles P. Poole Jr. & Frank J. Owens
5. Lehninger Principles of Biochemistry, Sixth Edition, Nelson and Cox, W.H. Freeman and Company

References:

1. Physical Chemistry: Gilbert W. Castellan
2. Physical Chemistry of Surfaces: Authur W. Adamson, Alice P. Gast
3. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C. N. R. Rao, Achim Müller, A. K. Cheetham, Wiley
4. NANO: The Next Generation-Mohan Sundar Rajan, National Book Trust, India

SESSION

2018-2019

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Course structure for

PhD

CS 702 **Advances in Computer Science and Engineering** **Total Lectures: 52**
4-0-0-4

Prerequisite(s): Knowledge of core subjects of computer science and engineering.

Objective(s): To strengthen the knowledge of core subjects of computer science and engineering.
To provide research orientation to the students and latest developments in core areas.

1. **Digital Computer Organization and Architecture:** Boolean algebra, Combinational and sequential circuits. Minimization, Number representations and computer arithmetic (fixed and floating point), Machine instructions and addressing modes, ALU, data-path and control unit, Instruction pipelining, memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode). [10]
2. **Data Structures and Algorithms:** Arrays, stacks, queues, linked lists, trees, binary search, trees, binary heaps, graphs, recursion, searching, sorting, hashing, asymptotic worst case time and space complexity, algorithm design techniques: greedy, dynamic programming and divide-and-conquer, graph search, minimum spanning trees, shortest paths, programming in C. [10]
3. **Theory of computer science and compiler design:** Regular expressions and finite automata, context-free grammars and push-down automata, regular and context-free languages, pumping lemma, Turing machines and undecidability, compiler design: lexical analysis, parsing, syntax-directed translation, runtime environments, intermediate code generation. [10]
4. **Operating System:** Processes, threads, inter-process communication, concurrency and synchronization, deadlock, CPU scheduling, memory management and virtual memory, file systems. [6]
5. **Databases:** ER-model, relational model: relational algebra, tuple calculus, SQL, Integrity constraints, normal forms, file organization, indexing (e.g., B and B+ trees), transactions and concurrency control. [6]
6. **Computer Networks:** Concept of layering. LAN technologies (Ethernet), flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state), TCP/UDP and sockets, congestion control, Application layer protocols (DNS, SMTP, POP, FTP, HTTP), basics of Wi-Fi, network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls. [10]

Outcome(s): This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles of computing to the analysis of computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to maintain life-long learning and continue to be motivated to learn new subjects.

Reference Books:

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd edition, 2008.
2. Thomas H. Cormen, "Introduction to Algorithms", PHI, 3rd edition, 2012.
3. John E. Hopcroft, Rajeev Motwani, J D Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson, 3rd edition.
4. A V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques and Tools", Pearson, 2nd edition, 2014.
5. Galvin, Silberschatz, Gagne, "Operating System Concepts", Wiley India, 9th edition, 2015.
6. Navathe, "Fundamentals of Database Systems", Addison Wesley, 5th edition, 2007.
7. Tanenbaum, "Computer Networks", PHI, 4th edition, 2002

EC702 Advances in Electronics & Communication Engineering **Total Lectures:52**

3-1-0-4

Objective: The course focuses on the basic theory and techniques used in the area of digital signal processing, VLSI design, Microwave Engineering, Antenna & Wave Propagation and Digital Data communication. It also offers a profound understanding of the design, analysis and applications of some complex circuits and devices with the help of computer aided simulation and synthesis tool for hardware design.

Prerequisite:
Basic understanding of core engineering courses given in the syllabus, is required.

VLSI Design Technology

MOS modeling and performance parameters, Design aspects: Review of MOS transistor models , Concept of Scaling and deep submicron VLSI design, Low Power VLSI design, Issues related to high speed VLSI Design (CMOS technology), New trends in Digital VLSI design, Example of Mixed VLSI Design, Advanced Testing and Verification Approaches, Wafer cleaning processes and wet chemical etching techniques. Introduction to hardware description languages (VHDL), logic, circuit and layout verification. MEMS **[10]**

Microwave & Radar Engineering

Maxwell's Equation, Wave Equation and Boundary conditions, Transmission lines, Microwave Passive Components, Measurements of Wavelength, Frequency, Impedance, SWR etc., Q of Cavity, Microwave Linear Beam Tubes, Reflex Klystron. Traveling Wave Tube, Transferred Electron Devices, Principle of operation of Radar, Radar equation, CW and Frequency Modulated Radar, MTI and Pulse Doppler Radar **[12]**

Antenna & Wave Propagation

Introduction of Antenna & its parameters. Reciprocity theorem, Review of microwave antennas- Parabolic Reflector, Cassegrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication. Frequency- independent antennas, Scattering and diffraction. Internal-equation methods, current distribution: Self and mutual impedances. **[10]**

Digital Data Communications

Local Area networks:- token ring, Ethernet, Traditional, Fast and GIGA bit Ethernet, FDDI, DIGITAL MULTIPLEXING :- TDM , T1 carrier , CCITT , CODECS, COMBO CHIPS , North American Hierarchy , Line Encoding , T-carrier , Frame Synchronization Inter Leaving Statistical TDM FDM , Hierarchy ,Wave Division Multiplexing . **[10]**

Signal Processing

Multi-rate Digital Signal Processing: Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion. Linear Prediction And Optimum Linear Filters: Forward and backward linear prediction; Properties of the linear prediction – error filters; Applications of linear prediction., Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters. Power Spectral Estimation: Principle and traditional methods of spectral estimation; Modern methods of parametric estimation; Applications of spectral analysis,. **[10]**

Course Outcomes:

This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles to the analysis of electrical and computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to electrical and computer engineering problems.
4. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
5. Ability to be competitive in the engineering job market.

Text books

1. R.E Collin, "Antennas & Radio Wave Propagation", Mc-Graw Hill
2. D M Pozar,"Microwave Engineering", JohnWilley & Sons
3. Proakis, Rader, Ling, and Nikias, Advanced digital signal processing, Macmillan, 1992
4. John P. Uyemura : Introduction to VLSI Circuits and Systems, John Wiley & Sons,Inc, 2002
5. Electronic communication systems, fundamentals through advanced - W. TOMASI, Pearson 4th Edition.
6. Introduction to Radar, M. I. Skolnik, McGraw Hill.

Reference books

1. Annapurna das & Sisir K das, Microwave Engineering Tata Mcgraw Hill.
2. Data communication and networking - B.A. Forouzen
3. Kin. Lu. Wong, "Compact and Broadband Microstrip Antenna", John Wiley & Sons
4. S. Stergiopoulos (editor), "Advanced Signal Processing Handbook: Theory and Implementation for Radar, Sonar, and Medical Imaging Real-Time Systems", CRC Press LLC, 2001.
5. Neil Weste and David Harris, "CMOS VLSI Design ", 4thEd., Addison Wesley, 2011.

EE 702 **Advances in Electrical Engineering** **Total Lectures: 52**

4-0-0-4

Objective: To provide an exposure on the basic principles and techniques used in the area of ultra-capacitor, control systems and its sliding modes control, Smart Grid, Renewable Energy Integration. It also offers a profound understanding of the design, analysis and applications of Smart Grid, Renewable Energy integration with the help of computer aided simulation and synthesis tools / ETAP Software.

Pre-requisite: Basic understanding of core engineering courses given in the syllabus is required.

1. **Ultra- Capacitor:** Introduction, History, Basic principles of Ultracapacitors, Principles and energy storage mechanism, EC vs. Aluminum (Al) electrolytic capacitors, Capacitors vs. batteries, Benefits and limitations of Ultracapacitors, Ultracapacitor vs. Flywheels, Applications, Cell voltage, Comparison with battery or other energy storage devices, Cost of EC capacitors, Electrochemical Double Layer Capacitor: basic construction, Components of Ultracapacitor, EC capacitor sizes, Future of energy storage industry, Uninterruptible power supply and backup power. [8]
2. **Applications & Future Scenario of Ultra- Capacitor:** Modern day applications of Ultra capacitor, Future application growth, New material developments, Cost reduction, Ultra capacitor may overtake batteries, Market trends, ultra capacitors in the grid, Vehicular applications, Ultra capacitors in wind turbines, Water Desalination/Purification, New Ultra capacitor work at constant voltage, Electrochemical flow Ultra capacitor, Micro Ultra capacitor, Ultra capacitor for resistance welding. [8]
3. **Advanced control systems :** Introduction, Intuitive theory of sliding mode control, Sliding Surface, sliding mode, concept of equivalent control, sliding mode equations, sliding mode observer/differentiator, second order sliding mode. [7]
4. **Classical sliding modes:** Introduction, state feedback sliding mode control: Regular form, Eigen valve placement, quadratic minimization. State feedback control laws design: Single input system, multi-input system, unmatched uncertainty, output tracking with integral action. Output based hyper plane design, control law development. Integral sliding mode control: Problem formulations, control design objective, ISM control design. [8]
5. **Smart Grid:** Introduction, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, The Environmental Impacts of Smart Grid, Technologies Required for Smart Grid. [8]
6. **Renewable Energy Integration:** Introduction, Solar Energy, Wind Energy, Distributed Energy Resources Integration Challenges, Forecasting and Scheduling, Impacts of Renewable Energy into the Grid. [8]
7. **Smart Meter:** Details Description of Smart Meter, Benefits of Smart Meter, Technical Configurations of Smart Meter, Components of Smart Meter Network in Distribution System, Characteristics, Communication Protocols. [5]

Course Outcomes: This course helps our students to apply the knowledge of advanced principles, state of -the-art design techniques, software tools, and research methods for solving challenges of Smart Grid, Renewable Energy Integration and ultra capacitor.

Text Books:

1. R. P. Deshpande, "Ultra -capacitors: Future of Energy Storage", Mc-Graw Hill Education.
2. C-Edwards & S.K. Spurgeon, "Sliding mode control: Theory & Application", Taylor & Francis, 1998.

3. Shawkat Ali A. B. M., Smart Grids Opportunities, Developments and Trends, Springer-Verlag, London , 2013

Reference Books:

1. B. E. Conway, "Electrochemical Super capacitors: Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum Publishers (1999)
2. Utkin V.I., "Sliding modes in control & optimization", Springer-verlay, 1992.
3. Momoh James., Smart Grid Fundamentals of Design and Analysis, John Wiley &Sons, Inc., Hoboken, New Jersey, 2012

ET 901 **Research Methodology** **4-0-0-4**

1. **Introduction:** meaning of research, objectives, motivation for research, types of research, research approaches, research process, validity and reliability in research. [02]

2. **Problem formulation:** identification, selection & formulation of a research problem, objectives of formulation, criteria of a good research problem, review of literature. [03]

3. **Research design:** research framework, meaning & significance of research designs, features of a good research design, types of research design. [04]

4. Data for research: types of data, sources of data, methods of collecting data, data presentation techniques. Methods of data analysis. [10]
*Use of SPSS and MATLAB tools for data analysis.

5. **Mathematical background for research:** approaches to probability, probability distributions; binomial, Poisson, uniform, exponential and normal distributions. Review of basic statistical measures; measures of central tendency, measures of variation. Sampling methods, correlation analysis, simple regression, multiple regression, time series analysis, cluster analysis, clustering techniques. Queuing theory; introduction, simple Markovian queuing models. [10]

6. **Algorithmic Research:** introduction, types of algorithmic research problems, types of solution procedures, steps of development of algorithm. [04]

7. **Simulation:** introduction, need for simulation, simulation analysis of a case study. [03]

8. **Thesis writing:** format; general format of cover page, dedication, certificate, declaration, acknowledgement, abstract, list of contents, list of figures, list of tables, appendices, and references. Contents of thesis; background to research, literature review, problem statement, objectives of research, rationale for the study, motivation to the study, methods, definitions, research models, research design & analysis, results, findings, implications, contributions, significance of research, future directions, and conclusion. [04]
*Practical classes to be taken.

Reference Books.

1. Mr. R. Pannershelvam, "Research Methodology", Prentice Hall India, 2006.
2. Mr. C. R. Kothari, "Research Methodology : Methods and Techniques", Second edition, New Age International Publishers, 2006.
3. Mr. Ranjit Kumar, “Research Methodology: A step by step guide for beginners” , Second edition, Pearson, 2006

Outcome(s): *This course supports the achievement of the following outcomes*

- *Current trends in the rapidly evolving field*
- *The intellectual and philosophical framework necessary to explore wide spectrum of research in mechanical engineering.*
- *To contribute to expanding the frontiers of knowledge and to provide research training.*
- *Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, and research methods for solving engineering problems*

Text Books:

1. Timoschenko S.P. and Goodier J.N, "Theory of elasticity" McGraw-Hill Publishers
2. Dally and Riley, "Experimental stress analysis", McGraw-Hill Publishers
3. B.H. Amstead, Philip F, Ostwald and Myron L, "Manufacturing Processes" Begeman, John Wiley and sons, eighth edition.
4. Sunil Chopra & Peter Meindl, "Supply Chain Management: Strategy, Planning & Operation", Pearson Education Asia
5. Rao S. S, "Engineering Optimization- Theory and Practice", New Age International
6. Nag P. K, "Basic and Applied thermodynamics", TMH, Latest Edition
7. William M. Kays, Michael E. Crawford, "Convective Heat Transfer"**,** McGraw-Hill Publishers.

Reference Books:

1. Boresi & Sidebottom, "Advanced Mechanics of materials", Wiley International.
2. Garg and Venkitakrishnan, "Enterprise Resource Planning: Concepts and Practice", 2nd Ed, PHI
3. G.F. Benidict, "Advanced Manufacturing Processes",Marcel Deker Publisher.
4. Van Wylen G.H. & Sonntag R.E, "Fundamentals of Classical Thermodynamics", John Wiley & Sons.

NT-702 Advances in Nanoscience and Technology Total 52 lectures
3-1-0-4

Objective: The course focuses on the basic theory and techniques used in the area of nano Science & Technology. The paper covers important areas and gives profound understanding about nano world, synthesis of nano materials, various characterization techniques for nano materials and applications of nano Science & technology in the area of modern electronics, medical sciences and environmental sciences. It may guide and help the student in deciding about the research area in which he/ she may like to contribute further.

Pre-requisite:
Basic understanding of core science and engineering courses given in the syllabus

Course Outcomes:

This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles to the analysis of nano science & technological problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems
3. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to nano science & technology problems.
4. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
5. Ability to be competitive in the innovative research areas and relevant job market.

Syllabus details

1. Nano World : [12]

Introduction, History of nanomaterials, what is nano? Beginning of Nanoscience, Moore,s law, Nanoscience: The multidisciplinary science, Different types of nanomaterials, Properties of nanomaterials, Zero dimensional, one-dimensional and two dimensional nanostructures-clusters of metals and semiconductors, nanwires, Size dependent properties-size dependent absorption spectra-phonons in nanostructures, seeing nano-objects

2. Synthesis of Nanomaterials: [16]

Physical Methods: Top-down and bottom-up approach, Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxial, Chemical vapour deposition method and other variants, Electro deposition.

Chemical Methods: Chemical reduction method, Sol- gel, Micelles and microemulsions, Solvothermal synthesis, hydrothermal methods, photochemical synthesis, electrochemical synthesis, Thermolysis routes, Sonochemical routes, Liquid-liquid interface, Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, template synthesis, organic block copolymers, porous silicon, and Pulsed electrochemical deposition. Nanoporous Materials, Silicon, Zeolites, mesoporous materials, nanomembranes and carbon nanotubes, AgX photography, smart sunglasses, and transparent conducting oxides, molecular sieves, nanosponges.

Biological Methods of Synthesis: Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis

3. Characterization Techniques : [12]

X-ray diffraction, Scanning Probe Microscopy, SEM, TEM, Optical microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurements, Magnetic and electrical measurements. Lithographic Techniques: AFM based nanolithography and nanomanipulation, E beam lithography and SEM based nanolithography and nanomanipulation, Ion beam lithography, oxidation and metallization. Mask and its application. Deep UV lithography, X-ray based lithography

4. Applications of Nanomaterials: [12]

Electronic Applications:

Applications of nano for IC chips, STM based lithography-Molecular electronics- LEDs- Memories – CNT and Graphene based Electronic devices - transistor based sensors and its general applications- Applications of Nanomaterials in Space

Applications of Nanomagnetic materials

Nanomagnetism- Bionanomagnetism- type of magnet materials –tag and drag drug delivery – hyperthermia- hypothermia-MRI

Environmental Applications:

Bioremediation- removal of bacteria and microbes- sensors for DNA- Proteins, and Biological applications – self assembly systems- tissue culture- nanopharma

Text Books:

1. Nanoworld: An introduction to Nanoscience and technology – C N R Rao
2. A Textbook of Nanoscience and Technology: T. Pradeep
3. Nano: The Essentials-T. Pradeep
4. Introduction to Nanotechnology, Wiley, Charles P. Poole Jr. & Frank J. Owens
5. Lehninger Principles of Biochemistry, Sixth Edition, Nelson and Cox, W.H. Freeman and Company

References:

1. Physical Chemistry: Gilbert W. Castellan
2. Physical Chemistry of Surfaces: Authur W. Adamson, Alice P. Gast
3. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C. N. R. Rao, Achim Müller, A. K. Cheetham, Wiley
4. NANO: The Next Generation-Mohan Sundar Rajan, National Book Trust, India

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of ECE

Course structure for

B.Tech ECE

BS-15.411 Business Support System – Intelligent Network (BSS-IN) 3-0-0-3

Total Lecture: 42

Prerequisites: Linux Basic, Database Basic, TCP/IP Basic.

1	**Introduction to Telecom Market** Customer and Vendors, How Adds and promotion benefits, Statistics (Postpaid/Prepaid).	**[2]**
2	**Unit 2: GSM Basic and Evolution** Architecture, Call Flows (Cover RAN/CORE/IN), OSI/SS7 Basic, Evolution (2G to 5G)	**[4]**
3	**Unit 3: Intelligent Network Overview** Common Charging Architecture - High Level Common Architecture, Charging Mechanisms, Charging Functions- Offline Charging Funtions; Offline Charging Funtions; Architecture Mapping ,Charging Principles; Charging data generation and quota supervision; Charging information utilization, OCS - Required Functionality, OCS - Reference Model/Architecture, OCS Rating Function, OCS Functionality Message Flows, OCS CDRs, Policy Control And Charging; Reference Architecture;Policy Control Requirements; Reference Points; Functional Entities; PCC Rules; QoS Rules; PCC Procedure and Flows, Refill And voucher management, Subscriber/Customer management - Customer Care	**[11]**
4	**Unit 4**: **Billing Mediation and Provisioning Basic** CDR, UDR, TAP files, RAP files, NRTRDE, Billing System architecture (Mediation, usage and tariff database, formatting and rating processes, invoice generation),Types of usage (duration, volume, QoS, day and time, number of events, type of service),Types of rating (batch rating, pre-event rating, post-event rating, backwards rating, prepaid balance management, spending control/unbilled limit), Standard rating functions (staircase, offset, linear), Parameters of billing (usage & recurring &onetime charges, discounts & fees & taxes),Types of billing (regular, on-demand, immediate, simulation, information), Different product features (supports MVNO, real-time discounts, cross discounts, shared balances, multiple balances), Different marketing tools (business partners, bundles and counters, F&F, free units, discounts), Typical Telecom Environment: Multivendor environment, Std Protocols & proprietary Interfaces, Integration challenges, File Mediation fundamentals: ASN.1, Need, Typical Use Cases, Architecture, Event Mediation fundamentals: Diameter, 3GPP, Need, Typical Use Cases, Architecture Provisioning fundamentals: MML, CAI, CAI-3G etc, Need, Typical Use Cases, Architecture	**[14]**
5	**Protocols/Tools** TCP/IP/SCTP; Stack Description ; Connection Flow; Messages Flow; Use Cases ,SIGTRAN/SS7; Stack Description; Connection Flow; Messages Flow; Use Cases, DIAMETER; Stack Description; Connection Flow ;Messages Flow; Use Cases, CAMEL ; Stack Description; Connection Flow ;Messages Flow ;Use Cases	**[9]**
6	**3PP Services integration with BSS** Integration With CRBT/MoMo, IVR Services, Practical Example/Use Cases.	[2]
	Assessment	[2]

Comment [D88]: Skills Development

CS -14.203 **Data Structures** **Total Lectures: 40**

Credit : 3-0-0-3

Prerequisite(s): CS-14.101, CS-14.111

Objective(s): To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures.

1. **Introduction:** Basic Terminology, Elementary Data Organization, Algorithm, Efficiency of an Algorithm, Time and Space Complexity, Asymptotic Notations, Time-Space Trade- Off, Abstract Data Types. **[4]**
2. **Array:** Definition, Single and Multidimensional Arrays, Representation of Arrays: Row Major Order, and Column Major Order, Application of Arrays, Sparse Matrices and Their Representations. **[4]**
3. **Searching & Sorting:** Sequential Search, Binary Search, Comparison and Analysis, Hash Function, Collision Resolution Strategies, Insertion Sort, Selection Sort, Bubble Sort, Quick Sort, Merge Sort, Heap Sort, Radix Sort. **[6]**
4. **Linked list:** Singly Linked Lists, Doubly Linked List, Circular Linked List, Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List. **[6]**
5. **Stack:** Primitive Stack Operations: Push and Pop Array and Linked List Implementation of Stack, Application of Stack: Prefix and Postfix Expressions, Evaluation of Postfix Expression, Recursion, Tower of Hanoi Problem. **[4]**
6. **Queue:** Queue Operations, Circular Queues, Array and Linked List Implementation of Queues, Dequeue and Priority Queue. **[4]**
7. **Tree:** Binary Trees, Binary Tree Representation, Tree Traversal Algorithms: Inorder, Preorder and Postorder, Threaded Binary Trees, Huffman Algorithm, Binary Search Trees AVL Trees. **[6]**
8. **Graph:** Terminology, Sequential and Linked Representations of Graphs: Adjacency Matrices, Adjacency List, Adjacency Multi List, Graph Traversal: Depth First Search and Breadth First Search, Spanning Trees. **[6]**

Comment [D1]: Skills Development

Comment [D2]: Skills Development

Comment [D3]: Skills Development

Comment [D4]: Skills Development

Comment [D5]: Skills Development

Outcome(s): Upon completion of the course the student should

- be knowledgeable of certain abstract data types (ADT).
- be able to make a critical assessment of different implementations of an ADT.
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems.

Text Books:

1. Lipschutz, "Data Structures" Schaum's Outline Series, TMH, 2006.

Reference Books:

1. Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI, 2nd Edition, 2009.
2. Horowitz and Sahani, Fundamentals of Data Structures, Galgotia Publication, 1999.
3. Jean Paul Trembley and Paul G. Sorenson, An Introduction to Data Structures with applications, McGraw Hill, 2nd Edition, 2003.
4. G. A. V. Pai, Data Structures and Algorithms, TMH, 2008.

CS-14.202 **Java Programming** **Total Lectures: 40**

Credit : 3-0-0-3

Prerequisites: CS14.101, CS-14.205.

Objectives: The objective of this Course is to:

- Cover issues related to the definition, creation and usage of classes, objects and methods. Become comfortable with object-oriented programming and learn to think in terms of objects.
- Discuss the principles of inheritance and polymorphism. The concepts would be demonstrated through problem analysis assignments.
- Provide the foundation of good programming skills by discussing key issues of the design of object-oriented software, including programming design patterns and documentation.
- Cover the basics of APIs as well as allow students to explore the Java Abstract Programming Interface.

5. **Overview:** Introductionto java, importance of Java, interactive development environments: Eclipse/Net Beans, basics of OOP. **[4]**
6. **Data Types, Variable, and Arrays:** primitive data types, type casting,arrays, operators and control structures. Identifiers, constants and literals. **[6]**
7. **Classes and Objects:** Class fundamentals, declaring objects, assigning object referencevariables, introducing methods, constructors, the this keyword, garbage collection, the finalize() method, overloading methods, using objects as parameters and return type, introducing access control, understanding static, introducing final, introducing nested and inner classes, exploring the string class, using command-line arguments. **[9]**
8. **Inheritance:** Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final in inheritance, the object class. **[4]**
9. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, user defined exception. **[6]**
10. **Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, thread priorities, managing threads, Thread class built-in functions **[4]**
11. **I/O and String Handling:** I/O basics, reading console input, writingconsole output, the Print Writer class, reading and writing files, string constructors, operations on String, String tokenizing, String Buffer **[7]**

Comment [D37]: Employability

Comment [D38]: Employability

Comment [D39]: Employability

Outcomes: Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP

EC 15.311 **Telecommunication Switching Systems** **Total Lectures: 40**

3-0-0-3

Objectives:

1. To acquire knowledge on simple telephone communication and basics of switching system.
2. To get acquainted with electromechanical switching systems.
3. To gain knowledge on digital switching systems, stored program control system, traffic engineering, telephone networks and ISDN.
4. To apply the knowledge of Telecommunication Switching in designing switching systems.

Prerequisite: NONE

1. **Introduction to Switching Systems:** Introduction, simple telephone communication, basics of switching system [4]
2. **Electromechanical Switching Systems: Introduction to Strowger switching system,** Crossbar switching systems, single stage and multistage switching systems, common control, pulse dialling, tone dialling. [6]
3. **Digital Switching Systems:** Stored Program Control, centralised SPC, distributed SPC, software architecture, application software, space division, and time division switching, time multiplexed space division, time multiplexed time division switching and combination switching. [10]
4. **Traffic Engineering:** Erlang's equation, blocking probability and B-D equation. [4]
5. **Telephone Networks:** Subscriber loop, digital subscriber loop, high speed digital transmission over subscriber line, wire-in, wire-less media, coaxial cables, optical fibre cables, microwave propagation, satellite transmission, numbering plan, charging plan, Inchannel signalling, common channel signalling. [10]
6. **ISDN and ATM Standards:** ISDN architecture, channels, interfaces, protocol, B-ISDN architecture, frame relay, ATM protocols [6]

Comment [D53]: Skills Development

Comment [D54]: Skills Development

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of telecommunication Switching Systems.
2. Able to describe different mechanical and electronic switching systems, telephone networks.

Able to design various switching systems.

Text Books:

1. Telecommunication Switching Systems and Networks, Thiagarajan Viswanathan, PHI
2. Telecommunication Switching, Traffic and Networks, J. E. Flood, Pearson Education

EC 15.314 **FUNDAMENTALS OF MEMS** **Total Lectures: 40**
3-0-0-3

Objective: The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques. This enables them to design, analysis, fabrication and testing the MEMS based components.

Pre-requisite: Knowledge of materials and VLSI is highly desired.

1.	**Introduction:** MEMS Roadmaps, Benefits of Miniaturization, Benefits of Scaling.	**[2]**
2.	**Fabrication Process:** oxidation, film deposition, lithography, etching, ion implantation, diffusion.	**[8]**
3.	**Micromachining:** Surface Micromachining: basic process flow, release, stiction, material choices, residual stress, stringers and planarization, MUMPS, Summit, electroplating, 3D out-of-plane. Bulk Micromachining: wet etch based, dissolved wafer process, SOI MEMS, Scream, Hexsil MEMS, sealed cavity deep RIE.	**[6]**
4.	**Process Integration:** interleaved, MEMS-first, MEMS-last, bonded integration, wafer-to-wafer transfer, fluidic assembly.	**[4]**
5.	**Mechanics of Materials for MEMS:** stress, strain, material properties, measurement & characterization of mechanical parameters.	**[3]**
6.	**Microstructural Elements:** bending moment and strain, flexural rigidity, residual stress, boundary conditions, spring combinations.	**[3]**
7.	**Energy Methods:** application to clamped-clamped beam under axial load, resonance frequency determination, free-free beam, disk, ring, lumped-element mechanical equivalent circuits.	**[4]**
8.	**Circuit Modeling of MEMS:** resonator equivalent circuits, thermal circuits, fluidic circuits.	**[3]**
9.	**Electronic and Mechanical Noise:** electronic noise sources, Brownian motion noise, circuit noise calculation procedure, SNR, dynamic range.	**[3]**
10	**Micromechanical Circuits:** general filter topologies, insertion loss (noise figure), shape factor, design with k and q values, termination impedance, resonator and couplers, circuit modeling of coupled resonators, systematic micromechanical filter design procedure, oscillators, RF MEMS switches.	**[4]**

Comment [D79]: Skills Development

Comment [D80]: Skills Development

Outcome: 1. Be familiar with the important concepts applicable to MEMS, their fabrication.
2. Be fluent with the design, analysis and testing of MEMS.
3. Apply the MEMS for different applications.

Text Books:

1. Senturia's "Microsystem Design"
2. Kovacs' "Micromachined Transducers Sourcebook"
3. Jaeger's "Introduction to Microelectronic Fabrication"
4. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.

References Books:

1. Gaberiel M. Rebiz, "RF MEMS Theory, Design and Technology", John Wiley & Sons,2003
2. Charles P. Poole, Frank J. Owens, "Introduction to nanotechnology" John Wiley & sons, 2003.
3. Julian W. Gardner, Vijay K Varadhan, "Microsensors, MEMS and Smart devices", John Wiley & sons, 2001.

EC 15.315 **BASICS OF ROBOTICS** **Credit : 3-0-0-3**
Total Lectures: 40

• To introduce the basic concepts, parts of robots and types of robots.
• To make the student familiar with the various drive systems for robot, sensors and their applications in robots.

Prerequisite: Nil

Unit I- Introduction **[8]**

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems- Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-Robot Drive systems- Hydraulic, Pneumatic and Electric system.

Unit II - End Effectors And Robot Controls **[8]**

Mechanical grippers-Slider crank mechanism, Screw type, Rotary actuators, cam type-Magnetic grippers-Vacuum grippers-Air operated grippers-Gripper force analysis-Gripper design-Simple problems-Robot controls-Point to point control, Continuous path control, Intelligent robot-Control system for robot joint-Control actions-Feedback devices-Encoder, Resolver, LVDT-Motion Interpolations-Adaptive control.

Unit III-Robot Transformations And Sensors **[8]**

Robot kinematics-Types- 2D, 3D Transformation-Scaling, Rotation, Translation- Homogeneous coordinates, multiple transformation-Simple problems. Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors – Robotic vision sensor-Force sensor-Light sensors, Pressure sensors.

Unit IV-Robot Cell Design And Applications **[8]**

Robot work cell design and control-Sequence control, Operator interface, Safety monitoring devices in Robot-Mobile robot working principle, actuation using MATLAB, NXT Software Introductions-Robot applications- Material handling, Machine loading and unloading, assembly, Inspection, Welding, Spray painting and undersea robot.

Unit V-Micro/Nano Robotics System **[8]**

Micro/ Nanorobotics system overview-Scaling effect-Top down and bottom up approach-Actuators of Micro/Nano robotics system-Nanorobot communication techniques-Fabrication of micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot-Swarm robot-Nanorobot in targeted drug delivery system.

Outcomes: The Student must be able to understand the basics of Robot.

Text Books:

1. Niku Saeed B., Introduction to Robotics: Analysis, Systems, Applications, PHI, New Delhi 2001
2. John J.Craig, “Introduction to Robotics”, Pearson, 2009.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.

Comment [D58]: Skills Development

Comment [D59]: Skills Development

Comment [D60]: Employability

Comment [D61]: Employability

EC 15.316 **ROBOTICS AND CONTROLS** **Total Lectures: 40**
Credit : 3-0-0-3

OBJECTIVES:

- . To get exposure about basic robot kinematics, dynamics, control and programming.

Prerequisite: Basics of Robotics

UNIT I Introduction **[4]**

Definition, Structure, Classification and Specifications of Robots, Industrial Robots.

UNIT II Robot Elements and Control **[4]**

Manipulators, Drives, Sensors, End Effectors, Configuration, Force/Torque Relationship, Trajectory Planning, Position Control, Feedback System, Digital Control.

UNIT III Modeling of Robots **[10]**

Comment [D81]: Skills Development

Coordinate Frames, Mapping and Transformation; Direct Kinematic Model; Inverse Kinematics; Manipulator Differential Motion; Static Analysis; Jacobian.

UNIT IV Manipulator Dynamics **[10]**

Acceleration of a rigid body, mass distribution, Newtons equation, iterative Newton Euler dynamic formulation, Lagrangian formulation of manipulator dynamics, Bond graph modeling of manipulators, Trajectory Planning.

UNIT V Linear and Non Linear Control of Manipulators **[12]**

Comment [D82]: Skills Development

Control law partitioning, trajectory following control, multi input multi output control systems, Cartesian based control scheme. Force Control of manipulators: hybrid position/force control.

Outcomes: The Student must be able to design automatic manufacturing cells with robotic control using the principle behind robotic drive system, end effectors, sensor, machine vision robot kinematics and programming.

Text Books:

1. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
2. Mittal R. K. and Nagrath I. J., “Robotics and Control”, Tata McGraw Hill, New Delhi 2003.

Reference Books:

1. Ghosal Ashitava, “Robotics: Fundamental Concepts and Analysis”, Oxford University Press 2006.
2. Schilling R. J., “Fundamentals of Robotics Analysis and Control”, Prentice Hall Inc 1990.

EC 15.413 **Advanced Embedded System** **Total Lectures: 40**

3-0-0-4

Objective:

1. To teach the Fundamentals on design attributes of functional units of a Processor
2. To discuss on Hardware software partitioning in system design
3. To teach intra & Inter processor Communications
4. To discuss strategies for processor Communications

Understanding of necessity of operating system in advanced embedded systems.

Prerequisite: EC 14.202 Microprocessor Programming and Interfacing, EC 14.306 Microcontroller and Embedded System

7.	Introduction to Embedded Hardware and Software: Terminology – Gates – Timing diagram – Memory – Microprocessor buses – Direct memory access – Interrupts – Built interrupts – Interrupts basis – Shared data problems – Interrupt latency - Embedded system evolution trends – Interrupt routines in an RTOS environment.	[8]
8.	System Modelling with Hardware/Software Partitioning: Embedded systems, Hardware/Software Co-Design, Co-Design for System Specification and modelling- Single-processor Architectures &,Multi-Processor Architectures, comparison of Co- Design Approaches, Models of Computation, Requirements for Embedded System Specification, Hardware/Software Partitioning Problem, Hardware/Software Cost Estimation, Generation of Partitioning by Graphical modelling, Formulation of the HW/SW scheduling, Optimization.	[8]
9.	Hardware/ Software Co-Synthesis: The Co-Synthesis Problem, State-Transition Graph, Refinement and Controller Generation, Distributed System Co-Synthesis.	[8]
10.	Memory and Interfacing: Memory: Memory write ability and storage performance – Memory types – composing memory – Advance RAM interfacing communication basic – Microprocessor interfacing I/O addressing – Interrupts – Direct memory access – Arbitration multilevel bus architecture – Serial protocol – Parallel protocols – Wireless protocols – Digital camera example.	[8]
11.	Concurrent Process Models and Hardware Software Co-Design: Modes of operation – Finite state machines – Models – HCFSL and state charts language – state machine models – Concurrent process model – Concurrent process – Communication among process –Synchronization among process – Implementation – Data Flow model. Design technology – Automation synthesis – Hardware software co-simulation – IP cores – Design Process Model.	[8]

Comment [D89]: Skills Development

Comment [D90]: Employability

Outcomes: After completing this module, students will be expected to be able to:

1. Implement a RTOS based embedded system and uunderstand the embedded systems design process.
2. Define a specification for an embedded system.
3. Design an embedded system based on a specification.
4. Discuss methods for implementing reliable embedded systems to solve various problems.

EC 15.415 **ROBOT PROGRAMMING** **Total Lectures: 40**
Credit : 3-0-0-3

OBJECTIVES: To study the use of robot programming for various applications.

Prerequisite: Nil

UNIT I - Basics of Robot Programming **[8]**

Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands- Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.

UNIT II - Val Language **[8]**

Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications.

UNIT III - Rapid Language **[8]**

RAPID language basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, subroutine command based programming. Move master command language- Introduction, syntax, simple problems.

UNIT IV - Practical Study of Virtual Robot **[8]**

Robot cycle time analysis-Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot studio online software- Introduction, Jogging, components, work planning, program modules, input 13 RB-2013 SRM and output signals-Singularities-Collision detection-Repeatability measurement of robot-Robot economics.

UNIT V - VAL-II and AML **[8]**

VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot. AML Language-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor commands-Data processing.

Outcomes: Upon completion of this course the students can able to understand the basic of Robot programming.

Text Books:

1. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2008.
2. Deb. S. R. “Robotics technology and flexible automation”, Tata McGraw Hill publishing company limited, 1994.

Reference Books:

1. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “*Robotics control, sensing, vision and intelligence”*, McGraw Hill Book co, 1987.
2. Craig. J. J. “*Introduction to Robotics mechanics and control”*, Addison-Wesley, 1999.

Comment [D91]: Skills Development

Comment [D92]: Employability

EC 16.305 **Semiconductor Physics** **Total Lectures: 40**

3-1-0-4

Course Objective

The aim of the course is to develop physics and engineering strategies of semiconductor materials and to discuss their functionalities in modern electronic and optoelectronic devices.

Prerequisites : Basic Modern physics , Optics

1	Introduction to solid state materials - crystal structure - Reciprocal lattice - Brillouin zone and rules for band (*k* - space) representation. Dynamics of electrons in periodic potential: Kronig - Penny and nearly free electron models - Real methods for band structure calculations; Bandgaps in semiconductors - Holes and effective mass concept - Properties of conduction and valance bands.	[8]
2	Fermi distribution and energy - Density of states - Valance and conduction band density of states - intrinsic carrier concentration - intrinsic Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors - Bandgap Engineering.	[8]
3	Scattering Mechanism: electron - electron and electron - phonon scattering. Macroscopic transport: Carrier transport by Diffusion - Carrier transport by Drift: Low field, High field and very high field (Impact ionization) - Einstein relation.	[8]
4	Electron - hole pair generation and recombination: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons : Origin, electronic levels and properties Radiative and nonradiative recombination (Shockley - Read - Hall and Auger) processes. Carrier transport - continuity equations. Optical constants: Kramers - Kronig relations.	[8]
5	Optical processes in semiconductor, choice of materials for LED, LED power and efficiency, LED structures - Planar LED, Dome LED, Surface Emitting LED, Edge Emitting LED, Optical detection principle, quantum efficiency, Photoconductor, p-n photodiode, p-i-n photodioe, APD, Heterojunction diode, optocouplers.	[8]

Comment [D51]: Skills Development

Comment [D52]: Skills Development

Course Outcome

This course will provide the students with a basic understanding of the physics and principles of semiconductor material and the operation of the most important semiconductor devices in modern microelectronics and photonics.

EC-14. 403 **Antenna and Wave Propagation** **Total Lectures: 40**

3-0-0-3

Objective: To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications and RADAR.

Pre-requisite: EC-14.208 Principles of Electromagnetics

1. **Introduction**: Basic properties of transmitting, and receiving antenna, gain, bandwidth, and polarization, Effective aperture and Friss transmission formula. [4]
2. **Physical Concept of Radiation:** Retarded potentials hertzian dipole, antenna parameters, radiation pattern, gain, directivity, effective aperture, reciprocity and radiation from dipoles of arbitrary length. [6]
3. **Theory of Array Antenna: A**rrays of point sources, Endfire and Broadside arrays, Log-periodic, Yagi-uda arrays, Analysis of Rhombic antenna. Design of Rhombic Antennas, Loop Antenna: Radiation from small loop and its radiation resistance. Helical antenna: Normal and axial mode operation. synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method [10]
4. **Frequency Independent Antenna:** Slot, horn antenna, parabolic antenna, aperture antennas and microstrip antenna:Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas. [8]
5. **Wave Propagation:** Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, Sky wave propagation- propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, troposphere propagation, Super refraction. [7]
6. **Antennas for Mobile Satellite System:** Antenna for aeronautical mobile systems, cell-site and mobile antenna, adaptive antennas. [5]

Outcomes: After completion of the course, students will be able to

- select the appropriate portion of electromagnetic theory and its application to antennas.
- distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.
- assess the need for antenna arrays and mathematically analyze the types of antenna arrays.
- distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.
- outline the factors involved in the propagation of radio waves using practical antennas.

Text Books:

1. C. A. Balanis, Antenna Theory and Design, 3rd Ed, John Wiley & Sons, 2005.
2. W. L. Stutzman, and G. A. Thiele, Antenna Theory and Design, 2nd Ed, John Wiley & Sons, 1998.
3. R. S. Elliot, Antenna Theory and Design, Revised edition, Wiley-IEEE Press, 2003.

Reference Books:

1. R. E. Collin, Antennas and Radio Wave Propagation, McGraw-Hill, 2014.
2. K.D. Prasad, Antenna and Wave Propagation, 3rd Ed., Satya Prakashan, New Delhi, 2003

Comment [D84]: Skills Development

EC-14.201 **Electronic Devices and Circuits** **Total Lectures: 40**
3-1-0-4

Objective To acquire fundamental knowledge of operation, design and application of various Electronic devices and circuits.

Prerequisite Basic Electronics and Physics of electron.

1. **Junction Diode:** Junction breakdown**,** Current components in a p-n diode, Quantitative analysis of p-n diode characteristics and equivalent circuit, diode resistance, interconnections of diodes, transition and diffusion capacitance. [6]

2. **Transistors**: Operation of transistor, transistor current components, transistor circuit configurations, transistor biasing schemes and operating point stabilization, hybrid-pi model of BJT, low and high frequency models of JFET, MOS Devices - NMOS, PMOS and CMOS [11]

3. **Small Signal Amplifiers at Low Frequency:** Coupling schemes for multistage amplifiers, frequency response of coupled amplifier, RC coupled transistor amplifier, transformer coupled transistor amplifier, cascode circuits, Differential amplifier, Darlington amplifier. [7]

4. **Power Amplifiers:** Power amplifier circuits, class-A, class-B, class-AB, class-C, push pull amplifiers- class-A, class-B, Class- AB, complementary symmetry push-pull and quasi-complementary symmetry, push-pull amplifiers. [8]

5. **Oscillators:** Classification criterion for oscillation, tuned collector, Hartley, Colpitts, RC phase shift, Wien bridge and crystal oscillators, astable, monostable and bistable multivibrators, Schmitt trigger [8]

Outcome: After completion of this course, students would be able to understand the working phenomena and applications of various electronic devices and circuits. Knowledge gained from this course would also be utilized to design different electronic circuits and devices.

Text Books:
1. Millman J. & Halkias C.C., "Electronic Devices and Circuits" McGraw Hill.
2. Thomas L. Floyd, "Electronic Devices", Pearson Education.
3. Robert L. Boylestad & Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education.

Reference Book: Bell, David A., "Operational Amplifiers & Linear ICS" Prentice Hall of India.

Comment [D6]: Skills Development

Comment [D7]: Skills Development

Comment [D8]: Skills Development

Comment [D9]: Skills Development

EC-14.202 **Microprocessor Programming and Interfacing** **Total Lectures: 40**
3-0-0-3

Objective: To develop an in-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques.

Pre-requisite: The students should have good background on digital circuits (should have attended the course Switching Circuits and Logic Design).

1. **The Microcomputer:** Evolution of microprocessor, address bus and data bus, introduction to machine language and assembly language, logic devices for interfacing: 74244, 74245, 74373 **[3]**
2. **The 8085 Processor:** Architecture, pin diagram and description of various signals, read, write and op-code fetch cycles, interrupt structure, instruction set and Assembly language programming. [12]
3. **The 8086 Microprocessor Architecture :** Architecture, details of sub-blocks such as EU, BIU; memory segmentation and physical address computations, pin diagram and description of various signals, minimum and maximum mode of operations, supporting chips viz. 8284, 8288 and memory mapping [8]
4. **Programming of 8086:** Addressing modes of 8086, instruction set of 8086, assembly language programming, counters and time delays, stack structure of 8086 and subroutine. [7]
5. **Interfacing of 8085 / 8086 with Programmable Chips:** Interfacing of 8255 Programmable peripheral interface, 8251 USART, 8253/8254 Programmable Interval Timer and Direct Memory Access Controller 8237/8257 DMA, 8259 Programmable Interrupt Controller. [10]

Outcome: **Upon completion of this course, the student will be able to:**

1. The student will learn the internal organization of some popular microprocessors and microcontrollers.
2. The student will learn hardware and software interaction and integration.
3. The students will learn the design of microprocessors/microcontrollers-based systems.

Text Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Application with the 8085; Penram International Publishing (India).
2. A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals; TMH.

Reference Books:

1. D. V. Hall, Microprocessors and Interfacings; TMH, second Edition.
2. B. P. Singh and Renu Singh, Advanced Microprocessors and Microcontrollers; New Age International Publishers, Third Edition.A. K. Ray & K. M. Bhurchandi, Advanced Microprocessors and Peripherals; TMH.

Comment [D20]: Skills Development

Comment [D21]: Skills Development

Comment [D22]: Skills Development

Comment [D23]: Skills Development

EC-14.203 **Digital Electronics** **Total Lectures: 40**
3-1-0-4

Objective: The aim of this course is to present the principles and techniques of combinational and sequential digital logic design and optimization at a gate level. The use of transistors for building gates is also introduced.

Pre-requisite: Basic Electronics course in First Year.

1 **Number Systems and Codes:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic. [2]

2 **Introduction to Boolean Algebra:** Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [2]

3 **Logic Gates:** Diode and transistor as a switch, basic logic gates, derived logic gates, block diagrams and truth tables, logic diagrams from Boolean expression and vice versa, converting logic diagram to universal logic, positive logic, negative logic and mixed logic. [5]

4 **Simplification of Boolean Functions:** K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method. [5]

5 **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]

6 **Sequential Circuits:** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters. [10]

7 **Logic Families:** Logic gate characteristics (propagation delay, speed, noise margin, fan-in, fan-out, power dissipation), standard logic families (RTL, DCTL, TTL, ECL, MOS) [5]

8 **Programmable Logic:** Introduction to programmable logic array (PLA), programmable array logic (PAL). [1]

Comment [D10]: Skills Development

Comment [D11]: Skills Development

Comment [D12]: Skills Development

Comment [D13]: Skills Development

Comment [D14]: Skills Development

Outcome: Graduates will have knowledge of digital systems. They will understand how to analyze and design digital logic circuits, and be familiar with digital ICs.

Text Books: 1. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Patparganj, Delhi, 4thEdition, 2009.
2. Floyd, T. L. and Jain, R.P., "Digital Fundamental", Pearson Education, Patparganj, Delhi, 8thEdition, 2009.
3. Tocci, R. J., Widmer, N. and Moss, G., "Digital System: Principles and Applications", Pearson Education, Patparganj, Delhi, 10thEdition, 2007.

EC-14.204 **Integrated Circuit and Applications** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: EC-14.201(Electronics Devices and Circuits)

1.	**Differential Amplifier:** Operational amplifier, bipolar and FET differential amplifiers, constant current source, current mirror, level translator, block diagram of operational amplifier, frequency response and stability, operational amplifier parameters, offset compensation techniques.	**[6]**
2.	**Application of Op-amp:** Inverting and non-inverting amplifiers, voltage follower, integrator and differentiator circuits, instrumentation amplifier, current to voltage converter and voltage to current converter, voltage to frequency conversion, analog simulation of differential equations using operational amplifiers.	**[7]**
3.	**Oscillators:** Phase shift, Wein bridge, quadrature, square wave, triangular wave, sawtooth wave and voltage controlled oscillator.	**[5]**
4.	**Active Filters:** Low pass, high pass, band pass and band reject filters, designing of second order filters using Butterworth approximations, higher order filters and state variable filters.	**[6]**
5.	**ICs and Applications:** Clipping and clamping circuits, comparator, LM-311 comparator, schmitt trigger, log and antilog amplifiers, half and full wave rectification, IC-8038, IC LF-398, IC-555.	**[6]**
6.	**Voltage Regulator and PLL:** Voltage regulator IC-723, switching regulators, regulator IC series 78xx, 79xx, building blocks of PLL, IC-565 and its applications, four-quadrant multiplier and its applications.	**[10]**

Comment [D24]: Skills Development

Comment [D25]: Skills Development

Comment [D26]: Skills Development

Comment [D27]: Skills Development

Comment [D28]: Skills Development

Comment [D29]: Skills Development

Outcome: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Gayakwad R. A., "Op-Amps and Linear Integrated Circuits", PHI, New Delhi, 3rd Edition.
2. Singh B. P. and Singh Rekha, "Electronic Devices and Integrated Circuits", Pearson Education, Patparganj, Delhi.
3. Coughlin R. F. and Driscoll F. F., "Operational Amplifiers & Integrated Circuits", Pearson Education, Patparganj, Delhi.

Reference Books:

1. Franco S., "Design with Operational Amplifiers and Analog Integrated Circuits", Pearson Education, Patparganj, Delhi.

EC-14.206 **Consumer Electronics** **Total Lectures: 40**

3-1-0-4

Objective: This subject will introduce the students with working principles, block diagram and advance features of consumer electronics appliances. Also this will familiarize students with latest advancements in Electronic manufacturing industry. Knowledge so gained would also help in troubleshooting and maintaining different electronic gadgets and appliances.

Pre-requisite: Basic understanding of electric circuits and components and some knowledge of basic electronic devices such as diodes, transistors etc.

1. **Introduction to Electronics Engineering:** Review of basic electrical & electronic circuits and components. Difference in electrical and electronic engineering. Introduction to electronics industry in India and the world; consumer electronics gadgets classification and applications. Introduction to ESDM (Electronic System Design & Manufacturing). **[4]**
2. **Audio devices and systems:** Characteristics of sound signal: level and loudness, pitch, frequency response, fidelity and linearity, Reverberation. Audio level metering, decibel level in acoustic measurement. Microphone: working principle, sensitivity, response. Loud speaker: working principle, characteristic impedance, and watt capacity, loud speaker types. Sound recording: Optical recording, stereophony. Audio system: CD player, home theatre sound system. Digital console: block diagram, working principle, applications. FM tuner: concepts of digital tuning, ICs used in FM tuner TDA 7021T. PA system: planning, speaker impedance matching, Characteristics, power amplifier. **[12]**
3. **Television and Video Systems:** Monochrome TV standards, scanning process, aspect ratio, persistence of vision and flicker, picture resolution. Composite video signal: horizontal and vertical sync details. Colour TV standards, colour theory, hue, brightness, saturation, luminance and chrominance. PAL system, channel bandwidth. Digital TVs: - LCD, LED, PLASMA, HDTV, 3-D TV, projection TV, DTH receiver. CD and DVD player: working principles. **[10]**
4. **Home and Office Appliances:** FAX and Photocopier Microwave Oven: types, technical specifications Washing Machine: wiring diagram, electronic controller for washing machine, technical specifications, types of washing machine, fuzzy logic Air conditioner and Refrigerators: Components features, applications and technical specification. Digital camera and cam coder. **[10]**
5. **Advanced trends in Electronic manufacturing industry:** Basics of semiconductor technology and integrated circuits. Introduction to embedded intelligence in electronic gadgets: microcontroller based systems; different ICs used in the systems such as 8051, Op-Amp, 555 timer, and Digital ICs. **[4]**

Outcome: After the completion of the course, students are able to acquire required learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

i. Troubleshoot different types of microphones, audio systems and colour TV receiver.
ii. Maintain various electronic home appliances.

Text Books:

1. Audio video systems : principle practices & troubleshooting ; Bali R. and Bali S.P. ; Khanna Book Publishing Co. (P) Ltd. , 2010
2. Consumer Electronics; S.P. Bali ; Pearson Education India, 2010
3. Audio video systems ; Gupta R. G. ; Tata Mc Graw Hill, New Delhi, 2010
4. Colour Television & Video Technology; A. K. Maini ; CSB Publishers

Reference Books:

1. Modern Television Practices ; Gulati R. R. ; New Age International Publication, New Delhi, 2010
2. Standard Handbook on Audio Engineering ; Whitaker Jerry & Benson Blair ; McGraw Hill Professional ; 2010
3. VCR-principles, maintenance & repair by S.P. Sharma, Tata Mc Graw Hill, New Delhi

Comment [D30]: Skills Development

Comment [D31]: Skills Development

Comment [D32]: Skills Development

EC-14.208 **Principles of Electromagnetics** Total Lectures: 40

3-0-0-3

Objective: To develop the understanding of basics concepts of electromagnetic field theory and its applications.

Pre-requisite: Basic understanding of laws of Physics and Mathematics

1. **Introduction**: Transformation of a point and a vector in different coordinate systems, Differential length, area, volume Physical meaning of gradient, divergence and curl, Laplacian of a scalar, Divergence theorem, Stoke's theorem, review of electrostatic and magneto static fields. [8]
2. **Time Varying Fields and Maxwell's Equations:** Faraday's law of electromagnetic induction, Maxwell's equations in integral and differential form, potential functions, electromagnetic boundary conditions. [8]
3. **Electromagnetic Waves:** Introduction, Helmholtz wave equation, Wave equations and their solutions for free space, lossy dielectric, Lossless dielectrics and good conductor medium, Poynting vector and the flow of power. Reflection of plane wave at dielectric media and conducting surfaces for normal incidence. [10]
4. **Transmission lines:** Types of transmission lines, transmission line parameters, two conductor transmission line equations, input impedance, standing wave ratio and power of transmission lines, smith chart, transmission line impedance matching techniques. [6]
5. **Guiding Structures:** General wave behaviors along uniform guiding structure, rectangular and circular wave guides, wave propagation in rectangular and cylindrical cavity resonators. [8]

Comment [D33]: Skills Development

Outcome: After completion of this course, students would be understanding the concept of electric and magnetic fields, both static and dynamic, and gain insight in various application areas like transmission lines and waveguides.

Text Books:

1 Matthew N. O. Sadiku, Principles of Electromagnetics (Fourth Edition); Oxford University Press.

2 William H. Hayt: Engineering Electromagnetic, TMH.

3 Raju, Electromagnetic field theory and Transmission lines, Pearson Education.

4 John D. Kraus: Electromagnetics, McGraw Hill.

Reference Books:

1 David J. Griffiths, Introduction to Electrodynamics (Third Edition); Pearson Education.

2 M. L. Sisodia and G. S. Raghuvanshi, Microwave Circuits and Passive Devices, New Age Publication.

EC-14.210 **Comprehensive I** **Total Lectures: 40**
0-0-0-3

Objective To acquire intensive knowledge and proficiency in some special field of knowledge.

Prerequisite Basic concepts of all prior program related courses such as, principles of semiconducting materials and devices, digital logic systems and theories of circuits and networks.

1. Comparative study of BJT and MOS transistors in respect of operation, circuit configuration, biasing stability, high and low frequency models, small-signal amplifiers and oscillator design issues.
2. Boolean function implementation using logic gates, comparative studies of RTL, DTL, TTL and ECL logic families in respect of speed, noise and power dissipation, logic function design based on PLA and PAL.
3. Application of Laplace transformation to network equations, steady-state and transient response of low-pass, high-pass and band-pass networks, hybrid and transmission parameters of two-port networks, RL, RC, and RLC network synthesis.

Comment [D36]: Skills Development

Outcome: After completion of this course, students would be able to understand the principles of entire field of major subjects till the second year of study.

Text Books:

1. Millman J. & Halkias C.C., "Electronic Devices and Circuits" McGraw Hill.
2. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Patparganj, Delhi, 4th Edition, 2009.
3. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", John Wiley and Sons, Inc., 1960.

Reference Book:

1. Robert L. Boylestad& Louis Nashelsky, "Electronic Devices and Circuit Theory", Pearson Education.
2. Karim, M.A. and Chen. X., "Digital Design: Basic Concepts and Principles", CRC Press Taylor & Francis Group, Printed in India by Saurabh Printers, 2nd Indian reprint, 2010.
3. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", Tata McGraw-Hill, 2007.

EC-14.301 **Signal Processing and Applications** **Total Lectures: 40**
3 – 1 – 0 – 4

Objective:

- To understand the fundamental characteristics of continuous- and discrete-time signals and systems in terms of both the time and transform domains and to develop the mathematical skills to solve problems involving convolution and sampling.
- The students would be familiar with different methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors. The course emphasizes intuitive understanding and practical implementations of the theoretical concepts.

Pre-requisite: None

1. **Representation and classification of Signals**: Signal classification - Continuous and discrete time, Periodic - aperiodic, even - odd, energy - power, Deterministic - random, real valued - complex exponential, sinusoidal, time scaling, time shifting, Sampling and discrete time processing of continuous-time signals, Concept of frequency in continuous-time and discrete-time signals. **[06]**
2. **Basics of Systems and Transformation**: Properties of systems – linearity, time invariant, causal, stable, inverse, static and dynamic, system impulse response, convolution, correlation, Transformation - Fourier series, continuous time and discrete time Fourier transform, Laplace transform, z-transform, its properties, limitations and inverse transforms, pole – zero concept, computation of impulse response and transfer function using transforms. **[06]**
3. **Analysis of Continuous time and discrete time systems:** Block diagram representation, linear time-invariant (LTI) systems, interconnection of LTI Systems, discrete time systems and their types, systems with finite and infinite duration impulse response, recursive and non-recursive structures, system realizations in direct , transpose, cascade and parallel forms. **[08]**
4. **DFT, FFT and DCT Algorithms:** Discrete Fourier transform (DFT), linear convolution using DFT, efficient computation of the DFT - Fast Fourier transform (FFT) algorithms, radix-2 & 4 FFT algorithms, discrete cosine transform (DCT) - DCT-1 and DCT-2, energy compaction property of DCT. **[06]**
5. **Digital Filter Design:** Review of analog filters – comb and notch types, Design of infinite Impulse Response (IIR) filter from analog filters - Bilinear and Impulse invariant transformation, Finite Impulse Response (FIR) filter - amplitude & phase responses, linear phase filters, transversal filters, windowing techniques, comparison between IIR and FIR filters. **[08]**
6. **Applications of signal processing:** DTMF signal detection, spectral analysis of deterministic and random signals, musical sound processing, signal compression and radar application. **[06]**

Outcome: After completion of the course, students will be able to

- Understand the process of sampling and spectral characteristics of periodic and aperiodic signals using Fourier analysis and determine the response of LTI system using Fourier analysis convolution.
- Understand the meaning and implications of the properties of signals and systems, and represent discrete-time signals analytically and visualize them in the time domain.
- Understand the Transform domain and its significance and problems related to computational complexity.
- Design discrete time filters, compute different errors in design process.

Text Books:

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawab, PHI, 2nd Edition.
2. Signals and Systems – Tarun Kumar Rawat, Oxford Higher Education, 2010
3. Digital Signal Processing – A Computer Based Approach, S. K. Mitra, 3rd Ed, McGraw-Hill.

Comment [D40]: Skills Development

Comment [D41]: Skills Development

Comment [D42]: Skills Development

Comment [D43]: Skills Development

EC-14.302 **Microwave Engineering** **Total Lectures: 40**

3-0-0-3

Objective: To acquire fundamental knowledge of Microwave and apply in engineering applications.

Pre-requisite: Electromagnetic Field Theory.

1. **Introduction:** **[03]**
   Microwaves, Generation: Brief idea of microwave tubes and microwave solid state devices, properties and applications.

2. **Microwave Circuits:** **[07]**
   Equivalent voltage and current definition in waveguides, concept of impedance, impedance matrix, admittance matrix, scattering matrix and transmission matrix**.**

3. **Microwave Passive Devices:** **[10]**
   Excitation of waveguides through probes, loops and apertures. Terminations: matched loads and short, attenuators, phase shifters, two hole directional coupler, E-plane tee, H-plane tee, magic tee, microwave propagation in ferrites, isolators and circulators.

4. **Microwave Active Devices:** **[14]**
   Reflex Klystron, Two cavity Klystron, Travelling Wave Tubes, Magnetrons, Gyrotron, construction, operation and practical applications of Gunn diode, Tunnel diode and IMPATT diode**.**

5. **Microwave Measurements:** **[06]**
   Detection of microwaves, measurement of microwave power, impedance, frequency, VSWR, Q-factor and scattering parameters.

Comment [D62]: Skills Development

Comment [D63]: Skills Development

Outcome: After completion of the course, students would be able to apply microwave concepts and equations in engineering and solve voltage and current equations.

Text Books:

1. David M. Pozar, Microwave Engineering (Third Edition), John Willey & sons.
2. Samuel Y. Liao, Microwave devices and Circuits (Third Edition), Pearson Education.
3. Annapurna Das &Sisir K Das, Microwave Engineering (Second Edition), McGraw-Hill Companies.

Reference Book:

1. Matthew N. O. Sadiku, Principles of Electromagnetics (Fourth Edition), Oxford University Press

EC-14.303 **Principles of Analog Communication** **Total Lectures: 40**
3-1-0-4

Objective:
- To develop a fundamental understanding on communication systems with emphasis on analog modulation techniques.
- To appreciate the mathematical concepts that form the foundations of analog communication

Pre-requisite: Signals and Systems, Statistics and Probability Theory

1. **Linear Modulation Techniques:** Basic blocks of communication systems, Review of signals and systems, Linear Modulation, Time domain and frequency domain description of AM (DSB-FC), DSB-SC, SSB and VSB signals. Generation and detection of linear modulation techniques, Super-heterodyne receivers and design. **[12]**
2. **Angular Modulation Techniques:** Basic concepts, Frequency Modulation Spectrum Analysis of FM Wave, Generation and detection of narrow band and wide band frequency modulation, Phase modulation, FM detection techniques-phase locked loops, Commercial broadcasting systems. **[8]**
3. **Sources of Noise and their characterization:** Random Variables, Random process and their characterization. Noise in Analog communication System. SNR calculations for synchronous detection of DSB and SSB and envelope detection of AM, SNR calculations for angle modulation system. Pre-emphasis and de-emphasis. Threshold effect in angle modulation. **[8]**
4. **Multiplexing and Multiple Access Techniques:** Frequency division Multiplexing, time division multiplexing, multiple access techniques. **[5]**
5. **Sampling and Pulse Modulation:** Sampling theorem – ideal and natural sampling and reconstruction, Pulse-Amplitude Modulation, Pulse-Time Modulation. **[7]**

Comment [D44]: Skills Development

Comment [D45]: Skills Development

Comment [D46]: Skills Development

Outcome:

1) Apply the basic knowledge of signals and systems and understand the basics of communication system and analog modulation techniques.
2) Evaluate the communication system performance in the presence of noise and summarize the merits and demerits of all the conventional analog modulation system.
3) Understand the basics of different of multiplexing and multiple access techniques and their application in cellular networks.
4) Understand the fundamentals of digital transmission of analog signals.
5) Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for modulators, demodulator and communication systems using CAD tool.

Text Books:

1) B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford university press, 4th Edition.
2) P. K. Ghosh, Principles of Analog and Digital Communication, Orient Black Swan Publishers Pvt. Ltd., 1st Edition
3) Taub and Schilling, Principles of Communication Systems, TMH.
4) E. Ziemer William H. Tranter, Principles of Communication, John Wiley & Sons 5th Edition.

Reference Books:

1) S. Haykins, Communication Systems (4/e), Wiley.
2) *Kennedy, Davis, Electronic Communication Systems (4/e), McGraw Hill.*

EC-14.304 **Principles of Digital Communication** **Total Lectures: 40**
3-1-0-4

Objective: The objective of this course is to introduce the students to the basic concepts of digital communication. The aim of this course is to study the fundamental aspects of digital communication systems. The understanding of the fundamentals of digital communication by studying theory, numerical and implementation of circuits.

Pre-requisite: The basics of Communication Systems and Techniques.

1. **Model of a Communication System:** Introduction, advantages of digital communication over analog communication, probability theory random process and random variables. **[6]**
2. **Digital Communication Techniques:** Sampling theorem and techniques, uniform and non-uniform quantization techniques, PCM, DPCM, DM, and ADM, compression standards, time division multiplexing and synchronization, Digital multiplexing hierarchy, Electrical representation of binary sequences Bandwidth requirement of PCM. **[10]**
3. **Information Theory and Coding:** Channel capacity, Shannon capacity, source entropy, Shannon-Fano, Huffman coding, linear block codes and syndrome decoding, cyclic codes, BCH codes, convolution, Viterbi coding and decoding. **[10]**
4. **Digital Modulation Techniques:** Base-band transmission, inter-symbol interference and adaptive equalization, digital modulation and demodulation techniques, bandwidth consideration of different digital modulation schemes, matched filter and probability of error analysis, carrier and timing recovery techniques. **[14]**

Comment [D64]: Skills Development

Comment [D65]: Skills Development

Outcome:

- The students can understand the concepts of digital communication.
- They acquire and apply the knowledge to implement the concepts for designing an efficient communication system.
- They become able to identify, analyse and implement new ideas in digital communication systems for proposing alternate solutions.

Text Books:

1. B. P. Lathi, “Modern Digital and Analog communication Systems”, Oxford University Press, 2010.
2. P. K. Ghosh, Principles of Analog and Digital Communication, Orient Black Swan Publishers Pvt. Ltd., 1st Edition
3. H. Taub, D L Schilling, Goutom Saha, “Principles of Communication”, TMH.

Reference Books:

1. Simon Haykin, “Communication Systems”, Wiley India.
2. H P HSU and D Mitra, “Analog and Digital Communications”, TMH
3. John G. Proakis, “Digital Communications”, McGraw-Hill International.

EC-14.306 **Microcontroller and Embedded Systems** **Total Lectures: 40**
3-0-0-3

Objective: The objective of this course is to teach students design and interfacing of microcontroller-based embedded systems. The course covers fundamentals, The 8051 Architecture, Assembly Language Programming, Instruction set, Serial Communication and Interfacing techniques of 8051 Microcontroller.

Pre-requisite: Programming skills and fundamental knowledge of microcontrollers, microprocessors and digital design.

1. **Introduction to Microcontrollers, Architecture and Memory Interfacing:** Overview of the 8051 family, 8051 Microcontroller's Architecture, Pin configuration, Common memory types and Tradeoffs, External Memory interfacing. **[7]**
2. **Programming of 8051:** Addressing modes of 8051, instruction set of 8051, assembly language programming of 8051, stack structure of 8085, delays, and subroutines, Applications of interrupts, timer/counter and serial port, Components of Integrated Development Environment for software development. **[16]**
3. **Interfacing of 8051:** Interfacing of 8051 with sensors, Keyboard, ADC, DAC, LCD, Stepper Motor and D.C motor. **[8]**
4. **Introduction to Embedded systems and processors:** Introduction and Examples of Embedded Systems, Concept of Embedded System. Design challenge, Processor technology, IC technology, Design technology, Trade-offs: Custom single purpose processor hardware, general-purpose processor: introduction, basic architecture, operation, super-scalar architecture, application specific instruction set processors, microcontrollers, digital signal processors, selection of embedded processor. **[6]**
5. **Software aspect of embedded system:** Challenges and issues in embedded software development, Software and hardware requirements, Real time system, Real time operating systems, Kernel, architecture: mutex, semaphore, testing and verification. **[3]**

Comment [D66]: Employability

Comment [D67]: Employability

Comment [D68]: Skills Development

Comment [D69]: Employability

Outcome: Upon completion of this course, the student will be able to:

1. Program, build and test a microcontroller system.
2. Interface a microcontroller system to user controls and other electronic systems.
3. Describe the internal architecture of microcontroller systems, including counters, timers, ports, and memory.
4. Understand and design embedded systems and real-time systems.
5. For real-time systems:
   - Identify the unique characteristics of real-time systems.
   - Explain the general structure of a real-time system.
   - Define the unique design problems and challenges of real-time systems.

Text Books:

1. M. A. Mazidi, The 8051 Microcontroller & Embedded Systems; Pearson Education.
2. I. Scott McKenzie and Raphael C.W. Phan; The 8051 Microcontroller; Pearson Education.
3. Raj Kamal, Embeded System; Tata Mcgraw-Hill.

Reference Books:

1. David E Simon, An Embedded Software Primer; Pearson Education.

EC-14.401 **VLSI Design** **Total Lectures: 40**
3-1-0-4

Objective:	The educational objectives of the VLSI design course are: **1.** Graduates who desire to pursue an engineering career in VLSI Design arena will be widely employed in positions they find appropriate and desirable. **2.** Graduates who desire to pursue higher degrees will be successful in gaining mission and advancing in programs they find appropriate and desirable.
Pre-requisite:	EC-14.201 Electronics Devices and Circuits, EC-14.203 Digital Electronics.

1.	**Basic VLSI Design Issues:** IC design techniques- hierarchical design, design abstraction and computer-aided design	[4]
2.	**MOS Transistor Theory:** Current-voltage characteristics of MOSFETS, threshold voltage and body effect, MOSFET design equations, second order effects, MOSFET capacitances	[8]
3.	**NMOS and CMOS Inverter:** NMOS and CMOS inverters, W/L ratio for NMOS and CMOS inverters, β_n/β_p ratio, noise margin, NMOS and CMOS Voltage transfer Characteristics, CMOS delay and power dissipation	[8]
4.	**MOS Inverter's Switching Characteristics:** Calculation of delay times, Inverter design with delay constraints	[6]
5.	**Stick Diagram & Layout:** Stick diagrams, CMOS design style, design rules: lambda based design rules, layout design	[8]
6.	**Basic VLSI Circuit Design Techniques:** Inverter equivalent of series and parallel MOS circuits, logic design with delay and power constraints, worst case design, complex logic design	[6]

Outcomes:

- Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing fundamental areas of VLSI design.
- Ability to apply in-depth knowledge of VLSI design principles, systems, and devices to the solution of real time problems.
- Ability to design and evaluate a component or system to meet desired needs within the field of VLSI design.
- Ability to function as a member of a multidisciplinary team in the solution of engineering problems such as providing CAD solution for device fabrications.

Text Books:

1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI, 3rd Ed., 2011
2. Neil H.E. Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 4th Ed., 2011
3. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design, Tata Mc-Graw-Hill, 3rd Ed., 2003

Reference Books:

1. Jab M. Rabaey, Anantha Chandra Kasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI, 2nd Ed., 2012
2. Michal John Sebastian Smith, Application-Specific Integrated Circuits, Pearson Education, 6th Ed., 2009

Comment [D83]: Employability

EC-14.433 **Industrial Training Seminar** **Credits: 2**

Industrial training plays a very important role for engineering graduates of all disciplines. As an engineering student, training can help to implement the concepts that students have learnt in their classes.

Objective: To enhance the knowledge of the students on different cutting edge technologies which have become important part of respective industries.

Industrial training offers the following:

1. Experience of industrial environment/conditions to girls students.
2. Enable the students to learn engineering techniques by observation and practice.
3. Show how theory presented in class is applied in practice.
4. Provide contact with practicing engineers.
5. Familiarize the student with practices and problems faced by companies employing engineers.
6. Give the student the responsibility of completing a piece of work.
7. Enable and accord industry opportunity to shape and participate in the development of future human resources.

Comment [D87]: Employability

Training Outcomes and Assessment

1. Ability to acquire and apply fundamental principles of science and engineering.
2. Capability to communicate effectively
3. Ability to identify, formulate and model problems and find engineering solution based on a systems approach.
4. Ability to conduct research in the chosen fields of engineering.
5. Understanding of the importance of sustainability and cost-effectiveness in design and developments of engineering solution.
6. Ability to be a multi-skilled engineer with good technical knowledge, management, leadership and entrepreneurship skills.
7. Awareness of the social, cultural, global and environmental responsibility as an engineer.
8. Capability and enthusiasm for self-improvement through continuous professional development and life-long learning.

EC-14.441 **Principles and Practices of Management** **Total lectures : 26**
Credits : 2-0-0-2

Prerequisite(s): None

Objective(s):

1. To expose the students to fundamental concepts of management and its processes in organizations.
2. To describe the various skills necessary for effective managers.
3. To explain the Individual and Group Behavior along with various leadership Styles

1. **Planning and Organizing** [5]
   Management: Concept, Nature and functions; Planning: Concept, Missions, Objective and Strategies, Steps in Planning; Organizing: Concept, Formal an Informal Organization, Decentralization of Authority, Delegation of Authority, Principles of Organizing, Line and Staff Authority.
2. **Staffing and Controlling** [4]
   Staffing: Definition, Recruitment, Selection, Placement, Promotion, Separation, Performance Appraisal; Controlling: Concepts and Process, Controlling as a Feedback System, Requirements for Effective Control.
3. **Motivation** [4]
   Concept; Theories and Process of Motivation: Maslow's Need-Hierarchy Theory, Herzberg's Hygiene Theory, Goal-Setting Theory, Vroom's Expectancy Theory.
4. **Personality** [3]
   Concept and Determinates, Types and Traits, Personality Attributes Influencing Organizational Behavior, Locus of Control, Machiavellianism, Self-Esteem, Self-Monitoring, Risk-Taking.
5. **Group Behavior and Interpersonal Relationship** [6]
   Groups: Concept and Classification, Stages of Group Development, Rolesand Norms, Group Decision-Making: Group versus Individual, Group Decision Making Techniques and Process, Interpersonal Relationships, Understanding Self and Others, Developing Interpersonal Relationships, Transactional Analysis, Johari Window.
6. **Leadership** [4]
   Concept and Functions; Theories of Leadership: Traits, Behavioral, Situational/Contingency; Inspirational approaches to Leadership: Charismatic Leadership, Transformational Leadership, Transactional Leadership, and Contemporary Leadership.

Outcome(s): By studying this Course, students would be able to understand various Management functions, individual and group behavior. They would also know various styles of Leadership and its applicability. The course would help the students in understanding various organizational contexts and help them understand organizational systems in a better way.

Text Books:

1. Koontz, Harold and Weihrich, Heinz, Essentials of Management: An International, Innovation and Leadership Perspective, 10th Edition, McGraw Hill Private Limited, India, 2015
2. Robbins, Stephen P., Timothy Judge and Neharika Vohra, Organizational Behavior, 12th Ed., Pearson Education, 2011.

Reference Books:

1. Prasad L. M., Principles and Practice of Management, 9th Edition, Sultan Chand & Sons, 2015
2. Aswathappa K. Organizational Behavior, Eighth Edition, Himalaya Publishing House.
3. James A. F. Stoner, Freeman A. Edward, and Daniel A. Gilbert Jr., Management, Pearson Education
4. Fred Luthans, Organisational Behaviour, 11th Ed., Mc - Graw Hill, 2009

Comment [D86]: Entrepreneurship

EC-15.312 **Advance Radio Access Network (ARAN)** **Total Lectures: 40**

3-0-0-3

Objective:
To acquire skills on different legacy and advance RAN's Architecture, Design & Optimization along with latest industries concepts on 5G, IOT, Volte, RAN Cloud etc.

Prerequisite:
Digital Modulation Techniques & Data Transmission, Antenna and Wave Propagation, Basics of Mobile Communication

1.	**Introduction to RAN:** Telecom E2E approach, RAN Life Cycle,RF basics, Microwave Theory, Propagation Models, Modulation Theory, Antenna Theory. Latest Industry Concepts – 5G, IOT, Volte, RAN Cloud	[4]
2.	**RAN Overview**:Introduction to Cellular Concepts, Introduction to Power Control, Introduction to Protocol Stacks, GSM, WCDMA, LTE (Overview, Architecture, Air Interface), Generalized Call Flows	[12]
3.	**RAN Design:**RF Design Overview, Initial Radio Network Design (Link Budget, Radio Network Dimensioning & Nominal Design), Final Radio Network Design, Radio Planning Tools & IBS Introduction, Radio Propagation Model Tuning, LRAN Initial Radio Network Design (Sample Report)	[12]
4.	**RAN Optimization:**Pre Launch Optimization (Process Overview, Introduction to Drive Testing (Data Collection Methodology, Data Post Processing),Post Launch Optimization, (Process Overview, Introduction to Counters and OSS, KPI Improvement Methodology)	[12]

Outcome: After completion of this course, students would be able to understand the industry level ways of working of RAN with different design and optimization techniques. Students will get heads up in terms of upcoming advance technologyconcepts.

Text Books:

1. Ericsson Academy (Ericsson Internal)
   - Air Interface
   - Protocol and Procedures
   - GSM, UMTS, LTE Fundamentals
   - RAN Design & Performance Management.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2007.
3. Theodore S. Rappaport, "Wireless Communication", Pearson Education, Asia, New Delhi, 2002.

Reference Books:

1. John G. Prokis and Masoud Salehi," Digital Communication", McGraw-Hill, Fifth edition.

Comment [D78]: Employability

EC-15.313	System Design Using HDL	Total Lectures: 40
		3-0-0-3

Objective: To acquire fundamental knowledge of designing of digital systems using VHDL.Students will acquire practical working knowledge of creating digital circuits using commercial Computer-Aided-Design (CAD) tools.

Pre-requisite: Knowledge of digital logic and digital circuits are highly desired.

1. **Programmable Logic Design:** ASIC, ROM, PLA, PAL, CPLD and FPGA. **[3]**
2. **VHDL Based Design:** An overview of VHDL, Role of VHDL in system design, Introduction to CAD tools for system design, Introduction to Xilinx IDE software. **[3]**
3. **VHDL Fundamentals:** Entity and architecture declaration, Introduction to behavioral, dataflow and structural models, package, package declarations and package body. **[6]**
4. **Basic Elements of VHDL:** Data objects – constant, variable and signal, Data types – scalar and composite, Predefined Operators – logical, relational, shift, adding and multiplying, Overloading – literal and operator. **[4]**
5. **VHDL Statements:** Process, variable assignment, signal assignment, sequential statements, conditional statements, loop**,** if, case, next statements, assertion and report statements, signal drivers and signal assignment statements, conditional signal assignments, select and generic. **[10]**
   Subprograms: Application of functions and procedures, Overloading and signal assignments, Component declaration, Component instantiation.
6. **Combinational Circuit Design:** VHDL models of combinational circuits such as Adder, Multiplexer, De-multiplexer, Encoder, Decoder, Code converters, Comparators, Parity generators, Multipliers and implementation of Boolean functions. **[7]**
7. **Sequential Circuit Design:** VHDL Models of sequential such as edge triggered D flip flop, T flip flop and J K flip flop, serial in serial out register, serial in parallel out register, parallel in parallel out register, counter, memory, ALU. **[7]**

Comment [D55]: Employability

Comment [D56]: Skills Development

Comment [D57]: Employability

Outcome: After completion of the course, students would be able to:

- Identify, formulate, and solve engineering problems
- To use the technique, skills, and modern engineering tools necessary for engineering practice.

Text Books:

1. J. Bhaskar, VHDL Primer, Pearson Education Asia, 3rd Ed.
2. Douglas L. Perry, VHDL Programming by Examples, Tata McGraw Hill, 4th Ed.
3. Yogesh Misra, Digital System Design Using VHDL, Dhanpat Rai & Co., 1st Ed.

EC-18.402 **Wireless Networks** **Total Lectures: 40**
3-1-0-4

Objective: To acquire fundamental knowledge of various types of wireless networks and apply them to wireless communication applications.

Pre-requisite: EC-14.303 Principles of Analog Communication, EC-14.304 Principles of Digital Communication

1. **Introduction:** Introduction to wireless networks, Wireless communication systems – Paging system, cordless telephone system, cellular telephone system [4]

2. **Basics of cellular communication systems**: Frequency reuse, channel assignment, call handoff, interference and system capacity, Mobile radio propagation – path loss and fading, 2G, 2.5 G and 3G wireless networks**.** [10]

3. **Multiple Access Techniques**: Frequency Hopped Multiple Access, Code Division Multiple Access, Hybrid Spread Spectrum Multiple Access, Packet Radio, Carrier Sense Multiple Access, Reservation Protocol [10]

4. **Equalization, Diversity and Channel Coding**: Fundamentals of equalization, Linear equalization, Nonlinear equalization, Diversity techniques – space diversity, time diversity, frequency diversity, polarization diversity, RAKE receiver, Block code and convolution code. [8]

5. **Wireless Networking**: Wireless local area network, RF and IR WLAN, advantages and applications, IEEE 802.11, IEEE 802.16, HYPERLAN, Bluetooth, WiMax, Ultra Wide Band communication. [8]

Comment [D93]: Skills Development

Comment [D94]: Skills Development

Comment [D95]: Skills Development

Outcome: After completion of the course, students would be able to apply wireless communication concepts and ideas to engineering applications and to develop high performance wireless communication network.

Text Books:

1. T. S. Rappaport, Wireless Communication, Principles and Practice, 2nd Ed, Pearson Education, 2009
2. Upena Dalal, Wireless Communication, Oxford University Press, 1st Ed., 2009.
3. J. Schiller, Mobile communications, Addison-Wesley.

Reference Book:

1. William C. Y. Lee, Mobile cellular telecommunication – Analog and Digital systems, McGraw Hill, 2nd Ed, 2006

EC-18.442 **Engineering Economics** **Total Lectures: 26**
Credit: 2-0-0-2

Prerequisite(s): Nil

Objective(s):
1. Provide students with fundamental concepts of engineering economics.
2. Provide students with economical methods to compare and evaluate alternatives based on present, annual, rate of return, and benefit over cost analyses.
3. Emphasize practical engineering-based applications and the use of real data examples.

1. **Introduction**: Definitions, Scope; Microeconomics vs. Macroeconomics; Engineering and engineering economics; Principles of engineering economics. [2]
2. **Theory of Demand & Supply**: Determinants, law of demand, law of supply, equilibrium, elasticity of demand. [3]
3. **Economics Applied to Industries**: Theory of production; production function, Law of variable proportions, Returns to scale, Theory of cost; Various concepts of cost: Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost, average cost, marginal cost, total cost etc; Break even analysis. [6]
4. **Market Structures& Pricing Techniques:** Meaning of Market, Types of Market- perfect competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets). [5]
5. **Replacement analysis and depreciation**: Replacement Analysis Decision Map, Basic aspects of depreciation, Deterioration & Obsolescence, and its methods [3]
6. **Optimization technique**: Optimization under constraints and without constraints, optimal resource allocation, optimization under risk and uncertainty. [4]
7. **Capital budgeting**: Concept; under certainty and uncertainty, Techniques; Discounting &compounding techniques, IRR, NPV, PBP, Profitability index, Accounting rate of return. [3]

Comment [D96]: Skills Development

Comment [D97]: Skills Development

Outcome(s):
1. Understand major principles of economic analysis for decision making among alternative courses of action in engineering.
2. Apply cost estimation and alternative analysis techniques for engineering applications.
3. Recognize the economic impact of engineering solutions.
4. Calculate depreciations and understand the impact of inflation.
5. Perform breakeven analysis for a single project and between two alternatives.

Text Books:
1. Salvatore, Dominick. Managerial Economics, Prentice Hall of India, 6th Ed.
2. D. N. Dwivedi, Managerial Economics, OUP, Vikas Publication, 7th Ed.

Reference Books:
1. Suma Damodran, Managerial Economics, OUP, 2nd Ed.

EE-14.201 **Network Analysis & Synthesis** **Total Lectures: 40**
3-1-0-4

Objective: This course helps in analysis of A.C & D.C circuits and it also help to design the circuit models for the minor and major projects.

Prerequisite: Knowledge of Laplace transformation

1. **Development of Circuit Concept:** Introduction, capacitance, inductance and resistance parameters, approximation of a physical system as a circuit, reference directions for current and voltage, voltage and current sources, active element conventions, dot convention for coupled circuits, topological description of networks, linear graphs of a network and its parts, loops and trees, incidence matrix, cut-set matrix and tie-set matrix. [8]
2. **Network Equations**: Kirchhoff's laws, minimum number of network equations, source transformations, formulation of network equations, loop variable analysis & node variable analysis and duality. [6]
3. **Analysis of RLC Circuits**: Laplace transformation, some basic theorems for the Laplace transformation, transient response of RL, RC and RLC circuits using Laplace transform with D.C input and A.C. with sinusoidal input, partial fraction expansion, solution of problems by Laplace transformation. [8]
4. **Network Theorems**: Superposition and reciprocity theorems, Thevenin's and Norton's theorems, Millman's theorem, Tellegen's theorem, and maximum power transfer theorem, application of these theorems to networks with a.c and d.c excitation. [8]
5. **Two Port Network** Two port parameters, impedance, admittance, hybrid, inverse hybrid, transmission parameters, relationship between various parameters, reciprocity and symmetry of two port network, inter connection of two port networks. [6]
6. **Synthesis of Passive Network**: Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [6]

Comment [D15]: Skills Development

Comment [D16]: Skills Development

Comment [D17]: Skills Development

Comment [D18]: Skills Development

Comment [D19]: Skills Development

Course outcome: Upon successful completion of this course, students should be able to:

1. Gain fundamental knowledge of the basic electrical elements such as resistance, capacitors and inductances.
2. Understand circuit representation as graphs and implementation of KVL and KCL in the circuits and to solve the circuit problems by Laplace transformation method and also by applying various networks theorems.
3. Analyze small RLC circuits by hand. Use network techniques, like node analysis and loop analysis, to write equations for large linear circuits.
4. Apply Thevenin and Norton theorems and concept of linearity and superposition to analyze and design circuits and networks.

Text Books

1. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", John Wiley and Sons, Inc., 1960.
2. A. Chakrabarti, "Circuit Theory – Analysis and Synthesis", Dhanpat Rai & Co., 2001. International Editions, 1993.
3. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", Tata McGraw-Hill, 2007.
4. W. H. Hyatt Jr. and J. E. Kemmerly, "Engineering Circuits Analysis", McGraw-Hill.

EE-14.204 **Electrical Measurement and Instrumentation** **Total Lectures: 40**
3-0-0-3

Objective: To make students conversant with concepts of measurement and various electrical and electronics instruments, transducers and bridges.

Pre-requisite: Basic Electrical engineering, Basic Electronics engineering

1	**Concepts of Measurements:** Introduction, accuracy and precision, repeatability, errors in measurement, sources of errors, types of errors, statistical analysis of measurement data, graphical representation of measurement, data as distributions, Gaussian graph and precision indices.	[6]
2	**Analog Instruments:** Types of operating torques in an analog instrument, Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Shunts and multipliers. Applications of instruments for measurement of single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment.	[6]
3	**Bridge:** DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, Weins bridges.	[6]
4	**Electronic Instruments for Measuring Basic Parameters:** Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, Q meter, Vector Impedance meter, signal analyzers- wave analyzers, harmonic distortion analyzers and spectrum analyzers.	[6]
5	**Potentiometers:** DC and AC potentiometers, Principles, Standardization and application.	[5]
6	**Transducers:** Introduction , Classification, Selection Criteria, Characteristics, Construction, Working Principles and applications of following Transducers- RTD, Thermocouples, Thermistors, LVDT, RVDT, Strain Gauges, Tachogenerators, Piezoelectric Transducers, Ultrasonic Flow Meters.	[6]
7	**Oscilloscopes:** CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay.	[5]

Comment [D47]: Skills Development

Comment [D48]: Skills Development

Comment [D49]: Skills Development

Comment [D50]: Skills Development

Outcome: Students will be able to understand electrical and electronic measuring devices and instrumentation like bridges, transducers, CRO etc.

Text Books:

1. Albert D. Helfrick, Wiliam D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning Private Limited, 2011.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai and Co., 2005.

Reference Books:

1. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill, II Edition 2004.
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2007.
3. A.J. Bouwens, 'Digital Instrumentation', Tata McGraw Hil.,1997
4. E.O. Doebelin, 'Measurement Systems – Application and Design', Tata McGraw Hill publishing company, 2007.

EE-14.303 **Control System Engineering** **Total Lectures: 40**
3-1-0-4

Objective: The student gains the knowledge of the fundamental principles of analog and digital control system engineering, time response and frequency response analysis with its practical implementation. This course helps in understanding the design of Compensator and PID controller for the Automatic control of Industry.

Pre-requisite: MA-14.201 Applied Mathematics, EE-14.201 Network Analysis & Synthesis

1.	**Introduction:** Introduction to control systems, digital control system, types of control systems and their examples, mathematical modeling of systems (mechanical and electrical).	[10]
2.	**Reduction Techniques:** Block diagram reduction and signal flow graph representation of systems.	[10]
3.	**Domain Analysis:** Time domain and frequency domain analysis of systems.	[7]
4.	**Stability:** Concept of stability and algebraic criteria (Hurwitz's and Routh's stability criterion).	[4]
5.	**Plotting Techniques:** Root locus techniques, Bode plots, polar plots Nyquist criterion and Nichol's chart.	[7]
6.	**State Variables:** State variable analysis and design.	[2]

Outcome: After completion of the course,

- The student will be able to get acquainted of analog and digital control system.
- The student will analyze and to design and development of automatic controller for industrial application.
- The student will gain the knowledge of stability analysis and improvement of stability for control system.
- This course becomes very beneficial for the graduates who wish to work in core sectr industry as most of the core sector is state-of-art control.
- This course becomes very beneficial for the 4th year student who will choose elective paper in Digital control system and other control system elective.

Text Books:

1. K. Ogata, "Modern Control Engineering," Pearson Education/Prentice Hall of India, 2003.
2. I. J. Nagrath and M. Gopal, "Control System Engineering," New Age International Publishers, 2003.
3. M. N. Bandyopadhyay, "Control Engineering Theory and Practice," Prentice Hall of India, 2003.

Reference Books:

1. Syed Hasan Saeed, "Automatic Control Systems (with MATLAB Programs)," S. K. Kataria & Sons, Publisher of Engineering & Computer Books.
2. Samarjit Ghosh, " Control Systems: Theory and Applications," Pearson Education, Second Edition, 2009

Comment [D85]: Skills Development

EE-14.304 **Power Electronics** **Total Lectures: 40**

3-0-0-3

Objective:

- To introduce to students the theory and applications of power electronics systems for high efficiency, renewable and energy saving conversion systems
- To prepare students to know the characteristics of different power electronics switches, drivers and selection of components for different applications
- To develop students with an understanding of the switching behavior and design of power electronics circuits such as DC/DC, AC/DC, DC/AC and AC/AC converters

Prerequisite: Network Analysis, Basics of Electronics Engineering, Engineering Mathematics

1. **Introduction:** Review of power semiconductor devices, SCR, Static and dynamic characteristics, Turn-on and Turn-off methods and circuits, Ratings and protection of SCRs, Series and parallel operation of thyristor, Other members of thyristor family. [8]
2. **Phase Controlled Converters:** Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits, Single phase dual converters and their operation with circulating and non-circulating currents. [10]
3. **AC Voltage Controllers:** Types of single-phase voltage controllers, Single-phase voltage controller with R and RL type of loads, gate pulse requirements to trigger the SCRs of ac voltage controllers. [5]
4. **Cyclo-converters:** Principles of operation, Single phase to single phase step up and step down cycloconverters. Three phase to single phase cycloconverter. [5]
5. **DC Choppers:** Principle of chopper operation, Control strategies, Types of choppers, Step up and step down choppers, Types of choppers and operations. [5]
6. **Inverters:** Single phase VSI: half bridge and full bridge inverters and their steady state analysis, Series and parallel inverters, three phase bridge inverters with 180 degree and 120 degree modes of operation. Current source inverters, CSI with R load (qualitative approach). [7]

Comment [D70]: Skills Development

Comment [D71]: Skills Development

Comment [D72]: Skills Development

Comment [D73]: Skills Development

Outcome:

- The student will be able to understand the principle of operation of commonly employed powerelectronic converters
- The student will be capable of analyzing non-linear circuits with several power electronic switches
- The student will be equipped to take up advanced courses in Power Electronics and its application areas

Text Books:

1. Rashid, M., Power Electronics, Prentice Hall of India Private Limited (2006).
2. P. S. Bimbhra, Power Electronics, Khanna publishers.

Reference Books:

1. Mohan, N., Undel, T. M. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley and Sons (2007).

MA 14.201 **Applied Mathematics** **Total Lecture: 40**
3-1-0-4

Objective: To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1. Linear Programming: Introduction**,** Graphical method (bounded & unbounded solutions); Simplex method, Artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). **[12]**

2. Numerical Methods: Solution of system of equations (Gauss elimination and Gauss - Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector Runge-Kutta methods). **[10]**

Comment [D20]: Skills Development

3. Complex Analysis: Function of complex variable, analytic function, Cauchy- Riemann equations(without proof), integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula(without proof), zeros and singularities of complex functions, residues. **[06]**

4. Integral Transform: Laplace transform and inverse Laplace transform First and Second Shifting theorems, Convolution theorem (without proof), Solution of ordinary differential equations with initial conditions by Laplace transforms. Fourier series of periodic functions, even and odd functions, Fourier half-range series; Basics of Fourier transforms. **[12]**

Comment [D21]: Skills Development

Outcome: After completion of the course, students would be able to apply the knowledge of linear programming , numerical methods ,complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. Grewal B.S. & Grewal J.S., Higher Engineering Mathematics, Khanna publishers, 39th Edition: 2005.
3. Taha H.A., Operation Research: An Introduction, Pearson.
4. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.

Reference Books:

1. Jain R.K. & S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 2003.
2. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
3. James B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Babu Ram, Engineering Mathematics, Pearson, Year 2010.

MA 14.202 **Statistics and Probability Theory** **3-1-0-4**
Total Lecture: 40

Prerequisite: Basic Mathematics

Objective: To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

1	Introductory Ideas: Recapitulation of Basic Probability theory; Law of addition and law of multiplication ;conditional probability; total probability; Bayes' theorem and it's applications.	[06]
2	Random Variables and Distribution: Discrete and continuous random variables; types of distribution; probability mass and density functions; mean, variance and standard deviation of distribution.	[04]
3	Theoretical Probability Distribution: Discrete types (Binomial) and Continuous type (Normal,Students'); applications of basic ideas to these distributions.	[08]
4	Sampling Theory: Sampling distribution of mean and variance; central limit Theorem.	[04]
5	Testing of Hypothesis: Simple and Composite hypothesis; Type I and Type II errors; tests of significance and level of significance.	[04]
6	Correlation and Regression: Simple, partial and multiple correlations; linear regression.	[06]
7	Queuing Theory and Queuing Models: Birth and death process; pure birth and pure death process; Classification of queuing models: M/M/1, M/M/1/N, M/M/S and M/M/S/N.	[08]

Comment [D34]: Skills Development

Comment [D35]: Skills Development

Outcome: After completion of the course, students would be able to apply the knowledge of Statistics and Probability in engineering and solve curriculum problems.

Text Books:

1. A.P.Baisnab and Manoranjan Jas, Elements of Probability and Statistics, 2003, TMH.
2. Pugalararasu, Probability and Queuing Theory, TMH.
3. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, June 2002.
4. Gupta & Kapoor, Fundamental of Applied statistics, SCS Publisher, Jan 2001.
5. B.V. Ramana, Higher Engineering Mathematics, TMH, 2006.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH.
2. Palaniammal, Probability and Random Processes, PHI.
3. Spiegel, Probability and Statistics (Schaum's outline Series), TMH.
4. Miller and Freund's, Mathematical Statistics with Applications, 7e, Pearson.
5. Richard A. Jonson, Probability and Statistics for Engineers, Pearson.

RM 17.101 **Research Methodology** **2-0-0-2**

1	**Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research.	[2]
2	**Problem Formulation:** Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature.	[2]
3.	**Research Design:** Research Framework, Meaning & Significance of Research Designs, Features of a good Research Design, Types of Research Design.	[4]
4.	**Data for research:** Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis.	[6]
5.	**Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAb, Network Simulators, ETAP, Solid Works, MultiSim.	[6]
6.	**Thesis Writing:** Contents, Referencing Styles, Ani Plagiarism Policy, Literature Review, Motivation, Objectives, research gap, Methodology, Research Deasin and Analysis, Results, Findings, Implications, Contributions, Significance of research, Scope for future work and conclusion.	[6]

Comment [D74]: Skills Development

Comment [D75]: Skills Development

Comment [D76]: Skills Development

Comment [D77]: Skills Development

Text Books:

1. R. Pannershelvam, "Research Methodology" Prentice Hall India, New Delhi, 11th Edition, 2013.
2. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International (p) Limited, Publishers New Delhi, 2nd edition, 2008.
3. William G.Zikmund, "Business Research Methods", Cengage Learning New Delhi, 9th edition,2009.
4. Mark Saunders, "Research Methods for Business Students" Pearson Education New Delhi, 5th edition, 2013.
5. Donald R Cooper, "Business Research Methods" Tata McGraw-Hill Publishing Company Limited New Delhi, 9th edition, 2008.
6. Dr.A.K.Phophalia, "Modern Research Methodology: New Trends and Techniques" Paradise Publishers Jaipur, 1st edition, 2010.
7. Pankaj Madan, "Research Methodology", Global Vision Publishing House, New Delhi, 1st edition, 2010.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of EE

Course structure for

B.Tech EE

EE-14.201 **Network Analysis & Synthesis** **Total Lectures: 40**
3-1-0-4

Objective: This course helps in analysis of A.C & D.C circuits and it also help to design the circuit models for the minor and major projects.

Prerequisite: Knowledge of Laplace transformation

1. **Development of Circuit Concept:** Introduction, capacitance, inductance and resistance parameters, approximation of a physical system as a circuit, reference directions for current and voltage, voltage and current sources, active element conventions, dot convention for coupled circuits, topological description of networks, linear graphs of a network and its parts, loops and trees, incidence matrix, cut-set matrix and tie-set matrix. [8]
2. **Network Equations**: Kirchhoff's laws, minimum number of network equations, source transformations, formulation of network equations, loop variable analysis &node variable analysis and duality. [6]
3. **Analysis of RLC Circuits**: Laplace transformation, some basic theorems for the Laplace transformation, transient response of RL, RC and RLC circuits using Laplace transform with D.C input and A.C. with sinusoidal input, partial fraction expansion, and solution of problems by Laplace transformation. [8]
4. **Network Theorems**: Superposition and reciprocity theorems, Thevenin and Norton theorems, Millman theorem, Tellegen theorem, and maximum power transfer theorem, application of these theorems to networks with a.c and d.c excitation. [8]
5. **Two Port Network**: Two port parameters, impedance, admittance, hybrid, inverse hybrid, transmission parameters, relationship between various parameters, reciprocity and symmetry of two port network, inter connection of two port networks. [6]
6. **Synthesis of Passive Network**: Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [6]

Course Outcome: Upon successful completion of this course, students should be able to:

- Gain fundamental knowledge of the basic electrical elements such as resistance, capacitors and inductances.
- Understand circuit representation as graphs and implementation of KVL and KCL in the circuits and to solve the circuit problems by Laplace transformation method and also by applying various networks theorems.
- Analyze small RLC circuits by hand. Use network techniques, like node analysis and loop analysis, to write equations for large linear circuits.
- Apply Thevenin and Norton theorems and concept of linearity and superposition to analyze and design circuits and networks.

Text Books:

1. M. E. Van Valkenberg, "Introduction to Modern Network Synthesis", Pearson, 3rd Edition, 2016.
2. A. Chakrabarti, "Circuit Theory – Analysis and Synthesis", Dhanpat Rai & Co., 6th Edition, 2010.

Reference Books:

1. A. Sudhakar and S. P. Shyam Mohan, "Circuits and Network Analysis and Synthesis", McGraw-Hill, 5th Edition, 2015.
2. W. H. Hyatt Jr. and J. E. Kemmerly, "Engineering Circuits Analysis", McGraw-Hill, 7th edition, 2010.

EE-14.202 **Electrical Machines-II** **Total Lectures: 42**

3-1-0-4

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction and performance of A.C machines and synchronous machines.

Pre-requisite: Electrical Machine-I

1. **Basic Concept of A.C. Rotating Machines:** Introduction to Armature winding, Integral slot and fractional slot winding, Distribution factor (K_d), Pitch factor (K_p) and winding factor (K_w). Production of rotating magnetic field, EMF and torque equations, Effect of tooth harmonics and methods of reduction. [4]
2. **Synchronous Generator:** Construction, Cylindrical rotor and salient pole rotor, Principle of operation, Excitation system, Effect of winding factor on EMF, Armature reaction, Circuit model, Phasor diagram, O.C. and S.C. tests, Short-circuit ratio, Determination of voltage regulation by synchronous impedance, MMF and zero power factor methods. [7]
3. **Performance Characteristics of Synchronous Generator:** Two reaction theory, Phasor diagram, Power-angle characteristic of synchronous generators, Synchronizing power and torque, Synchronizing methods, Parallel operation of synchronous generator, Effect of change in excitation and mechanical power input on load sharing, Operation of alternator on infinite bus bars, Slip test. [6]
4. **Synchronous Motor:** Construction, Principle of operation, Equivalent circuit, Phasor diagram, Circuit model, Effect of change in excitation on armature current and power factor, Starting of synchronous motor, Synchronous condenser, Hunting, Applications. [6]
5. **Induction Motor:** Introduction, Construction, Principle of operation, Slip and rotor frequency, Comparison with transformer, Equivalent circuit model, Representation of mechanical load, No load and blocked rotor tests. Torque and power output, Losses and efficiency, Separation of losses. [7]
6. **Performance Characteristics of Three-Phase Induction Motor:** Circle Diagram, Torque-slip characteristics, Effect of rotor resistance, Starting torque and maximum torque, Starting and speed control methods, Cogging and crawling, Introduction to induction generator, Applications. [6]
7. **Single-Phase Induction Motor & special machines:** Introduction, Double revolving field theory, Cross field theory, Torque-speed characteristic, Equivalent circuit model, Starting methods, Applications, Stepper Motor, and Reluctance motor. [6]

Outcome: The students shall develop an insightful knowledge on various ac motors and ac generators.

Text Books:

1. D.P. Kothari and I.J. Nagrath,. "Electric Machines", McGraw-Hill,2nd Edition, 2004
2. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 5th Edition, 2013.

Reference Books:

1. A.E. Fitzgerald, Charles Kingsley and Stephen D.U Electric Machinery, Mc Graw-Hill, 2nd Edition, 2003.
2. J.B. Gupta, Theory and Performance of Electrical Machines, S.K. Kataria and Sons, 3rd Edition, 2002

EE-14.203 **Electrical Machines-I** **Total Lectures: 43**

3-1-0-4

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction details and performance of D.C machines and Transformer.

Pre-requisite: Electrical Engineering course of First Year.

1. **Basic Concepts of Electrical Machines:** Introduction, Electromagnetic induction, flux linkage, statistically and dynamically induced emf, Classification and description of electrical machines, Heating and cooling of electrical machines. [4]
2. **Elements of Rotating Machines**: Introduction, Basic Components, Rotor, Stator and field excitation. Generator and motor action, EMF and torque equations, Leakage flux, Losses and efficiency, Rating and loss dissipation, Electrical and mechanical degrees. [5]
3. **Introduction to D.C. Machines:** Constructional parts of d.c. machines and their function, Principle of operation, Armature winding- Lap and wave, Simplex and duplex, Method of excitation, Classification, Derivation of emf and torque equations, Process of commutation, Armature reaction, Interpoles, Compensating winding and equalizer rings. [6]
4. **D.C. Generator**: Operating characteristics- Magnetization, Internal and external characteristics, Critical resistance and critical speed, Process of building up of voltage, Causes of failure of voltage build-up and remedies, Parallel operation of d.c. generators, Applications. [6]
5. **D.C. Motor**: Basic equation for voltage, Power, Torque and speed, Condition for maximum power, Operating characteristics- Torque-current, Speed-current and Torque-speed characteristics. Comparison, Starters, Speed control methods, testing of d.c. machines-Swinburne, Hopkinson's and Series field tests. Calculation of efficiency, Applications. [6]
6. **Transformers**: Principle of operation, Construction and practical considerations, Ideal and physical transformer, emf equation, Transformation ratio, Phasor diagram. Performance analysis, Equivalent circuit, Losses and efficiency, Condition for maximum efficiency, Determination of equivalent circuit parameters by O.C. and S.C. tests, Per unit calculation, Polarity test, Voltage regulation, All day efficiency. [10]
7. **Transformer Connections and Operation**: Back-to-back test, Parallel operation, Autotransformer, 3-phase transformer, Vector group, Three-phase transformer connections- Star-star, Delta-delta, Star-delta, Delta-star, Zig-zag connections, Scott connection, Open delta connection, Transformer cooling. [6]

Outcome: Graduates will have the knowledge of DC Electric motor, DC Generator and Transformer. They will understand how these motors are operated for applications.

Text Books:

1. D.P. Kothari and I.J. Nagrath,. "Electric Machines", McGraw-Hill, 2nd Edition, 2004.
2. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 5th Edition, 2013.

Reference Books:

1. A.E. Fitzgerald, Charles Kingsley and Stephen D.U Electric Machinery, Mc Graw-Hill, 2nd Edition, 2003.
2. J.B. Gupta, Theory and Performance of Electrical Machines, S.K. Kataria and Sons, 3rd Edition, 2002.

EE-14.204 **Electrical Measurement and Instrumentation** **Total Lectures: 40**
3-0-0-3

Objective: To make students conversant with concepts of measurement and various electrical and electronics instruments, transducers and bridges.

Pre-requisite: Basic Electrical engineering, Basic Electronics Engineering

1. **Concepts of Measurements:** Introduction, accuracy and precision, repeatability, errors in measurement, sources of errors, types of errors, statistical analysis of measurement data, graphical representation of measurement, data as distributions, Gaussian graph and precision indices. [6]
2. **Analog Instruments:** Types of operating torques in an analog instrument, Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Shunts and multipliers. Applications of instruments for measurement of single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment. [6]
3. **Bridge:** DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, Weins bridges. [6]
4. **Electronic Instruments for Measuring Basic Parameters:** Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, Q meter, Vector Impedance meter, signal analyzers- wave analyzers, harmonic distortion analyzers and spectrum analyzers. [6]
5. **Potentiometers:** DC and AC potentiometers, Principles, Standardization and application. [5]
6. **Transducers:** Introduction , Classification, Selection Criteria, Characteristics, Construction, Working Principles and applications of following Transducers- RTD, Thermocouples, Thermistors, LVDT, RVDT, Strain Gauges, Tacho-generators, Piezoelectric Transducers, Ultrasonic Flow Meters. [6]
7. **Oscilloscopes:** CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay. [5]

Outcome: Students will be able to understand electrical and electronic measuring devices and instrumentation like bridges, transducers, CRO etc.

Text Books:

1. Albert D. Helfrick, Wiliam D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning Private Limited, 2011.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai and Co., 2005.

Reference Books:

1. H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, 2nd Edition, 2004.
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2nd Edition 2007.
3. A.J. Bouwens, 'Digital Instrumentation', McGraw Hil, 2nd Edition, 2002.
4. E.O. Doebelin, 'Measurement Systems – Application and Design', McGraw Hill publishing company, 3rd Edition, 2007.

EE-14.210 **Comprehensive-I**

0-0-0-3

Objective: This course provides the:

1. The fundamental principles in electric circuit theory and to be able to extend these principles into a way of thinking for problem solving in mathematics, science, and engineering.
2. To expose the students to the concepts of various types of electrical machines and applications of electrical machines.
3. Build a foundation of basic knowledge required for electrical power engineers.
4. Understand the sources of energy and their contributions to the energy and power needs of the nation and the world.

Pre-requisites: Network Analysis, Electrical Machine-I, Electrical Machine-II, Power Plant Engineering, Electrical Measurement & Instrumentation

1 **Network Analysis:** Kirchoff's Laws in the frequency domain and impedance combinations, Nodal and mesh analysis for phasor circuits, Power in the Unbalanced three-phase systems, Application of the Laplace transform to electric circuits and the transfer function

2 **Special Machines:** Tacho-generator, AC and DC servomotor, Linear induction motor, Single phase motor, Double field revolving theory, Capacitor start capacitor run motors, Shaded pole motor, Repulsion type motor, Universal motor, Stepper motor.

3 **Electrical Measurement and Instrumentation:** Instrumentation amplifiers- single differential amplifier and three amplifier configurations, D/A and A/D converters, and concepts of a measurement channel and its components, Data acquisition and distribution configurations, analyze sample and hold circuits and multiplexers, Transducer interfacing techniques, passive and active transducer measurement requirements, Error analysis in the measurement channel, types of errors; consider transducer errors, transducer output linearization, instrumentation amplifier errors, filter errors, A/D converter errors, sample and hold and multiplexer errors.

4 **Power Generation System:** Steam power plant generation cycles, Nuclear Power Generation Safety considerations in the nuclear industry. Developments in nuclear fusion. Decommissioning problems of nuclear sites. Nuclear waste disposal systems, Fuel Cells-Definition and principles of operation. Losses and efficiency. Possible fuels. Fuel-cell technologies and applications, Combined Heat and Power (CHP) schemes, Application of CHP systems for the provision of heating, cooling and electric power. Selection criteria of CHP prime-movers.

Outcome: Upon completion of this course, the students should be able to:

1. Use network techniques, to analysis large circuits.
2. Understand constructional details, principle of operation of Special Machines.

Text Books:

1. I.J Nagrath, "Electric Machines", McGraw hill Edition.4th Ed. 2010.
2. F. F. Kuo "Network Analysis & Synthesis", John Wiley & Sons, 2nd Ed., 1999.

Reference Books:

1. M. G Say, "Alternating Current Machines", ELBS & Piman, London, 2nd Ed 1984.
2. D Roy Choudhury., "Networks and Systems", New Age International Publishers, 2nd Ed 2010.
3. A K Sawhney, "A course in Electrical & Electronic Measurements & Instruments", Dhanpat rai, 3rd Edition, 2005.

EE-14.301 **Transmission & Distribution** **Total Lectures: 40**

3-1-0-4

Objective:
1. To learn the fundamentals of power system for designing a system that meets specific need.
2. To understand the factors affecting Insulators and also in Under Ground cables.
3. To calculate the various parameters in Distribution System.

Pre-requisite: Network Analysis& Synthesis

1. **Introduction:** Structure of a power system, Effect of Transmission voltage, Load factor, diversity factor, plant capacity factor, plant utilization factor, different types of tariffs, per unit quantities and its advantages, Impedance and Reactance Diagram. [5]

2. **Transmission Line Parameter:** Configuration, Type of conductors, Resistance of line, Skin & Proximity Effects, Calculation of Inductance and capacitance of single phase, three phase, Single circuit and double circuit transmission lines. [7]

3. **Performance of Transmission Lines:** Representation of short, medium and long transmission lines, Ferranti effect, SIL, Tuned Power Line, Power flow through transmission lines. [6]

4. **Insulator and Corona:** Overhead lines insulators type of insulators and their applications Potential distribution over a string of insulators, Methods of Equalizing the potential, Phenomenon of Corona, Corona Loss, Factors affecting Corona, Methods of reducing corona. [6]

5. **Mechanical Design of Transmission Lines:** Catenary curve, Calculation of sag and Tension, Effects of wind and ice Loadings, Sag Templates, Vibration dampers. [5]

6. **Underground Cables:** Types of Insulation for Cable, Sheath, Armour and Covering, Classification of cables, Effective Conductor Resistance, Inductive Reactance, Capacitance of single phase and three phase cables, Grading of Cables, Problems with Underground cables. [5]

7. **Distribution:** Comparison of various Distribution systems, type of Primary Distribution systems and Secondary Distribution systems, Choice of transmission voltage, Kelvin's law, Limitation of Kelvin's law. Necessity of neutral grounding, various methods of neutral grounding. [6]

Outcome: At the end of this course the student is expected to have understood the following:
- Basic principles of supply systems.
- Mechanical & electrical design of overhead lines.
- Performance of transmission lines.

Text Books:
1. Wadhwa C.L. "Electrical Power Systems Electronics", New Age International Publishers, 4th Edition, 2011.
2. Gupta, B.R., "Power System Analysis and Design" S.Chand and Co., Ltd, 2nd Edition, 2005.

Reference Books:
1. Grainger, J.J. and William D. Stevenson Jr., "Power System Analysis", McGraw Hill, 3rd Edition,2005.
2. AbhijitChakrabarti, SunitaHalder "Power System Analysis: Operation and Control", Prentice Hall of India, 2nd Edition, 2008.

EE-14.302 **Power System Analysis** **Total Lecture: 40**

3-1-0-4

Objective:
- To know the necessity of load flow in a regulated system.
- To examine the need of various analysis like fault analysis, short circuit analysis stability analysis, steady state and transient analysis.

Prerequisite: Transmission & distribution

1. **Load Flow Studies:** Bus admittance(Y bus) and Impedance (Z bus) matrices and their formation. Power flow in a transmission system, bus classification, Load flow equations and solution techniques-Gauss iterative method, Gauss-Seidel method, Newton-Raphson method, comparison of load flow solution techniques. [9]
2. **Fault Calculation and Network:** Symmetrical fault, Significance of Positive, Negative and Zero Sequence Components, Fault calculation, Sequence Networks, Unsymmetrical fault analysis – Single Line to Ground faults, Line to Line fault, Double line to Ground fault. [9]
3. **Power System Stability:** Steady state stability and transient stability- stability problem, rotor dynamics and swing equation, power angle equation and diagram, equal area criterion and its application, critical clearing angle, fault clearing time, factors influencing transient stability, methods of improving stability. [8]
4. **Economic Load Dispatch:** Station performance and operating characteristics, Incremental rate theory, optimal Load distribution within generating station and between various generating stations in a region, Transmission loss equation, Calculation of losses and Generation scheduling and dispatch. [8]
5. **Power System Control:** Load Frequency control:Load Frequency Problems, Speed Governing System, Reasons for Limits on Frequency. Excitation systems, Automatic Voltage Regulators, SCADA and Computer control. [6]

Outcome:
- Apply the load flow application to various power system problems like minimization of transmission line losses, minimization of the total fuel cost etc.,
- Analyze the economic dispatch problem in thermal power plant
- Design a power system solution based on the problem requirements and realistic constraint.

Text Books:
1. Grainger,J.J. and William D. Stevenson Jr., "Power System Analysis", McGraw Hill, 4th Edition,2005.
2. Wadhwa.C.L. "Electrical Power Systems Electronics", New Age International Publishers, 3rd Edition, 2011.

Reference Books:
1. Ashfaq Husain "Electrical Power Systems", CBS Publishers and Distributors, 4th Edition, 1996.
2. AbhijitChakrabarti, SunitaHalder "Power System Analysis: Operation and Control", Prentice Hall of India, 2nd Edition, 2008.

EE-14.303 **Control Systems Engineering** **Total Lectures: 40**

3-1-0-4

Objective: The student gains the knowledge of the fundamental principles of analog and digital control system engineering, time response and frequency response analysis with its practical implementation. This course helps in understanding the design of Compensator and PID controller for the Automatic control of Industry.

Pre-requisite: Mathematics, Network Analysis& Synthesis

1. **Introduction:** Introduction to control systems, digital control system, types of control systems and their examples, mathematical modeling of electrical and mechanical systems (f-v and f-i analogy). [8]

2. **Reduction Techniques:** Block diagram reduction and signal flow graph representation of systems. [6]

3. **Domain Analysis:** Introduction, correlation between Transient response and frequency response, standard input signals, Response of 1st and 2nd order systems, time domain specifications i.e. rise time, peak time, delay time, peak overshoot, settling time steady state error etc., different types of feedback systems, Steady state errors for unit step, unit ramp and unit parabolic inputs, controller components. [10]

4. **Stability:**Introduction, concept of stability, conditions for stable system, asymptotic, relative and marginal stability, Routh-Hurwitz criterion for stability. [4]

5. **Plotting Techniques:** Root locus techniques, Bode plots, polar plots Nyquist criterion and Nichol's chart. [8]

6. **State Variables:** Analysis of systems, state vector, state space, advantages of state space techniques, state space representation, State variable analysis and design. [4]

Outcome: After completion of the course,

- The student will be able to get acquainted of analog and digital control system.
- The student will analyze and to design and development of automatic controller for industrial application.
- The student will gain the knowledge of stability analysis and improvement of stability for control system.
- This course becomes very beneficial for the graduates who wish to work in core sectr industry as most of the core sector is state-of-art control.
- This course becomes very beneficial for the 4th year student who will choose elective paper in Digital control system and other control system elective.

Text Books:

1. K. Ogata, "Modern Control Engineering," Pearson Education/Prentice Hall of India, 4th Edition, 2003.
2. I.J. Nagrath and M. Gopal, "Control System Engineering," New Age International Publishers, 2nd Edition, 2003.

Reference Books:

1. Syed HasanSaeed, "Automatic Control Systems (with MATLAB Programs)," S.K. Kataria& Sons Publishers, 6th edition, 2008.
2. SamarjitGhosh, "Control Systems: Theory and Applications," Pearson Education, 2nd Edition, 2012.
3. M.N. Bandyopadhyay, "Control Engineering Theory and Practice," Prentice Hall of India, 2nd Edition, 2003.

EE-14.304 **Power Electronics** **Total Lectures: 40**
3-0-0-3

Objective:
- To introduce to students the theory and applications of power electronics systems for high efficiency, renewable and energy saving conversion systems
- To prepare students to know the characteristics of different power electronics switches, drivers and selection of components for different applications
- To develop students with an understanding of the switching behavior and design of power electronics circuits such as DC/DC, AC/DC, DC/AC and AC/AC converters

Prerequisite: Network Analysis and Synthesis, Basics of Electronics Engineering, Engineering Mathematics

1. **Introduction:** Review of power semiconductor devices, SCR, Static and dynamic characteristics, Turn-on and Turn-off methods and circuits, Ratings and protection of SCRs, Series and parallel operation of thyristor, Other members of thyristor family. [8]

2. **Phase Controlled Converters:** Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits, Single phase dual converters and their operation with circulating and non-circulating currents. [10]

3. **AC Voltage Controllers:** Types of single-phase voltage controllers, Singlephase voltage controller with R and RL type of loads, gate pulse requirements to trigger the SCRs of ac voltage controllers. [5]

4. **Cycloconverters:** Principles of operation, Single phase to single phase step up and step down cycloconverters. Three phase to single phase cycloconverter. [5]

5. **DC Choppers:** Principle of chopper operation, Control strategies, Types of choppers, Step up and step down choppers, Types of choppers and operations. [5]

6. **Inverters:** Single phase VSI: half bridge and full bridge inverters, three phase bridge inverters with 180 degree and 120 degree modes of operation, Series and parallel inverters, Introduction to current source inverters. [7]

Outcome:
- The student will be able to understand the principle of operation of commonly employed powerelectronic converters
- The student will be capable of analyzing non-linear circuits with several power electronic switches
- The student will be equipped to take up advanced courses in Power Electronics and its application areas

Text Books:

1. Rashid, M., Power Electronics, Prentice Hall of India Private Limited, 4th Edition,2006.
2. P.S. Bimbhra, Power Electronics, Khanna publishers, 5th edition, 2012.

Reference Books:

1. Mohan,N., Undel, T.M. and Robbins, W. P., Power Electronics: Converter Applications and Design, John Wiley and Sons, 3rd Edition, 2007.
2. Jain,A., Power Electronics and its Applications, Penram International Publishing (India) Pvt. Ltd., 4th Edition, 2008.
3. Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.N.K., Thyristoried Power Controllers, New Age International (P) Limited, Publishers, 2nd Edition, 2004.

EE-14.305 **Power Plant Engineering** **Total Lectures: 40**

3-0-0-3

Objective: This course facilitates the students to understand the basic functioning of generation and design/economics consideration of various power plants.

Pre-requisite: Electrical Engineering course of First Year.

1	**Introduction:** Energy sources and their availability, Principle types of power plants, Their special features and applications, Present status and future trends. Economic aspects in power Generation: Terms commonly used in system operation, various factors affecting cost of generation: Load curves, load duration curves, Connected load, maximum load, Peak load, base load and peak load power plants, load factor, Plant capacity factor, Plant use factor, Demand factor, diversity factor, Cost of power plant.	[10]
2	**Thermal Power Plant:** General developing trends, Essentials, Plant layout, Coal storage, Preparation, Handling, Feeding and burning, Ash handling, Dust collection, High pressure boilers and steam turbines, Their main components like super heaters, Economizers, Pre-heaters etc., Fuel efficiency/heat balance.	[8]
3	**Hydro Electric Power Plants:** Classifications, Plant layout, various components, Types of turbines, Pumped storage, hydro-electric plants, advantages and disadvantages. Environmental aspects for selecting the sites and locations of hydro power stations.	[8]
4	**Gas Turbine Power Plants:** Schematic arrangement, advantages and disadvantages of Gas turbine power plant. Open cycle and Closed cycle gas turbine power plant, Combined cycle power plant, Comparison of various power plants.	[6]
5	**Nuclear Power Plant:** Nuclear fuels, Nuclear energy, Main components of nuclear power plant, Nuclear reactors types and applications, Radiation shielding, Radioactive and waste disposal safety aspect.	[8]

Outcome: The students shall develop an insightful knowledge to apply the basic laws and operating principles in various power plants.

Text Books:

1. Deshpande, M.V., "Power Plant Engineering", McGraw Hill, 4th Edition 2004.
2. Gupta B. R., "Generation of Electrical Energy", S. Chand Publications, 14th Edition, 2011.

Reference Books:

1. Wood A.J. & Wallenberg B.F, "Power Generation and Control", John Wiley & Sons, 2nd Edition, 2012.
2. P.K Nag "Power Plant Engineering", McGraw Hill publications, 2nd Edition, 2008.
3. Arora S.C & Domkundawar S, "A course in Power Plant Engineering", Dhanpat Rai, 2nd Edition, 2002.

EE-14.310 **Reliability of Electrical Power System** **Total Lectures: 40**
3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to the concept of probability theory, distribution, network modeling and reliability analysis.

Pre-requisite: Power system analysis, Power system transmission and distribution, Matrices, Probability and Calculus.

1. **Review of Probability Theory:** Element of probability theory Probability Distribution, Random variable, Density and distribution functions. Mathematical expectation. Binominal distribution, Poisson distributions, Normal distribution, Exponential distribution, Weibull distribution.. [8]
2. **Reliability of Engineering Systems**:Component reliability, Hazard models, Reliability of systems with non-repairable components, series, Parallel, Series-Parallel, Parallel-series configurations. Non-series-parallel configurations, minimal tie-set, minimal cut-set and decomposition methods. Power System reliability. [8]
3. **Reliability of Engineering Systems**:Reliability model of a generating unit, State space methods, Combing states, sequential addition method, Load modeling, Cumulative load model, merging of generation and load models, Loss of load probability, Percentage energy loss, Probability and frequency of failure, Operating reserve calculations. [8]
4. **Power Network Reliability:** Weather effect on transmission lines, Common mode failures, Switching after faults, three, state components, Normally open paths, Distribution system reliability. [8]
5. **Composite System Reliability:** Bulk Power supply systems, Effect of varying load, Inter connected systems, correlated and uncorrelated load models, Cost and worth of reliability. [8]

Outcome: The students shall have a thorough understanding of the main principles in power system reliability analysis as well as knowledge of different methods and tools for reliability analysis.

Text Books:
1. J. Endreny, “Reliability Modeling in Electric Power Systems”, John Wiley & Sons. 1980
2. Roy Billinton& Ronald, N allan, “Reliability Evaluation of Power Systems”, Plenum Press, New York. 1990

Reference Books:
1. Sullivan, R.L., “Power System Planning”, Heber Hill, 1987.
2. Patrick O'Connor, Andre Kleyner“Practical Reliability Engineering”, Wiley 5th Edition,2012

EE-14.403 **Electric Drives and Control** **Total Lectures: 40**
3-1-0-4

Objective: This course aims to equip the students with a basic understanding of Electric drive system and their controls. The course also equips students with ability to understand selection of motor for industrial drive applications, and develops the ability to understand the characteristics and speed control of motors using power electronics based circuits.

Pre-requisite: Power Electronics, Electrical Machines and Control System.

1 **Introduction :**Introduction to an electric drive system, parts of electric drive system, choice criteria for drive system [5]

2 **Dynamics of Electric Drives:** Dynamic equations of an electric drive, torque equations, multi-quadrant operation, type of loads, energy loss during transients and load equalization. [5]

3 **Electric Drive Control:** Control of electric drives, modes of operation, speed control, open & closed loop drives, current limit control, torque limit control, position, PLL and speed control. [6]

4 **Selection of Motor Drive Rating:** Selection of motor rating – thermal model of motor, classes of duty and determination of motor rating for different classes of drive operation duty. [6]

5 **Control of DC Motor:** DC motor drive – starting, braking, transient analysis, speed control, controlled rectifier converters for DC drives and chopper fed DC drives. [9]

6 **Control of AC Motors:** Induction motor drive – starting, braking, transient analysis, speed control, Control of Induction Motor by AC Voltage controllers-Waveforms, Speed torque characteristics, Variable frequency control of induction motor by Voltage Source, Current Source inverters and cycloconverters. [9]

Outcome: After completion of the course, students would be able to apply the knowledge of various drives, their selection criteria and its control mechanisms for domestic and industrial applications.

Text Books:

1. Dubey G.K. “Fundamentals of Electrical Drives”,Narosa Publications, New Delhi, 2nd Edition 1995.
2. Gopal K. Dubey, “Power semiconductor Controlled Drives”, PHI publications, Newest 1st Edition 1989.

Reference Books:

1. Murphy J. M. D., Turnbull F.O., “Power Electronic Control of AC motors”, Pergamon Press, 1st Edition 1988.
2. Pillai S.K., “A first course on Electrical Drives”, New age International Publisher, 2nd Edition 1989.
3. U. A. Bakshi, M. V. Bakshi, “Electrical Drives and Controls”, Technical Publications Pune, 1st Edition 2009.

EE-14.404 **Renewable Energy Systems** **Total Lectures: 40**

3-0-0-3

Objective: This course provides the principles of renewable technologies for sustainable future. It also provides the details of renewable resources, energy conversion techniques and applications of solar, wind, biomass, geothermal, hydro-electric, wave and tidal energy technologies.

Pre-requisite: Power Plant Engineering

1	**Energy Scenario:** Energy Resources: Conventional and non-conventional, Energy needs of India, Energy consumption patterns, Worldwide Potentials of these sources, Energy efficiency, Energy security, Energy and its environmental impacts, Global environmental concern, Kyoto Protocol, Concepts of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF),Factors favoring and against renewable energy sources.	[8]
2	**Solar Energy:** Solar Energy basics-Extraterrestrial and Terrestrial radiation, Spectral energy distribution, Solar Radiation Geometry, Empirical equation for estimating solar radiation on horizontal surface. Solar Thermal Systems, Types of collectors-Concentrating and Flat plate, Efficiency calculations, Solar water heater- thermosiphon and pumped, Greenhouses heating and cooling, Photo Voltaic (PV) technology, Solar cells, Characteristic of PV systems, Equivalent circuit, Array design, Standalone and grid interactive system.	[8]
3	**Wind Energy:** Wind Energy, Wind speed and power relation, Power extracted from wind, Wind distribution and wind speed predictions, Wind power systems, System components, Types of turbine, Turbine rating, Variable speed operation, Maximum power Operation, Control systems, System design features, Standalone and grid connected operation.	[8]
4	**Other Energy Sources:** Biomass, Various resources, Energy contents, Technological advancements, Conversion of biomass in other form of energy, solid, liquid and gases, Gasoliers, Biomass fired boilers, Co firing, Energy Generation from agro-dairy apart from municipal waste ,used for vehicles , Hydro energy, Feasibility of small, mini and hydel plants: scheme, layout and economics, Tidal and wave energy, Geothermal and Ocean, Thermal Energy Conversion (OTEC) systems, Schemes, feasibility and viability	[8]
5	**Energy Storage and Hybrid System Configurations:** Energy storage, Battery, Types, Equivalent circuit, Performance characteristics, Battery design, Charging and charge regulators, Battery management, Fly wheel energy relations, Components, Benefits over battery,Fuel cell energy, Storage systems and Ultra capacitors, Energy Management.	[8]

Outcome: Upon completion of this course, the students should be able to:

1. Recognize the need of renewable energy technologies and their role in the world energy demand.
2. Distinguish between the sustainable energy sources and fossil energy sources
3. Describe the principles of renewable energy production from various renewable sources.

Text Books:

1. Rai G.D. “Non- Conventional Energy Sources”, Khanna Publishers, 4th Edition,2004.
2. Khan B.H., “Non-Conventional Energy Resources”,McGraw-Hill Education Private Limited, 2nd Edition, 2015.

Reference Books:

1. Kothari D.P. and Singal K.C. “Renewable Energy Sources and Emerging Technologies”, PHI Learning Private Limited, 2nd Edition, 2011.
2. Boyle, G. “Renewable energy: Power for a sustainable future” Oxford University press, 3rd Edition, 2014.

EE-14.405 **Electrical Machine Design** **Total Lectures: 42**

3-1-0-4

Objective: To provide knowledge of design aspects of various dc machines, ac machines and transformers.

Pre-requisite: Electrical Machines

1 **Fundamentals of Electrical Machine Design:** Standard specification of frame size, conductors and insulation, Magnetization and loss curves, Choice of specific loadings Heating and cooling of electrical machines. [6]

2 **D.C Machines:** Construction details, output equation, main dimensions, Choice of specific loadings, choice of number of poles, armature design, design of field poles and field coils ,design of commutator and brushes. [10]

3 **Transformers:** Construction details of core and shell type transformers, output rating of single phase and three phase transformers, optimum design of transformers, design of yoke, core and winding for core and shell type transformers, equivalent circuit parameters from design data and design of tank and cooling tubes of transformers. [10]

4 **A.C. Machines:** Construction details of A.C. machines, output equation, main dimensions, Choice of specific loadings, design of stator, design of squirrel cage and slip ring rotor equivalent circuit parameter from design data, Short circuit ratio, design of rotor of cylindrical pole and salient pole machines. [10]

5 **Computer Aided Design:** Need for computer aided design, Analysis method, Synthesis method, Introduction to analysis of Electric machine parameters using FEM. [6]

Outcome: After completion of the course, students would be able to apply the knowledge of magnetism in the design of transformer and rotating electrical machines.

Text Books:

1. A.K. Sawhney, A course in Electrical Machine Design, DhanpatRai and sons, New Delhi, 2nd Edition, 2002.
2. S K Sen, Principles of Electrical Machine Design with Computer Programme,Oxford and IBH publishing Co. Pvt Ltd., New Delhi, 3rd Edition, 2004.

Reference Books:

1. R.K Agarwal, Principles of Electrical Machine Design, S.K.Katariasons, New Delhi, 4th Edition, 2002.
2. V.N. Mittle and A. Mittle, Design of Electrical Machines, Standard Publications and Distributors, Delhi, 3rd Edition, 2002.

EE-14.411 **Smart Grid** **Total Lectures: 40**

3-0-0-3

Objective:

- This course aims to equip the students to understand the change in electricity power business from conventional sectors to smart grid sectors.
- To understand and analyze the basic architecture of smart grid and functions of its various components like renewables generation, measurement and communication system etc.

Pre-requisite: Power system , Electrical Measurement & Instrumentation

1	**The Traditional Power Generation and Transmission System:** Introduction, Power System reliability and quality, Voltage profile of power system, Power transfer Through radial feeder, Power system stability and control, Protection system, SCADA System.	[8]
2	**Smart Grid:** Introduction, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, The Environmental Impacts of Smart Grid, Technologies Required for Smart Grid.	[8]
3	**Renewable Energy Integration:** Introduction, Solar Energy, Wind Energy, Distributed Energy Resources Integration Challenges, Forecasting and Scheduling, Impacts of Renewable Energy into the Grid.	[8]
4	**Smart Grid Communications and Measurement Technology:** Communication, Measurement and Monitoring Technologies, Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) ,Smart Appliances, Advanced Metering Infrastructure (AMI),Communication Protocols.	[10]
5	**Smart Meter:** Details Description of Smart Meter, Benefits of Smart Meter, Technical Configurations of Smart Meter, Components of Smart Meter Network in Distribution System, and Characteristics of smart meters.	[6]

Outcome: Upon completion of the course the student will be able to:

1. Understand the difference between conventional grid and smart grid.
2. Understand the integration necessity and challenges of renewable in conventional grid system.
3. Understand the operation of communication and measurement technology in modern grid context.

Text Books:

1 Momoh James., "Smart Grid Fundamentals of Design and Analysis" ,John Wiley &Sons, Inc., Hoboken, New Jersey, 4th Edition, 2012

2 Bollen, Math and Hassan F, "Integration of Distributed Generation in The Power System", IEEE press, 2011.

Reference Books:

1 Shawkat Ali A. B. M., "Smart Grids Opportunities, Developments and Trends", Springer Verlag, London, 4th Edition, 2013.

2 Chowdhury S., Crossley P. "Microgrids and Active Distribution Networks" The Institution of Engineering and Technology, UK, 3rd Edition, 2009.

EE-14.412 **EHV AC & DC Transmission** **Total Lectures: 40**
3-0-0-3

Objective: To provide an in-depth understanding of the different aspects of Extra High Voltage A.C. and D.C. Transmission system design and Analysis.

Pre-requisite: Transmission & Distribution & Power System Analysis

1. **EHV AC System:** Flexible AC transmission, control of FACTS devices, reactive power planning, static VAR compensation, optimal location, Sub-synchronous resonance, Ferro-resonance, true saturation characteristic. [6]
2. **Transients in Three Phase EHV AC system:** Switching of three phase transformer banks, transmission lines, capacitive banks, effects of neutral connection. Symmetrical component method of analysis of three phase switching transients, effect of open conductors. EMTP application. [6]
3. **Traveling Waves:** Generation of traveling waves, refraction and attenuation of waves, effects of line terminators, multi-conductor systems. [6]
4. **Protection of EHV AC Lines:** Protection against switching over-voltages, lightning over-voltages. Surge diverters, surge capacitors and reactors, overhead ground wires. [6]
5. **HVDC Systems:** Comparison with AC systems. Various configurations, inversion and conversion, operation and control, harmonics and filters. Parallel operation of HVDC/AC system. Back to back connections. Multi-terminal HVDC system. Transients in HVDC converters. [6]
6. **Overvoltage and Insulation Coordination:** Lightning, switching and temporary overvoltage, BIL and SIL, methods of insulation coordination, conventional and statistical methods. [6]
7. **Gas Insulated Systems:** Gas Insulated lines, substations, advantages and problems. [4]

Outcome:
1. Understand issues of concern with EHVAC& DC transmission
2. identify and calculate the various parameters of EHV line for modeling
3. Estimate the over–voltages in EHV AC systems and protect against it.
4. Understand insulation coordination and gas insulated system.

Text Books:
1. Rakesh Das Begamudre, “Extra High Voltage Ac Transmission Engineering”, New Age International, 4th Edition, 2011.
2. Padiyar. K. R.,"HVDC Power Transmission Systems", New Academic Science, 2nd Edition, 2011

Reference Books:
1. A Chakraborti, D.P. Kothari “Performance, Operation and Control of EHV Power Transmission Systems”, T.M.H publication,2nd Edition, 1983.
2. TuranGonen “Electric Power Transmission System Engineering”,Taylor & Francis, 2nd Edition,2007.

EE-14.413 **Modern Control System** **Total Lectures: 40**
3-0-0-3

Objective: To impart knowledge about advances in control system in the areas of state-space modeling & stability of continuous & discrete system. It will also make students familiar with the non-linear system – their modeling and analysis. At the end of the course a student will be equipped to handle linear and non-linear control problems.

Pre-requisite: Linear Control System

1 **State Space Analysis of Continuous Time Systems**: State variable representation – Conversion of state variable form to transfer function and vice versa – Eigenvalues and Eigenvectors – Solution of state equation – Controllability and observability –Pole placement design – Design of state observer [8]

2 **Z-Transform and Sampled Data Systems:** Sampled data theory – Sampling process – Sampling theorem – Signal reconstruction –Sample and hold circuits – z-Transform – Theorems on z-Transforms – Inverse z-Transforms – Discrete systems and solution of difference equation using z transform – Pulse transfer function – Response of sampled data system to step and ramp Inputs – Stability studies –Jury's test and bilinear transformation. [6]

3 **State Space Analysis of Discrete Time Systems**: State variables – Canonical forms – Digitalization – Solution of state equations –Controllability and Observability – Effect of sampling time on controllability – Pole placement by state feedback – Linear observer design – First order and second order problems [6]

4 **Nonlinear Systems:**Types of nonlinearity – Typical examples – Phase-plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Basic concepts –Dead Zone – Saturation – Relay – Backlash – Liapunov stability analysis – Stability in the sense of Liapunov – Definiteness of scalar functions – Quadratic forms – Second method of Liapunov – Liapunov stability analysis of linear time invariant systems and non-linear system [6]

5 **MIMO Systems:**Models of MIMO system – Matrix representation – Transfer function representation – Poles and Zeros – Decoupling – Introduction to multivariable Nyquist plot and singular values analysis – Model predictive control. [5]

Outcome: Upon completion of the course the student will be able to develop the mathematical models for various types of systems using different techniques.

Text Books:
1. M. Gopal, "Digital Control and State Variable Methods", McGraw Hill Publication,4th Edition, 2012.
2. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall, 3rd Edition, 1997.

Reference Books:
1. Katsuhiko Ogata, "Discrete-Time Control Systems", Pearson Education, 2nd Edition, 2002.
2. Richard C. Dorf and Robert H., "Modern Control Systems", 8thEdition, PearsonEducation, 2004.

EE-14.414 **Computer Application in Power Systems** **Total Lectures: 40**
3-0-0-3

Objective: This course is designed to give students the required knowledge for the design and analysis of electrical power grids by using computer programs or a software. The computer programs or software make easy calculation of power flow in a power system network using various techniques.

Pre-requisite: Transmission & Distribution & Power System Analysis

1 **Network Modeling**: Development of network matrices using graph theory, Z-Bus and Y-Bus formation, component models, fixed tap, variable tap and phase shifting transformers. [5]

2 **Short Circuit Studies of Large Systems:** Symmetrical and asymmetrical fault analysis using Z-Bus and Y-Bus Method. [6]

3 **Advanced Load Flow Studies:** Load models, non-convergence of load flow solutions, remedial measures, second order methods, continuation power flow, sparse vector method. [8]

4. **Economic Operation and Security Analysis:** Optimal power flow problem and its solution methods, contingency evaluation methods; distribution factors, direct and indirect methods, contingency ranking and screening. [8]

5. **Angular and Voltage Stability Analysis:** Steady state and transient stability, mathematical models and numerical solution, voltage stability. [8]

6. **State Estimation:** Algorithm, tracking state estimator, bad data identification, Observability. [5]

Outcome:
1. Upon completing this course student able to analysis of different type fault in a power system by computer methods.
2. Student able to apply computer methods in different load flow techniques.

Text Books:
1. J.J.Grainger & W.D.Stevenson, "Power system Analysis",McGraw Hill, 3rd Edition, 2007.
2. HadiSaadat, "Power System Analysis",McGraw Hill ,2nd Edition, 2002.

Reference Books:
1. D.P.Kothari and I.J.Nagrath, "Modern power system analysis", McGraw HillEducation, 2nd Edition, 2003.
2. T.K.Nagsarkar M.S.Sukhija ,"Power System Analysis", OXFORD university press,4th Edition, 2007.

EE-14.415 **Power Quality** **Total Lectures: 40**

3-0-0-3

Objective: This course aims to equip the students with an understanding of emanation of various power quality disturbances their cause, effects and remedial action in particular to harmonics distortion.

Pre-requisite: Power system, Power Electronics

1 **Introduction:** Introduction, power quality -voltage quality, power quality evaluations procedures term and definition:general classes of power quality problem, causes & effect of power quality disturbances. [6]

2 **Voltage Sags and Interruption:** Voltage sags and interruption: sources of sags and interruption, estimating voltages sag performance, fundamental principles of protection, monitoring sags. [6]

3 **Transient Over Voltages:** Sources of transient over voltages, principles of overvoltage protection, devices for overvoltage protection, utility capacitor-switching transients, utility system lightning protection, managing ferro-resonance , switching transient problems with loads. [8]

4 **Harmonics:** Harmonic distortion, voltage versus current distortion, harmonics versus transients, harmonic indexes, harmonic sources from commercial loads, harmonic sources from industrial loads, locating harmonic sources, system response characteristics, effects of harmonic distortion, inter-harmonics. [10]

5 **Applied Harmonics:** Harmonics distortion evaluations, principles for controlling harmonics, harmonics studies devices for controlling harmonic distortion, filters, passive input filter standards of harmonics. [10]

Outcome: Upon completion of the course The student will be able understand

1. The reason for occurrence of power quality disturbances.
2. The difference between disturbing signals like sag, swell transients, harmonics.
3. Various types of filters to filter out the harmonic problems.

Text Books:

1. Dugan R. C.,"Electrical Power System Quality", McGraw Hill Publication, 3rd edition, 2008.
2. Arrillga A.J., "Power System harmonics", Wiley publication, 2nd edition, 2003.

Reference Books:

1. Derek A. Paice, "Power electronic converter harmonics",Wiley publication, 3rd Edition,1999.

EE-14.441 **Engineering Economics** **Total Lectures: 26**

2-0-0-2

Objective(s):

1. Provide students with fundamental concepts of engineering economics.
2. Provide students with economical methods to compare and evaluate alternatives based on present, annual, rate of return, and benefit over cost analyses.
3. Emphasize practical engineering-based applications and the use of real data examples.

Prerequisite(s): Nil

1. **Introduction**: Definitions, Scope; Microeconomics vs. Macroeconomics; Engineering and engineering economics; Principles of engineering economics. **[2]**
2. **Theory of Demand & Supply**: Determinants, law of demand, law of supply, equilibrium, elasticity of demand. **[3]**
3. **Economics Applied to Industries**: Theory of production; production function, Law of variable proportions, Returns to scale, Theory of cost; Various concepts of cost: Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost, average cost, marginal cost, total cost etc, Break even analysis. **[6]**
4. **Market Structures& Pricing Techniques:** Meaning of Market, Types of Market- perfect competition, Monopoly, Oligopoly, Monopolistic Competition (Main features of these markets). **[5]**
5. **Replacement analysis and depreciation**: Replacement Analysis Decision Map, Basic aspects of depreciation, Deterioration & Obsolescence, and its methods **[3]**
6. **Optimization technique**: Optimization under constraints and without constraints, optimal resource allocation, optimization under risk and uncertainty. **[4]**
7. **Capital budgeting**: Concept; under certainty and uncertainty, Techniques; Discounting &compounding techniques, IRR, NPV, PBP, Profitability index, Accounting rate of return. **[3]**

Outcome(s):

1. Understand major principles of economic analysis for decision making among alternative courses of action in engineering.
2. Apply cost estimation and alternative analysis techniques for engineering applications.
3. Recognize the economic impact of engineering solutions.
4. Calculate depreciations and understand the impact of inflation.
5. Perform breakeven analysis for a single project and between two alternatives.

Text Books:

1. Salvatore, Dominick. Managerial Economics, Prentice Hall of India, 6th Ed., 2010.
2. D.N. Dwivedi, Managerial Economics, Oxford University Press,Vikas Publication, 7th Ed., 2014.

Reference Books:

1. Suma Damodran, Managerial Economics, Oxford University Press, 2nd Ed, 2005.

EE-14.442 **Principles and Practices of Management** **Total Lectures : 26**

2-0-0-2

Objective(s):

1. To expose the students to fundamental concepts of management and its processes in organizations.
2. To describe the various skills necessary for effective managers.
3. To explain the Individual and Group Behavior along with various leadership Styles

Prerequisite(s): Nil

1. **Planning and Organizing:** Management: Concept, Nature and functions; Planning: Concept, Missions, Objective and Strategies, Steps in Planning; Organizing: Concept, Formal an Informal Organization, Decentralization of Authority, Delegation of Authority, Principles of Organizing, Line and Staff Authority. **[5]**
2. **Staffing and Controlling:** Staffing: Definition, Recruitment, Selection, Placement, Promotion, Separation, Performance Appraisal; Controlling: Concepts and Process, Controlling as a Feedback System, Requirements for Effective Control. **[4]**
3. **Motivation:** Concept; Theories and Process of Motivation: Maslow's Need-Hierarchy Theory, Herzberg's Hygiene Theory, Goal-Setting Theory, Vroom's Expectancy Theory. **[4]**
4. **Personality:** Concept and Determinates, Types and Traits, Personality Attributes Influencing Organizational Behavior, Locus of Control, Machiavellianism, Self-Esteem, Self-Monitoring, Risk-Taking. **[3]**
5. **Group Behavior and Interpersonal Relationship:** Groups: Concept and Classification, Stages of Group Development, Roles and Norms, Group Decision-Making: Group versus Individual, Group Decision Making Techniques and Process, Interpersonal Relationships, Understanding Self and Others, Developing Interpersonal Relationships, Transactional Analysis, Johari Window. **[6]**
6. **Leadership:** Concept and Functions; Theories of Leadership: Traits, Behavioral, Situational/Contingency; Inspirational approaches to Leadership: Charismatic Leadership, Transformational Leadership, Transactional Leadership, and Contemporary Leadership. **[4]**

Outcome(s): By studying this Course, students would be able to understand various Management functions, individual and group behavior. They would also know various styles of Leadership and its applicability. The course would help the students in understanding various organizational contexts and help them understand organizational systems in a better way.

Text Books:

1. Koontz, Harold and Weihrich, Heinz, Essentials of Management: An International, Innovation and Leadership Perspective, McGraw Hill Private Limited, India, 10th Edition, 2015.
2. Robbins, Stephen P., Timothy Judge and Neharika Vohra, Organizational Behavior, Pearson Education, 12th Ed., 2011.

Reference Books:

1. Prasad L. M., Principles and Practice of Management, Sultan Chand & Sons, 9th Edition, 2015
2. Fred Luthans, Organizational Behavior, McGraw Hill, 11th Ed., 2009

EE-17.419 **Power System Protection** **Total Lectures: 40**

3-1-0-4

Objective: To provide a broad coverage on all types of protective relays, circuit breakers and its working for practical power system protection system.

Pre-requisite: Electrical Machines & Power Plant Engineering

1 **Introduction to Protection System:** Introduction to protection system and its elements, functions of protective relaying, protective zones, primary and backup protection, desirable qualities of protective relaying, basic terminology. [4]

2 **Operating Principle and Relay Characteristics:** Electromagnetic relays, thermal relay, gas actuated relay. Amplitude and phase comparators, over current relays, directional relays, distance relays, differential relay. [8]

3 **Static Relays:** Comparison with electromagnetic relay, classification and their description, over current relays, directional relay, distance relays, differential relay. [6]

4 **Protection of Transmission Line:** Over current protection, distance protection, pilot wire protection, carrier current protection, protection of bus. [6]

5 **Apparatus Protection:** Protection of Transformer, Generator and Motor. [3]

6 **Circuit Breaking:** Properties of arc, arc extinction theories, re-striking voltage transient, current chopping, Resistance switching, capacitive current interruption, short line interruption, circuit Breaker ratings, [6]

7 **Circuit Breaker:** Operating modes, selection of circuit breakers, ratings of circuit breaker, constructional features and operation of Bulk Oil, Minimum Oil, Air Blast, SF6, Vacuum circuit breakers, HVDC circuit breaker, Testing of Circuit Breaker. [7]

Outcome: After completion of the course, students would be able to apply the knowledge of CB, various relaying schemes and overvoltage and protection against overvoltage.

Text Books:

1. Badri Ram and Vishwakarma, D.N., "Power System Protection and Switchgear", McGraw HillPublishing, 3rd Edition, 2001.
2. Ravindranath, B. and Chander, N., "Power System Protection and Switch Gear", New AgeInternational (P) Ltd,3rd Edition, Reprint 1996.

Reference Books:

1. Sunil S.Rao, "Protective Switch Gear", Khanna Publishers, 2nd Edition, 2000.
2. Y. G. Paithangar, "Fundamentals of power system protection", PHI Learning Private Limited, 4th Edition, 2010.

EE-17.501 **Energy Resources** **Total Lectures: 40**

3-1-0-4

Objective:

- To provide an exposure on various concepts of Non-renewable and renewable energy and also its domestics and industrial applications
- To understand the environmental and economic aspects of renewable energy sources

Prerequisite: Power Plant Engineering

1. **Commercial Energy:** Coal, Oil, Natural Gas, Nuclear power and Hydro – their utilization pattern, future projections of energy consumption, environmental impactof fossil fuels, Energy scenario in India – Growth of energy sector and its planning in India. [8]

2. **Solar Energy:** Solar radiation at the earth's surface, measurements and estimation of average solarradiation, solar thermal flat plate collectors, concentrating collectors, solar thermal applications, solar electric power plant - principle ofphotovoltaic conversion of solar energy, types of solar cells, Photovoltaic applications: batterycharger, domestic lighting, street lighting, water pumping etc - solar PV power plant, Net meteringconcept. [8]

3. **Wind Energy:** Nature of the wind, power in the wind, factors influencing wind, wind data and energy estimation, wind speed monitoring, wind resource assessment, Betz limit, site selection, wind energyconversion devices, classification, applications, safety and environmental aspects, wind energy potential and installation in India -Repowering concept. [8]

4. **Bio Energy:** Biomass resources and their classification, Biomass conversion processes, Thermo chemicalconversion - direct combustion, biomass gasification, pyrolysis and liquefaction, biochemicalconversion, anaerobic digestion, types of biogasPlants, applications, alcohol production frombiomass, bio diesel production, Urban waste to energy conversion, Biomass energy program inIndia. [8]

5. **Other Types of Energy:** Ocean energy resources, principle of ocean thermal energy conversion (OTEC), ocean thermalpower plants, ocean wave energy conversion, tidal energy conversion, small hydro, geothermal energy, geothermal power plants, hydrogen production and storage, Fuel cell: principle ofworking, various types, construction and applications. [8]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understanding of commercial energy and renewable energy sources
- Knowledge in working principle of various energy systems
- Capability to do basic design of renewable energy systems

Text Books:

1. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill, 4th edition 2006.
2. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, 3rd edition, 2012.

Reference Books:

1. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 6th edition 2011.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd, 2nd edition, 2006.

EE-17.502 **Energy Audit and Management** **Total Lectures: 40**

3-1-0-4

Objective:

- To provide a broad knowledge on current energy scenario and audit for various applications.
- To acquire the in-depth knowledge of the Energy management systems.

Prerequisite: Renewable Energy System

1. **Energy Scenario**: Role of Energy Managers in Industries , Energy monitoring, auditing & targeting , Economics of various Energy Conservation schemes, Total Energy Systems [8]
2. **Energy Audit**: Various Energy Conservation Measures in Steam, Losses in Boiler. Energy Conservation in Steam Systems, Case studies. [8]
3. **Basics of Energy Conservation:** Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor, energy consumption & energy saving potentials, Design consideration. [8]
4. **Refrigeration & Air conditioning:** Heat load estimation, Energy conservation in cooling towers & sprays ponds; Case studies Electrical Energy, Energy Efficiency in Lighting, Case studies. [8]
5. **Energy Management:** Organizational background desired for energy management motivation, detailed process of M&T-Thermostats, Boiler controls, proportional, differential and integral control, optimizers; compensators. [8]

Course Outcome: Upon successful completion of this course, students should be able to

- Perform energy audit on the systems and know in depth the energy management systems.

Text Books:

1. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.
2. Reay D.A, Industrial Energy Conservation, 1st Edition, Pergamon Press, 6th edition, 2008.

Reference Books:

1. L. C Witte, Philip S. Schmidt, D. R. Brown, Industrial Energy Management & Utilization, Hemisphere Publisher Corp., 1st edition, 1988.
2. Power System Engineering 2nd Ed. D P Kothari, I J Nagrath, McGraw-Hill, 4th edition, 2008.

EE-17.503 **Solar Energy Engineering** **Total Lectures: 40**

3-1-0-4

Objective:
- To develop the ability to understand / analyze the various solar energy design principles.
- To study the various applications of solar energy and storage systems.

Prerequisite: Renewable Energy System.

1. **Introduction:** Source of radiation, solar constant, solar charts, Measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder [5]

2. **Solar Non-Concentrating Collectors**: Design considerations, Classification- air, liquid heating collectors, Derivation of efficiency and testing of flat plate collectors, Analysis of concentric tube collector, Solar green house. [6]

3. **Solar System Design**: Classification, Concentrator mounting, Focusing solar concentrators, Heliostats. Solar powered absorption A/C system, water pump, chimney, drier, dehumidifier, still, cooker. [10]

4. **Photo-Voltaic Cell**: Characteristics-cell arrays-power electric circuits for output of solar panels, choppers, inverters, batteries-charge regulators, Construction concepts. [7]

5. **Energy Storage**: Sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change-Glauber's salt-organic compounds. [12]

6. **Solar Energy Applications**: Introduction and principle of operation of solar cooker, solar air heater, solar water heater, solar distillation, solar pond, solar thermal power generation – Greenhouse - Solar PV system.

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze and design the solar energy system with energy storage devices and perform the selection based on techno-economic view point.

Text Books:

1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003.
2. Edward E. Anderson, "Fundamentals for solar energy conversion", Addison Wesley Publ. Co., 2nd edition 2000.

Reference : Books

1. G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable energy Sources", Narosa Publishing House, New Delhi, 4th edition, 2007.
2. Energy Studies, Second Edition, by W. Shepherd and D. W. Shepherd, Imperial College Press, London, 3rd edition, 2004.

EE-17.504 **Wind Energy Conversion System** **Total Lectures: 40**

3-1-0-4

Objective: To provide the current status, importance, future trends and potential for Wind energy technologies as a complement to, or replacement for, conventional technologies.

Prerequisite: Renewable Energy System

1. **Wind Resource:** Wind characteristics: Meteorology of wind – wind speed distribution across the world – spatial and temporal factors – Eolian features - Biological indicators. Wind measurement: Anemometers – balloon trackers. Wind energy conversion systems (WECS) - classifications. [8]

2. **Wind Energy Conversion:** Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and Strip theory; Maximum power coefficient; Prandlt's tip loss correction; Rotor design and characteristics; Power, torque and speed characteristics – Wind turbine performance measurement – Loading analysis. [8]

3. **Wind Turbines Types:** Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator. [8]

4. **Wind Energy Application:** Wind pumps: Performance analysis, design concept and testing; Principle of Wind Energy Generators; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies. [8]

5. **Cost Economics**: Wind resource assessment and R & D costs, Fixed and variable costs, Value of wind energy, Life cycle costing and cash flow of wind power projects, Wind project owners / developers, Wind energy market. [8]

Course Outcome: Upon successful completion of this course, students should be able to

- Understand the atmospheric processes that produce wind energy.
- Explain the fundamental principle of wind turbine operation.
- Analyze the economics of wind energy.
- Explain recent commercial developments in wind energy and its future potential.

Text Books:

1. S. Rao & B.B. Parulekar, Energy Technology, Khanna publishers, 4th edition, 2005.
2. T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, Wind energy Handbook, John Wiley & Sons, 6th edition, 2011.

Reference Books:

1. Mukund. R. Patel, Wind and Solar Power Systems, Taylor & Francis, 2nd Edition 2001.
2. L .L. Freris, Wind Energy Conversion Systems, Prentice Hall, 4th Edition, 2010.

EE-17.505 **Advanced Energy Storage** **Total Lectures: 52**
4-0-0-4

Objective:
- To develop the ability to understand / analyze the various types of energy storage.
- To study the various applications of energy storage systems.

Prerequisite: Power Plant Engineering

1. **Introduction:** Necessity of energy storage, types of energy storage, comparison of energy storage technologies, Applications. [7]

2. **Thermal Storage System:** Thermal storage, Types, Modelling of thermal storage units, Simple water and rock bed storage system, pressurized water storage system, Modelling of phase change storage system, Simple units, packed bed storage units, Modelling using porous medium approach, Use of Transys. [9]

3. **Electrical Energy Storage:** Fundamental concept of batteries, measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries, Lead Acid, Nickel-Cadmium, Zinc Manganese dioxide and modern batteries: zinc-Air, Nickel Hydride, Lithium Battery. [12]

4. **Fuel Cell:** Fuel Cell, History of Fuel cell, Principles of Electrochemical storage, Types, Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis, advantage and drawback of each type. [10]

5. **Alternate Energy Storage Technologies:** Flywheel, Super capacitors, Principles & Methods, Applications, Compressed air Energy storage, Concept of Hybrid Storage, Applications. [14]

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze various types of energy storage devices and perform the selection based on techno-economic view point.

Text Books:

1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons, 2nd edition, 2011.
2. Ru-Shiliu, Leizhang, Xueliang Sun, Electrochemical technologies for energy storage and conversion, Volume 1 & 2, Wiley publications, 2nd Edition, 2012.

Reference Books

1. James Larminie and Andrew Dicks, Fuel cell systems Explained, Wiley publications, 1st edition, 2003.

EE-17.506 **Solar Photovoltaic Technology** **Total Lectures: 40**

3-1-0-4

Objective:

- To attain a broad comprehension of solar photovoltaic systems used for various applications.
- To know in depth the types and design of various PV-interconnected systems.

Prerequisite: Renewable Energy System

1. **Photovoltaic Basics:** Structure and working of Solar Cells - Types, Electrical properties and Behavior of Solar Cells – Cellproperties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays -Basics of Load Estimation. [8]

2. **Stand Alone PV Systems:** Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications - Typical applications for lighting, water pumping etc. [8]

3. **Grid Connected PV Systems:** Site selection and land requirements - Techno-economic analysis of solar PV power plants - Environmental considerations.Schematics, Components, Charge Conditioners, Interface Components - Balance of systemComponents - PV System in Buildings. [8]

4. **Design of PV Systems:** Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability - Simple Case Studies. [8]

5. **Solar Economics:** Application of economic methods to analyze the feasibility of solar systems to decide project / policy alternatives - Net energy analysis - and cost requirements for active and passive heating and cooling - for electric power generation - and for industrial process-heating. [8]

Course Outcome: Upon successful completion of this course students will be able to

- Explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems.

Text Books:

1. CS Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2nd Edition 2011.
2. Martin A. Green, Solar Cells: Operating Principles, Technology and System Applications, Prentice- Hall, 4th Edition, 2011.

Reference Books:

1. Nelson J., The Physics of Solar Cells, Imperial College Press, 2nd Edition, 2003.
2. Thomas Markvart, Solar Electricity, John Wiley and Sons, 2nd Edition, 2012.

EE-17.507 **Biomass and Small Hydel Plants** **Total Lectures: 52**
4-0-0-4

Objective:

- To provide understanding of the processes for converting biomass feedstocks to fuels by various approaches.
- To learn to evaluate technological, economic and business dimensions of energy production from biomass.
- To provide understanding of energy generation from small hydro power plant and hydel power plants management.

Prerequisite: Renewable Energy Sources

1. **Biomass Resources and Biomass Properties:** Biomass: definition, classification, availability, estimation of availability, consumption and surplus biomass, energy plantations. Potential of biomass and assessment. [8]
2. **Energy Conversions Techniques:** Thermo chemical conversion: Direct combustion, incineration, pyrolysis and gasification; Biomass stoves, improved chullahs and some exotic designs, Biological conversion: Biodegradation and biodegradability of substrate; Biochemistry and process parameters of biomethanation; Biogas digester types; Digester design and biogas utilisation; Bioconversion of substrates into alcohol: Methanol & ethanol Production, Chemical conversion: Hydrolysis and hydrogenation; Solvent extraction of hydrocarbons; Bioethanol; Chemicals from biomass. [11]
3. **Bio Diesel:** History, Production methods of Bio-diesel: Transesterification, Fuel quality, standards and properties, Availability of Raw materials for bio-diesel, Applications, Bio-diesel potential in India. [8]
4. **Waste To Energy** Introduction to Energy from waste, classification of waste as fuel, agro based, forest residue, industrial waste, Environmental monitoring system for land fill gases, Environmental impacts; Measures of mitigate environmental effects due to incineration. [7]
5. **Hydro Power:** Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works. [9]
6. **Hydel Plant Management:** Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in North East India. [9]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understand the challenges and problems associated with the use of various bioenergy sources with regard to future resource and the environment.
- Evaluate the cost-benefit of various biomass energy conversion processes.
- Identify remedies/potential solutions to the supply and environmental issues associated with biomass based energy resources.
- Conceptualize energy generation techniques and understand different small hydro power plant and hydel power plants management.

Text Books:

1. Capareda S, Introduction to biomass energy conversion, CRC Press, 4th Edition, 2014.
2. Harvey A. & Brown A, Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes. Practical Action publication, 2nd Edition, 2003.

Reference : Books

1. Brown RC and Stevens C, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons, 4th Edition, 2011.

EE-17.508 **Environmental Impact of Energy System** **Total Lectures: 52**

4-0-0-4

Objective: To achieve environmental improvements and know the environmental values and behavior.

Prerequisite: Power Plant Engineering.

1. **Impact of Energy Systems on Environment:** Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants. Methods of Environmental Impact Assessment. [12]
2. **Pollution Due To Thermal, Hydel and Nuclear Power Plants:** Potential sources of Pollution in thermal power plant, Air, water, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control. Various pollution control equipments such as dust collector, bag filter, electrostatic separator, working principle and selection criteria, designing the pollution control system, methods and limitation. Water pollution in thermal power plant, physical and chemical methods of pollution control, Land pollution effect of land pollution, measurement of land pollution. Limitations and advantages of pollution control systems. Hydrothermal plant environmental assessment, hydrothermal plant and rehabilitation measures for hydrothermal plant. Nuclear power plants and environmental pollution, pollution control measures. Effect of Hydroelectric power stations on ecology and environment. [14]
3. **Industrial and Urban Waste & Waste Energy Recovery:** Industrial waste, Waste and effluent treatment, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy. Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control. [10]
4. **Environmental and Pollution Control Laws:** United Nations Framework Convention on Climate Change (UNFCC), Protocol, Conference of Parties (COP) 19 Clean Development Mechanism (CDM), Prototype Carbon Funds(PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project. [10]
5. **Global Environmental Concern:** Global Environmental Issues, ozone layer depletion, Global Warming, Green House Gases Emission. [6]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understand environmental effects and act accordingly to improve the environmental conditions globally.

Text Books:

1. W.K. Foell, Management of Energy Environment Systems, John Wiley and Sons, 6th Edition, 2013.
2. M.C. Macedo Jr, Energy Management and Control Systems, John Wiley and Sons, 4th Edition, 2004.

Reference Books:

1. J.G. Rau, D.C. Wood, Environmental Impact Analysis Handbook, McGraw Hill, 7th Edition, 2005.
2. J.M. Fowler, Energy & Environment, McGraw Hill,, ERIC, 2nd edition, 2009.

EE-17.509 **Power System and Smart Grid** **Total Lectures: 52**

4-0-0-4

Objective:

- To provide the students a systems perspective of modern electricity markets and a systems approach to address various issues faced by the electricity sector.
- To present the student a vision of how Smart Grid will transform the current electricity grid to a reliable and sustainable modern energy system.

Prerequisite: Transmission and Distribution, Power System Analysis.

1. **Supply Side and Demand Side of Electricity:** Basics of electricity, Fossil fuels and hydro power plants, Renewable and alternative energy, Supply curve, Load characteristics, Load curve and load duration curve, Demand side management. [11]

2. **Transmission and Distribution Network:** Physical law of electricity, AC vs. DC power flow, Optimal Power flow and unit commitment models, Distribution network basics. [10]

3. **Basic Elements of Smart Grid:** The origin of power grid, dependency on power grid, desirable features of power grid, reliability, security, economic, efficiency, environmental friendly, safety. [11]

4. **Key Characteristics of Smart Grid:** Demand-side participation, Impact of Smart Grid on reliability, Impact of Smart Grid on air pollutant emissions reduction. [10]

5. **Issues Related to Smart Grid:**Communication and sensing in a smart grid, smart grid threats, vulnerabilities, cyber security strategies. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Gain Knowledge about the economic fundamentals of power systems and electricity markets.
- Understand the concepts of various components of Smart Grid, and their impacts on the energy industry, including renewable integration, demand side management, and greenhouse gas emission reduction.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 4th Edition, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 4th Edition, 2009.

Reference Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2017.

EE-17.510 **Power System for Renewable Energy Sources** **Total Lectures: 52**

4-0-0-4

Objective: To know the grid integration of renewable energy sources, different machines, power electronics devices uses in renewable energy power plants.

Prerequisite: Power System Analysis, Renewable Energy System.

1. **Introduction To Renewable Energy Grid Integration:** concept of mini/micro grids, and smart grids. Review of synchronous generators, Introduction to power system stability problems: rotor angle stability, voltage stability and voltage collapse, classification of stability. Modelling of synchronous machines: transformations, synchronous machine representation in stability studies. [12]
2. **Introduction To Induction Machines:** electrical characteristics, slip, speed torque characteristicsetc. Self-excited induction generator, Constant speed Induction generators, Variable speedInduction generators, Doubly fed Induction generators. [10]
3. **Introduction To Power Electronic Devices:** AC/DC converters, PWM, THD. Permanent magnetsynchronous generator, solar PV systems, fuel cell, aquaelectrolizer. [10]
4. **Issues in Integration of Different Generators:** Issues in integration of synchronous generator based, induction generator based and converterbased sources together.Network voltage management (discusses the issue of voltage levels). [10]
5. **Power Quality Management:** Voltage dips, harmonics and flickers.Frequency management. Influence of WECS on system transient response – IEEE standard and Polices. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Analyze the power quality management in renewable power plants.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 2nd Edition, 2009.

Reference : Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2006.

EE-17.512 **Power Electronics for Renewable Energy Source** **Total Lectures: 52**

4-0-0-4

Objective:
- To impart knowledge on Standalone, Grid connected and Hybrid renewable energy systems.
- To understand the different types of Electrical Machines and Power Converters employed for renewable energy conversion systems

Prerequisite: Power Electronics,Renewable Energy System.

1. **Introduction:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission), Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. [12]

2. **Electrical Machines For Renewable Energy Conversion:** Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG. [8]

3. **Power Converters:** Solar: Block diagram of solar photo voltaic system, Principle of operation: line commutated converters (inversion-mode), Boost and buck-boost converters, selection of inverter, battery sizing, array sizing, Wind: three phase AC voltage controllers, AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. [12]

4. **Analysis of Wind and PV Systems:** Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system, Grid connection Issues, Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system. [10]

5. **Hybrid Renewable Energy Systems:** Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Wind-PV, Maximum Power Point Tracking (MPPT). [10]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understand the concepts of Standalone, Grid connected and Hybrid Energy System
- Understand different types of Electrical Machines and Power Converters employed for Renewable Energy Conversion Systems.

Text Books:

1. Leon Freris, David Infield, Renewable Energy in Power Systems, John Wiley & Sons, 2008.
2. Rashid .M. H, Power Electronics Hand book, Academic press, 1st edition, 2007.

Reference Books:

1. Rai. G.D, Non-Conventional Energy Sources, Khanna publishes, 2nd edition, 2010.
2. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, John Wiley & Sons, 4th edition, 2011.
3. S.N. Bhadra, D.Kastha, Wind Electric Systems, Oxford University Press, 5th edition, 2005.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of ME

Course structure for

B.Tech ME

ME 14.401 **Thermal Engineering System** **Total Lectures: 40**
Credit 3-1-0-4

Prerequisite(s): Engineering Thermodynamics

Objective(s):

Thermodynamics is an essential part of engineering curricula, and has a broad application area such as transportation vehicles, power generation and cooling systems. The course will cover the basic principles of thermodynamics and will give students knowledge about how thermodynamics is applied in engineering practice.

1. **Steam Generator and Draft:** Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox etc, boiler mountings and accessories; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation. Introduction to high pressure boiler [8]
2. **Steam & Gas Nozzles:** Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, Off design operation of nozzle, Effect of friction on nozzle, critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. [8]
3. **Steam Turbines:** Introduction; classification of steam turbine; impulse turbine; working principal; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; efficiency of blade height; condition of maximum efficiency; internal losses in steam turbine; governing of steam turbine. [10]
4. **Compressors:** [6]
Classification, single and multistage reciprocating compressors, isothermal and volumetric efficiencies, centrifugal and axial flow compressors, surging, choking and stalling.
5. **Steam Condensers:** Component of steam condensing plant; types of condensers; air leakage in condensers; Dalton's law of partial pressure; Condenser vacuum, sources of air leakage & its disadvantages, vacuum efficiency; calculation of cooling water requirement; air expansion pump. [8]

Outcome(s):

Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques, including the use of empirical data and property tables, to the analysis of representative fluid and thermal energy components and systems.

Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques, including the use of empirical data and property tables, to the design analysis of auxiliary fluid and thermal energy components and systems representative of the systems encountered in the practice of electrical, industrial, and related disciplines of engineering.

Text Books:

1. P.K. Nag , “Basic and Applied Thermodynamics”, Tata Mc Graw Hill Pub
2. Kearton W. J, “Steam Turbine Theory and Practice”, CBS Publisher & Distribution Pvt Ltd, Latest Edition
3. R.K. Rajput, “Thermal Engg.”, Laxmi Publication

Reference Books:

1. Ballaney P. L, “Thermal Engineering”, Khanna Publishers, Latest Edition.
2. Yadav R, “Thermodynamics and Heat Engines”, Central Publishing House, Latest Edition
3. Chattopadhyay P, “ Boiler Operation Engineering”, TMH, 11th Edition, 2008.

ME 14.403 **Refrigeration and Air Conditioning** **Total Lectures: 40**

Credit-3-1-0-4

Prerequisite(s): Engineering Thermodynamics
Heat Transfer

Objective(s): *This course deals with the heating and cooling effects produced in domestic and industrial applications. The objectives of the course is to enable the student;*

- *To understand the principles of refrigeration and air conditioning.*
- *To calculate the cooling load for human comfort & different applications.*
- *To select the right equipment for a particular application.*
- *To understand the effect of temperature and pressure on moist air.*

6. **Introduction:** Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP), Fundamentals of air-conditioning system. [2]
7. **Air Refrigeration System:** Carnot refrigeration cycle; Temperature Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems. [4]
8. **Vapor Compression Refrigeration Systems:** Simple Vapour Compression Refrigeration systems-Limitations of Reversed Carnot cycle with vapour as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP. [5]
9. **Multistage Vapor Compression Refrigeration Systems:** Necessity of multistage compression, Compound VC cycle, Inter cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers. [7]
10. **Vapor Absorption Refrigeration Systems:** Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; Steam Jet Refrigerating System. [3]
11. **Refrigerants:** Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics. [3]
12. **Psychrometry:** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer. [7]

13. **Air Conditioning:** Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air-conditioning system; year round air conditioning; unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor; Inside design conditions; comfort conditions; components of cooling loads; internal heat gains; system heat gain: external heat gain; Transport air conditioning. [9]

Outcome(s):

Able to understand basic principles of refrigeration.
Able to understand simple and multiple vapour-compression cycle, gas refrigeration cycles and absorption cycles.
Ability to understand the principles of thermal comfort & ventilation
An ability to use refrigerant property tables and psychrometric chart.

Text Books:

1. Stocker W. F. and Jones J.W., "Refrigeration & Air conditioning", TMH, New Delhi, Latest Edition.
2. Arora C. P., "Refrigeration & Air conditioning", TMH, New Delhi, Latest Edition.

Reference Books:

1. Prasad M, "Refrigeration & Air conditioning", Wiley Eastern limited, New Delhi, Latest Edition.

ME 14.404 **CAD/CAM** **Total Lecture 40**
3-0-0

Prerequisite(s) **Mathematics (Matrix), Machine Design, C programming, Machine tool and Machining**

Objective(s)

- Understand the applications and benefits of CAD
- Understand geometric transformation.
- Understand various representations of curves and surfaces.
- Understand the various concepts and characteristics in geometric modeling.
- Understand the basic concepts of CAM. Analyze the components and systems of NC and CNC machine tools. Understand and apply various programming methods for specific jobs.
- Classify various CAPP systems.
- Understand FMS and CIMS with reference to components, advantages and applications.

1. **Fundamentals of CAD**: Introduction: Design Process: Application of computers in design: Creating manufacturing database: benefits of CAD. Computer Hardware; Graphic input devices; display devices; Graphics output devices; Central processing unit (CPU). CAD software and Database: Software configuration of a graphics system: functions of a graphics package: geometric modeling: Database structure and control; Graphics standard: GKS and IGES. **[4]**

2. **Geometric Transformations**: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrices. Application of geometric transformations. **[8]**

3. **Representation of curves and surfaces**: Polygon, meshed and ruled surfaces: Bezier curves; B-spline curves. **[6]**

4. **Geometric Modeling**: Wireframe model: solid modeling: representation, volumetric properties, surface modeling, concepts of hidden-line removal and shading: Kinematics analysis and simulation. Application of CAD techniques to finite Element Mesh Generation. Computer Aided Manufacturing (CAM) **[9]**

5. **Introduction of CAM**: Basic concepts of manufacturing system and CAD/CAM. NC/CMNC Machine Tools; NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system. **[9]**

6. **Computer Aided Process Planning**: Introduction and benefits of CAPP. Types of CAPP systems, machinability data selection systems in CAPP. **[2]**

7. **FMS and CIMS**: Flexible Manufacturing System (FMS) and Computer integrated manufacturing system: FMS and its advantages, components of a FMS system. Introduction to CIMS. **[2]**

Outcome(s)

- Understand the capabilities of general Computer Aided Designing Systems and CAD Systems for designing mechanical parts and elements in 2D and 3D dimensions.
- Use effectively CAD / CAM systems in order to produce the final NC code for the manufacturing of various mechanical parts and carry out exchange of data between CAD and CAM systems.
- Describe the principles of various manufacturing processes, manufacturing technology.

TEXT BOOKS:

1. Groover M.P., "Automation, Production Systems and Computer-Integrated Manufacturing", PHI, Latest Edition.
2. Zeid Ibrahim, "CAD/CAM : Theory & Practice", Tata Mc Graw Hill Publication, Latest Edition.

REFERENCE BOOKS:

1. Rao P.N., "CAD/CAM : Principle and Applications", Tata McGraw Hill Publication, Latest Edition

ME 14.405 **Total Lectures: 40**

Production Technology III

Pre – requisites: Material Science, Production Technology I **Credit-3-0-0-3**

Objective: *The course should enable the students :*

1. To exposed to fundamental concept of machining processes like grinding, super-finishing, thread and gear manufacturing.
2. To familiar with rapid prototyping.
3. To understand various non conventional manufacturing processes.

1 **Abrasive Machining:** Grinding machines, various grinding operations; Grinding wheels, preparation for wheel operation. Lapping, honing, super finishing. **[7]**

2 **Threads and Gear manufacturing:** Introduction, thread making, thread grinding, thread rolling, Gears types and gear making, machining of gears, gear finishing. **[6]**

3 **Powder Metallurgy:** Introduction, basic process, powder manufacturing, powder mixing and blending, composting, sintering. **[5]**

4 **Rapid prototyping and Micro Manufacturing:** Introduction, role of rapid prototyping & rapid tooling, features and classifications. Micro & Nano manufacturing processes, fabrication of electronics products and IC. **[6]**

5 **Jigs & Fixtures:** introduction, necessity for jigs & fixtures, elements of fixtures, locators, types of locators, clamping, locating principles. **[4]**

6 **Non Traditional Machining:** AJM, WJM, EDM, ECM, USM: working principle, components of set up, field of application, Parameters affecting machining characteristics, Material removal mechanism. **[12]**

Outcome *The students should be able to:*

1. Apply the knowledge of various advance manufacturing processes.
2. Identify various process parameters and their effect on processes.
3. Figure out application of modernization in machining.
4. Get the knowledge of Jigs and Fixtures so as to utilize machine capability for variety of operations

Text Book

1. Lindberg, "Processes and Materials of Manufacture", Prentice hall India (P) Ltd, Latest Edition.
2. Rao P. N, "Manufacturing Technology", TMH, Latest Edition.
3. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Pearson Publications.

Reference Book

1. Degarmo, Black and Kosher, "Material and Processes in Manufacturing", Latest Edition.
2. Kempster M. H. A, "Introduction to Jigs and Fixtures Design", Latest Edition.
3. Ghosh A, "Rapid Prototyping", EWP, Latest Edition.

ME 14.406 Operations Management

Total Lectures: 40

Pre – requisites: Elementary knowledge of calculus

Credit 3-1-0-4

Objective: *The course should enable the students :*

1. To understand the strategic significance of Operation management

2. To impart knowledge on Forecasting, Project management, Inventory, Scheduling & capacity planning with appropriate tools and techniques needed for understanding the operational situation.

1	**Manufacturing System:** Introduction to operation management, Types and characteristics of manufacturing systems.	[3]
2	**Forecasting Technique:** Use and types of forecasting, Methods of forecasting. Regression analysis	[6]
3	**Project Management:** Project management techniques; Introduction to CPM and PERT techniques, network analysis, activities and events, conventions adopted in drawing networks, graphical representation of events and activities.	[5]
4	**Materials Planning and Control:** Field and scope, materials planning; Inventories-types and classification; ABC analysis, economic lot size, EOQ model, leads time and reorder point, inventory control systems. Aggregate planning: definition, aggregate planning methods, Introduction to MRP and MRP-II, Master Production Schedule, Bill of materials.	[12]
5	**Operations Scheduling:** Concepts, loading, scheduling and sequencing, single processor scheduling, flow shop scheduling, job shop scheduling, scheduling criteria; Gantt chart.	[6]
6	**Capacity Planning:** Definition of capacity, capacity planning, capacity requirement planning, Capacity available and required.	[4]
7	**JIT & ERP:** Introduction to the new manufacturing concepts; JIT, lean manufacturing, pull and push systems of production; Kanban system. Introduction to ERP.	[4]

Outcome *The students should be able to:*

1. Understand and recognize key issues and problems in Operations Management.

2. Develop an understanding of how Operations Management functions relate to overall organization strategy, effectiveness and performance.

Text Book

1. Monks, J. G, "Operations Management", TMH, Latest Edition.
2. Russel Taylor, "Operations Management"**,** Wiley India.
3. Adam & Ebert, "Productions & Operations Management", PHI, Latest Edition.

Reference Book

1. Buffa W, "Modern Production/Operations Management", Eastern Ltd, Latest Edition.
2. Chary S.N, "Production and Operations Management", TMH, Latest Edition.

ME 14.407 **Industrial Engineering & Operation Research** **Total Lectures: 40**

Pre – requisites: Knowledge of linear algebra and basic mathematical concepts **Credit-3-0-0-3**

Objective: *The course should enable the students :*

1. To understand Concept of Industrial Engineering
2. To learn various Industrial Engineering techniques
3. To understand and apply operations research techniques to industrial applications
4. To understand Linear Programming concepts
5. To understand sequencing game theory

1 **Introduction to Industrial Engineering:** Relevance & importance of industrial engineering in industry. Productivity Management*:* Productivity measurement and improvement. [3]

2 **Plant Layout & Material Handling***:* Factors affecting plant location, Selection of plant site, Quantitative techniques of plant location decision, Plant layout, Types of layout Principles of layout design, Methods for evaluation of a layout, Quantitative techniques of developing layouts, Manual assembly lines, line balancing problems way to improve line balancing. Group Technology, parts family, parts classification and coding, production flow analysis. Introduction to material handling. [12]

3 **Work study & Ergonomics:** Method study, micro - motion study and principles of motion economy. Work measurement: time study, work sampling, standard data, PMTS. Introduction to ergonomics and its scope in relation to work. [7]

4 **Linear Programming**: Introduction to Operation Research, Problem formulation, Simplex methods, primal & dual problem, dual Simplex, sensitivity analysis. Transportation, & Assignment problems, Dynamic Programming. [12]

5 **Decision & Queuing Theory:** Decision under various conditions. Game Theory, Minimax & Maximin strategies. Introduction to Queuing Models. [6]

Outcome: *The students should be able to:*

1. Understand Concept of Industrial engineering and its role in industry.
2. Be good team member and project leaders to carry out projects in companies.
3. Build and solve Linear programming, Transportation models and assignment models.
4. Develop critical thinking and objective analysis decision making.

Text Books:

1. Khanna O P, "Industrial Engineering and Management", Dhanpat Rai Publications, Latest Edition.
2. Monks J. G, "Production/Operations Management", McGraw Hill, Latest Edition.

3. Taha H. A, “Operations Research – An Introduction”, Prentice Hall India, Latest Edition

Reference Books:

1. Chitale A. K & Gupta R. C, “Product Design and Manufacturing”, McGraw Hill Latest Edition.
2. Sanders M. and Mc Cormic, E., “Human Factors in Engineering”, McGraw Hill, Latest Edition.
3. Work Study, ILO, Geneva, Latest Edition.
4. Curie R, “Introduction to Work Study”, McGraw Hill, Latest Edition.
5. Philips R & Solberg, “Operations Research”, John Wiley, Latest Edition.
6. J K Sharma, Operations Research, Macmillan, 1997

ME 14.415 **Mechatronics** **Total Lecture 40**

Credit 3-1-0-4

Prerequisite(s) EC 14.101

Objective(s)

- *To study the definition and elements of mechatronics system.*
- *To learn how to apply the principles of mechatronics for the development of productive and efficient manufacturing systems.*
- *To study the hydraulic and pneumatic systems employed in manufacturing industry.*

1. **Introduction**: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. **[5]**

2. Review of fundamentals of electronics. Data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs. **[9]**

3. **Drives:** stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer **[6]**

4. **Hydraulic systems**: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. **[8]**

5. **Pneumatics:** production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description **[6]**

6. Description of PID controllers. CNC machines and part programming. Industrial Robotics. **[6]**

Outcome(s)

- *Be able to analyze and design mechatronics system used for automstion.*
- *Demonstrate knowledge on basic electronics used in manufacturing systems.*
- *Be able to design hydraulic systems for automating manufacturing systems.*
- *Be able to design pneumatic systems for automating manufacturing systems.*

Text Books:

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. J. Musa, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012.

Reference Books:

1. G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile and industrial applications, SAE, 1994.
2. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.
3. R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005

ME 14.419 **Non Convectional Energy Resources** **Total Lectures: 40**

Credit: 3-1-0

Prerequisite(s): Nil

Objective(s):

- *To familiarize students with the various renewable energy sources.*
- *Awareness of the potential of renewable energy technologies, for sustainability in particular.*
- *Suitable applications of solar, wind, biomass, hydro, geothermal and ocean energy.*
- *Awareness and development of suitable social and economic models with implications.*

1. **Energy Scenario**
   Energy resources in India and worldwide, energy needs and consumption patterns, social and economic implications, global environmental impact, Kyoto protocol, salient features of renewable energy technologies, pollution control and sustainability, Indian govt. policies and Supreme Court directive on renewable energy, subsidies, incentives and other financial implications, ROI., energy audit, energy optimization, green buildings. **10**

2. **Solar Energy Applications**
   Solar thermal systems: Domestic and industrial water heating, green houses, concentrated solar power (CSP), solar refrigeration and air conditioning, solar appliances- cookers, dryers, desalination of water, turbines.
   Solar photovoltaic systems (PV): Solar cell fundamentals, classification, comparison of silicon, thin film, Building Integrated photovoltaic (BIPV) panel technologies, stand alone and grid – integrated systems including storage and other components, economics. **10**

3. **Wind Energy**
   Fundamentals of wind energy, wind power systems- turbines, site selection and economics. grid connected operation, comparison with other renewable systems. **10**

4. **Other Energy Sources**
   Biomass-Conversions and energy content, mini hydro power plant, advantages and economics, geothermal, ocean tidal, wave and thermal energy, fuel cells, hybrid Systems, energy storage, emerging technologies. **10**

Outcome(s):

- *Identify appropriate renewable technology for application.*
- *Assess the economics and ROI.*
- *Implement concepts of clean development mechanism (CDM) and carbon credits.*
- *Utilize energy management and renewable energy systems in everyday life.*
- *Select ecofriendly, cost effective, energy efficient alternatives to unsustainable practices.*

Text Books:

1. B.H. Khan, "Non-Conventional Energy Resources", Tata McGraw-Hill, Latest Edition.
2. G. D. Rai, "Non-Conventional Energy Sources", Khanna Publication, First Edition

Reference Books:

1. M. M. El-Wakil, "Power Plant Technology", McGraw-Hill, Latest Edition.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

B.Tech CSE

CS-14.101 **Programming Language** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To learn principles of programming by the structured native language 'C'.
- To comprehend the rudiments, constructs, syntax, and statements with essentials of efficient compiling, running and debugging processes.

1. **Introduction:** The role of programming languages, programming paradigms, language description and syntax structure, basics of structured programming, object-oriented programming, functional programming, logic programming, concurrent programming. [10]

2. **Fundamentals of 'C' language** : Character set, variables data types constants, arithmetic,relational and logical operators, type conversion,increment,decrement, bitwise and assignment operators, conditional expressions, statements and blocks, *if-else*,*switch*, loops-*do-while*, *while*, *for*; *break*, *continue* and *goto* statements, labels. [10]

3. **Functions, pointers and Arrays**: Basics of functions, automatic, external, static and register variables, scope rules, and header files, recursion and C preprocessor, arrays, pointers and addresses, pointers and arrays address arithmetic, character pointers and functions, pointer arrays, pointers to functions, pointers and multidimensional arrays, command line arguments. [10]

4. **Structures, unions and file processing:** Basics of structures, structures, and functions, arrays of structures, pointers to structures, self-referential structures, unions, bit fields, theconcept of files, standard input and output, formatted output, file access in different modes, reading from and writing to a file. [10]

Outcome(s):

- Students would be able to apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner.

Text Books:

1.Brain W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second edition, Pearson Education, 2013,

2.Ravi Sethi&K.V.Viswanatha, Programming Languages-Concepts, and Constructs, Second edition, Pearson Education,2013,

Reference Books:

1.Herbert Schildt, C: The Complete Reference, Fourth Edition, McGraw-Hill Education, 2017

2.E Balagurusamy, Programming in ANSI C, Tata McGraw - Hill Education,6th edition,2012

CS-14.201 **Discrete Structures** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): None

Objective(s):
- To Introduce fundamental concepts and applications of discrete structure in the field of computer science

1.	**Sets, Relations and Functions**: Set theory, combination of sets, multi-sets, ordered pairs, set identities, relations, operations on relations, properties of relations, composite relations, equality of relations, order of relations, functions, classification of functions, operations on functions, recursively defined functions.	[8]
2.	**Partially Ordered Sets:** Definition, combination of partial order sets, Hasse diagram, lattices: definition, properties of lattices: bounded, complemented, modular and complete lattice, morphisms of lattices.	[6]
3.	**Algebraic Structures:** Groups, subgroups and order, cyclic groups, cosets, Lagrange's theorem, normal subgroups, permutation and symmetric groups, group homomorphisms, rings, fields, integers modulo n.	[6]
4.	**Propositional Logic:** Proposition, well formed formula, truth tables, tautology, satisfiability, contradiction, algebra of proposition, theory of inference, natural deduction, predicate logic: first order predicate, well formed formula of predicate, quantifiers, and inference theory of predicate logic.	[7]
5.	**Counting:** Basic principles, permutations, combinations, summations, principle of inclusion and exclusion, pigeon-hole principle, generating functions and recurrence relations.	[6]
6.	**Graph Theory:** Graphs, isomorphic and homomorphic graphs, subgraphs, Eulerian chains and cycles, Hamiltonian chains and cycles, graph traversal algorithms, chromatic number, plannar graph.	[7]

Outcome(s): On the successful completion of the course, the student will be able to:
- Understand the theory and techniques of logic, graphs and trees, and algebraic systems.
- Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.

Text Books:
1. Bernard Kolman, Robert C., Busb Sharon, Cutler Ross, Discrete Mathematical Structures, PHI, 6th Edition, 2009.
2. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw- Hill, 7th Edition, 2011.

Reference Books:
1. Swapan Kumar Chakraborty, BikashKanti Sarkar, Discrete Mathematics, Oxford Higher Education, 2011
2. C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, Tata Mcgraw-Hill, 3rd Edition, 2008.

CS-14.202 **Java Programming** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 14.101 (Programming Language)

Objective(s): The objective of this course is to:

- cover issues related to the definition, creation and usage of classes, objects and methods.
- discuss the principles of inheritance and polymorphism.
- provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- cover the basics of API and to explore the java abstract programming interface.

1.	**Overview:** Introduction to Java, importance of Java, interactive Development Environments: Eclipse/Net Beans, basics of OOP.	[4]
2.	**Data Types, Variable, and Arrays:** Primitive data types, type casting, arrays, operators and control structures, identifiers, constants and literals.	[6]
3.	**Classes and Objects:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, this keyword, garbage collection, the finalize() method, overloading methods, using objects as parameters and return type, introducing access control, understanding static, introducing final, introducing nested and inner classes, exploring the string class, using command-line arguments.	[9]
4.	**Inheritance:** Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final in inheritance, the object class.	[4]
5.	**Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, JAVA's built-in exceptions, user defined exception.	[6]
6.	**Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managing threads, thread class built-in functions.	[4]
7.	**I/O and String Handling:** I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer.	[7]

Outcome(s): Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifies, automatic documentation through comments, error exception handling).
- Use of development environment like Eclipse for collaborative programming

Text Books:

1. Herbert Schildt, Java The Complete Reference, Herbert Schildt, 8th Edition, 2011.
2. John Jukowski, Mastering Java, 2002.

Reference Books:

1.Allen B. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
2. Paul Deitel, Harvey Deitel , Java How To Program (Early Objects), 10th Edition, 2014.

CS -14.203 **Data Structures** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1.	**Introduction:** Basic terminology, elementary data organization, algorithm, efficiency of an algorithm, time and space complexity, asymptotic notations, time-space trade- off, abstract data types.	[4]
2.	**Array:** Definition, single and multidimensional arrays, representation of arrays: row major order, and column major order, application of arrays, sparse matrices and their representations.	[4]
3.	**Searching & Sorting:** Sequential search, binary search, comparison and analysis, hash function, collision resolution strategies, insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort.	[6]
4.	**Linked list:** Singly linked lists, doubly linked list, circular linked list, insertion, deletion, traversal, polynomial representation and addition, generalized linked list.	[6]
5.	**Stack:** Primitive stack operations: push and pop array and linked list implementation of stack, application of stack: prefix and postfix expressions, evaluation of postfix expression, recursion, and tower of Hanoi problem.	[4]
6.	**Queue:** Queue operations, circular queues, array and linked list implementation of queues, dequeue and priority queue	[4]
7.	**Tree:** Binary trees, binary tree representation, tree traversal algorithms: inorder, preorder and postorder, threaded binary trees, Huffman algorithm, binary search trees AVL trees.	[6]
8.	**Graph:** Terminology, sequential and linked representations of graphs: adjacency matrices, adjacency list, adjacency multi list, graph traversal: depth first search and breadth first search, spanning trees.	[6]

Outcome(s): On the successful completion of the course, the student will be able to:

- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:

1. Lipschutz, "Data Structures" Schaum's Outline Series, TMH, Revised Edition Feb. 2014

Reference Books:

1.Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI, 2nd Edition, 2012.

2. Horowitz and Sahani, Fundamentals of Data Structures, University Press, 2nd Edition2008.

3. Jean Paul Trembley and Paul G. Sorenson, An Introduction to Data Structures with applications, McGraw Hill, 2nd Edition, 2003.

4. G. A. V. Pai, Data Structures and Algorithms, TMH, 2008

CS-14.204 **Database Management Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS 14.207(Computer Information System), CS14.203 (Data Structures).

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS & RDBMS in the organization.

1.	**Introduction:** Databases and database users, database system concepts and architecture, data modeling using the entity-relationship (ER) model, enhanced entity relationship model.	[7]
2.	**Relational Data Model:** Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model.	[7]
3.	**Structured Query Language (SQL)**: SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views.	[4]
4.	**Database Design:** Functional dependencies and normalization of relational databases, first normal form (1NF), 2nf, 3nf, boyce-codd normal form (BCNF), multi valued dependency, 4NF, join dependency, 5NF.	[8]
5.	**Transaction Processing:** Introduction, properties, recoverability, serializability, concurrency control techniques: two phase locking protocol, concurrency control based on time-stamp ordering, database recovery techniques: recovery concepts, recovery techniques based on deferred and immediate update, the ARIES recovery algorithm.	[7]
6.	**Object and Object-Relational Databases:** Concepts for object databases, object database standards and design, object relational and extended relational systems.	[7]

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.

Text Books:

1. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Management Systems, Edition, Pearson Education, 2013.

2. Raghu Ramakrishnan, Database Management Systems, 3rd Edition, Tata McGraw Hill, 2008.

Reference Books:

1. G.W. Hansen, and J.V. Hansen, Database Management and Design, 2nd Edition, Prentice Hall India, 2000.

2. Korth and Schilberschatz, Database System Concepts, 5th Edition, Tata McGraw Hill, 2006.

3. C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CS -14.205 **C++ Programming** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To get a basic knowledge of object-oriented concepts.
- To master in programming related to classes inheritance using C++.

1.	**Object Oriented Programming:** Basic concepts of object-oriented programming, Structured versus object oriented programming, merits and demerits of object oriented methodology.	[5]
2.	**Beginning With C++:** Preprocessor directives, Variables, data types, constants, operators, scope resolution operator, memory management operators, decision and loop controls, arrays, strings, functions	[5]
3.	**Classes And Objects:** Class definition, Structure versus class, accessing member functions within a class, data hiding, arrays within a class, static data and member functions, objects, friend functions and friend classes, constant member functions, pointers to members, constructors and destructor	[7]
4.	**Overloading and Exception Handling:** Definition, unary operator overloading, binary operators overloading, overloading of new and delete operators, manipulation of string using operators, type conversion, overloading with friend functions, function overloading, error and exception handling	[8]
5.	**Inheritance and Overriding:** Derived and base classes, type of inheritance, Derived class constructors and destructor, overriding member functions, public and private inheritance, virtual base classes, abstract classes, this pointer, virtual functions and pure virtual functions, static and dynamic bindings	[8]
6.	**I/O Streams and The Standard Library:** Header files, I/O stream library, stream I/O for objects, File I/O.	[4]
7.	**Templates:** Class templates, function templates, overloaded function templates, member function templates.	[3]

Outcome(s): On the successful completion of the course, the student will be able to:

- To gain the basic knowledge on object oriented concepts.
- To understand the role of inheritance, polymorphism, dynamic binding and generic structures in building reusable code.
- To implement features of object oriented programming to solve real world problems.

Text Books:

1. Herbert Schildt, "C++: The Complete Reference "4th edition, TMH July 2017.
2. Robert Lafore, "Object-Oriented Programming in C++", 4th edition, SAMS.

Reference Books:

1. Bjarne Stroustrup,"Programming-Principles and Practice Using C++", Addison-Wesley,4th Edition 2013
2. E. Balagurusamy,"Object Oriented Programming With C++",5th edition 2011, TMH

CS -14.206 **Theory of Computation** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): CS 14.201(Discrete Structures)

Objective(s): The goal of this course is to

- Provide students with an understanding of basic concepts in the theory of computation.
- To understand variety of issues in the mathematical development of computer science theory, particularly finite representations for languages and machines, as well as gain a more formal understanding of algorithms and procedures.

1. **Finite Automata and Regular Expression:** Finite state systems, basic definitions, regular languages and regular expression, finite automata ,Equivalence of DFA and NDFA , Kleen's theorem, pumping lemma for regular sets, regular expression with algebraic method Using Arden's Theorem, closure properties of regular sets, minimization of finite automata, Mealy and Moore machine - conversion of Mealy machine into Moore machine and vice versa. [11]
2. **Context-Free Grammars:** Context-free grammars, union, concatenation of CFG, derivation trees, simplification of context-free grammars, Chomsky normal form, Greibach Normal form, ambiguous context-free grammar. [9]
3. **Context-Free Languages and Pushdown Automata:** Pushdown automata and context-free languages, pumping lemma for CFL, closure properties of CFL, decision, algorithms for CFL. [8]
4. **Turing Machine:** Turing machine model, techniques for Turing machine construction, Turing machines as language acceptor, combining Turing machines, properties of recursive and recursively enumerable languages, universal Turing machine. [8]
5. **Chomsky Hierarchy of Languages:** Regular grammars, unrestricted grammars and Turing machines, context-sensitive grammars and linear bounded automata. [4]

Outcome(s):

- Be able to prove the equivalence of languages described by finite state machines and regular expressions.
- Be able to construct pushdown automata and the equivalent context free grammars.
- Be able to prove the equivalence of languages described by pushdown automata and context free grammars.
- Be able to construct Turing machines and Post machines.
- Be able to prove the equivalence of languages described by Turing machines and Post Machines.

Text Books:

1. Peter Linz, An Introduction to Formal Languages and Automata, Third Edition, Jones and Bartlett, 2001.
2. Hopcroft, Motwani, Ullmann, Introduction to Automata Theory, Languages and Computation, Pearson Education, Second Edition, 2005.

Reference Books:

1. Daniel I. A. Cohen, Introduction to Computer Theory, Prentice-Hall, Second Edition,1997.
2. Martin, Introduction to Languages and the theory of Computation, Tata McgrawHill, Third Edition, 2006

CS-14.207 **Computer Information Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): None

Objective(s):

- To give essential knowledge about computer information system and its components

1.	**Introduction:** Evolution of computers, generation of computers, classification of computers, block diagram of digital computers, memory unit, ALU,CPU, I/O devices, basic bus architecture, software classification, machine language, assembly languages and high level languages, assembler, compilers and interpreters, process of compilation, programming language generations, introduction to operating systems and role of the operating system.	[8]
2.	**Digital Logic:** Introduction to Boolean algebra and logic gates, K-map representation and Boolean function simplification, number systems: conversion from one number system to another, binary operations, complement representation of numbers, alphanumeric codes, floating point representation of numbers, floating point arithmetic operations.	[6]
3.	**Digital Circuit Building Blocks:** Adders, subtractors, comparators, encoders, decoders, multiplexers, de-multiplexers, latches, flip-flops, master slave flip flops, shift registers and counters.	[10]
4.	**Internet Technologies**: Introduction to computer networks, Internet, WWW and E-mail, web browsers, introduction to LAN,MAN, WAN, introduction to the design of web pages, HTML tags and CSS, web servers, server scripting, XML.	[8]
5.	**Software Development:** a systematic approach to program design, coding, testing, and debugging, application of these skills to the construction of robust programs, use of programming environments and tools to aid in the software development process.	[6]
6.	**Computers and Society**: Impact of computers in social life, education, business, issues of security and privacy, computer ethics.	[2]

Outcome(s):

- On successful completion of this course, students will be able to take specialized courses with strong fundamentals of Computer Information Systems.

Text Books:

1. P.K. Sinha, Computer Fundamentals, BPB Publications, 6th Edition, 2017
2. M. Morris Mano, Digital Logic & Computer Design, Pearson, 2nd Edition, 2010
3. Roger S. Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill Higher Education, 8th Edition, 2014
4. Thomas Powell, HTML and CSS: The Complete Reference, Tata McGraw-Hill, 5th Edition, 2010

Reference Books:

1. Andrew S.Tanenbaum, Computer Networks, Pearson Education, 5th Edition, 2013
2. Rajaraman, Fundamentals of Computers, PHI, 6th Edition, 2014

CS-14.232 **Computer Organization and Architecture** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS-14.207 (Computer Information System)

Objective(s):

- To have a thorough understanding of the basic structure and operation of a digital computer.
- To discuss in detail the operation of the arithmetic unit including the algorithms &
- implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
- To study the different ways of communicating with I/O devices and standard I/O interfaces. To study the hierarchical memory system including cache memories and virtual memory.

1.	**Introduction:** Von-Neuman architecture, register transfer and micro operations: register transfer language, arithmetic micro-operations, logic micro-operations, shift micro- operations, bus and memory transfers, computer organization and design: instruction cycle, computer registers, common bus system, computer instructions, addressing modes, design of a basic computer.	[8]
2.	**Central Processing Unit:** General register organization, stack organization, instruction formats, data transfer and manipulation, program control, RISC, CISC characteristics, pipeline and vector processing: pipeline structure, speedup, efficiency, throughput and bottlenecks, arithmetic pipeline and instruction pipeline	[8]
3.	**Computer Arithmetic:** Hardware implementation of addition and subtraction, multiplication algorithms, Booths multiplier, array multiplier, division algorithms, floating point arithmetic: floating point representation, add, subtract, multiplication, division.	[8]
4.	**Memory & I/O Organization:** Memory hierarchy, RAM, ROM chips, memory address map, memory connection, associative memory, cache memory and virtual memory: paging and segmentation, auxiliary memory: magnetic disks, magnetic tapes, Input-output interface, Asynchronous data transfer, modes of transfer, priority interrupt, DMA, IOP.	[8]
5.	**Hardwired and Microprogrammed Control:** Hardwired control, microprogrammed control: microinstruction, microprogram sequencing, wide-branch addressing, microinstruction with next-address field, prefetching microinstruction.	[6]
6.	**Advance Topics:** Case study on Pentium series processors.	[2]

Outcome(s): On the successful completion of the course, the student will be able to:

- Understand basic structure of a digital computer.
- Perform arithmetic operations of binary number system.
- Know the organization of the control unit, arithmetic and logical unit, memory unit and the
- I/Ounit.

Text Books:

1. M. Morris Mano, Computer System Architecture, Pearson Education, 3rd edition, 2008.
2. Carl Hamacher, ZvonkoVranesic and SafwatZaky, Computer Organization, Tata McGraw Hill, 5th edition, 2002.

Reference Books:

1. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/ Software interface, Elsevier, 3rd edition, 2005.
2. William Stallings, Computer Organization and Architecture – Designing for Performance, Pearson Education, 6th edition, 2000.
3. John P. Hayes, Computer Architecture and Organization, Tata McGraw Hill,3rd edition,1998.

CS-14.301 **Design and Analysis of Algorithms** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): CS-14.201(Discrete Structures), CS-14.203(Data Structures)

Objective(s):
- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms power.

1.	**Introduction:** Fundamentals of algorithms and problem solving, asymptotic notations, time complexity and analysis of algorithms, solutions of recurrence relations, master theorem and summations techniques.	[8]
2.	**Analysis of Sorting and Searching Algorithms:** Linear, binary and interpolation search, insertion, selection, merge, quick and heap sort, stability and other issues, hashing.	[8]
3.	**Algorithm Design Approaches:** Greedy method (knapsack problem, job sequencing problem), dynamic programming (assembly line scheduling, matrix chain multiplication), backtracking (8 queens problem, sum of subsets), branch and bound (0/1 knapsack problem), divide and conquer algorithms (Strassen matrix multiplication), problems based on these design paradigms.	[8]
4.	**Tree and Graph algorithms:** Spanning trees, Prim and Kruskal's algorithm, Huffman coding, BFS and DFS, disjoint set operations, connected components, shortest path algorithms in a graph such as Dijkstra, Bellman Ford, Warshall's etc.	[8]
5.	**Complexity Classes:** P,NP,NP hard and NP complete problems, reducibility, decision and optimization problems, examples of NP complete problems such as 3 CNF, clique, vertex cover and traveling salesman problem, basic introduction of approximation algorithms.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:
- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.
- Modify existing algorithms to improve efficiency.

Text Books:
3. Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, PHI Learning Private Limited, 3rd edition, 2016.
4. Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, Computer Algorithms, Silicon Press, 2nd edition, 2008.

Reference Books:
3. Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 3rd edition, 2012.
4. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, 1st edition, 2006.
5. Donald E. Knuth, The Art of Computer Programming, Volumes 1& 3, Pearson Education, 2009.
6. Steven S. Skiena, The Algorithm Design Manual, Springer, 2nd edition, 2008.

CS-14.303 **Operating System** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.207 (Computer Information System)

Objective(s):

- Understand the fundamental operating system abstractions like processes, threads, files, semaphores, IPC and deadlocks.
- Understand operating system from user's perspective as well as from system's perspective.
- Understand the principles of concurrency and synchronization.
- Understand basic resource management techniques.
- Understand different theoretical principles in depth through hands on high level programming.

1.	**Overview:** Definition, types of operating systems: mainframe, server, multiprocessor, personal computer, real-time, embedded and smart card, system calls and utilities, batch, multiprogramming and multitasking operating system.	[3]
2.	**File Systems:** File concept, user and system programmer view of file systems, different modules of a file system, disk structure, disk-space allocation methods: contiguous, linked, indexed directory structures, file protection, disk scheduling algorithms.	[6]
3.	**Process Management:** Process concepts, threads, scheduling concepts, types of schedulers, scheduling algorithms, process state diagram, comparison of various CPU scheduling algorithms, multi-level queue scheduling.	[6]
4.	**Memory Management:** Logical and physical address spaces, base, limit and relocation registers, address binding, dynamic loading and linking, partitioning, swapping, contiguous memory allocation, non-contiguous memory allocation: segmentation, paging and segmentation.	[8]
5.	**Process Synchronization and deadlock:** Independent and concurrent processes, shared memory approach and message passing approach, mutual exclusion, synchronization, inter process communication, critical section problem and its solution to semaphores: binary and counting semaphores, wait/signal operations and their implementation, classical problems of synchronization, deadlock.	[11]
6.	**Case Studies:** Windows, UNIX and Linux: scheduling and memory management.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Analyze the primary functionalities of operating system.
- Manage system resources efficiently as an operating system designer.
- Develop new operating systems as well as work on existing ones to develop them further.

Text Books:

1. Galvin, Silberschatz, Gagne, Operating System Concepts, Wiley India, 9th edition, 2015.

Reference Books:

1. Andrew S. Tanenbaum, Modern Operating Systems - Prentice-Hall, Inc., 4th edition, 2015.
2. Deitel, Operating Systems, Pearson Education , 3rd edition, (2012 reprint).
3. **Stallings, Operating Systems: Internals and Design Principles, Pearson education, 7th edition 2013.**

CS-14.305 **Logic in Computer Science** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.201(Discrete Structures), CS-14.207(Computer Information Systems)

Objective(s):

- To introduce the main notions of mathematical logic: logical notations (syntax) and how to assign meaning to them (semantics).
- To study formal frameworks (in the sense of being rigorous as well as in the sense of manipulating "form") for constructing logical arguments (proof theory).
- To study some deductive systems for propositional and first-order logic.
- To introduce the concept of fuzzy logic.

1.	**Introduction:** Role of logic in computer science, problem representation, review of the principle of mathematical induction, the principle of structural induction, review of Boolean algebra, language, models, interpretations, validity, proof, decision problems in logic, decidability.	[6]
2.	**Propositional Logic:** Syntax, semantics, logical and algebraic concepts, identities and normal forms, tautology checking, propositional satisfiability, propositional resolution and tableaux method.	[10]
3.	**First Order Predicate Logic:** Quantifiers, first order models, validity and satisfiability, forward and backward chaining, Skolmization, normal forms, unification, Horn formulas and programs, resolution and tableaux.	[12]
4.	**Binary Decision Diagrams:** Representing Boolean functions, algorithms for ordered reduced binary decision diagram (OBDD), geometric templates from spatial relations, image based rendering, symbolic model checking, relational Mu-calculus, coding CTL models and specification.	[8]
5.	**Fuzzy Logic:** Classic sets, fuzzy sets and membership, fuzzy set operations, Cartesian product, operations and properties of crisp relationship, operations and properties of fuzzy relationship.	[4]

Outcome(s): On successful completion of this course, the students will be able to

- Use propositional and first-order logic.
- Apply of logic in specifying properties.
- Develop proof by induction.
- Design binary decision diagrams.
- Identify the scope for fuzzy logic.

Text Books:

3. Huth M and Ryan M, Logic in Computer Science: Modelling and Reasoning about Systems, Cambridge University Press, 2nd edition, 2004.
4. Enderton H B, A Mathematical Introduction to Logic, Academic Press, 2nd edition, 2001.

Reference Books:

5. Arindama Singh, Logics for Computer Science, Prentice Hall of India, 1st edition, 2004.
6. M. Ben-Ari, Mathematical Logic for Computer Science, Springer, 2nd edition, 2003.
7. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 3rd edition, 2009.
8. C. L. Chang and R. C. T. Lee, Symbolic Logic and Mechanical Theorem Proving, Academic Press, 1st edition, 1973.

CS 14.309 **Microprocessor and Assembly Language Programming** **Total Lectures: 40**
Credit: 3-0-0 -3

Prerequisite(s): CS 14.207 (Computer Information System)

Objective(s):
- To study architecture and memory management of 8-bit and 16-bit microprocessor (8085 & 8086)
- To study assembly language programming and use it to solve various problems.

1.	**Introduction:** Evolution of Microprocessor and its types, 8085 microprocessor architecture, buses, registers, flags, 8085 pin configuration & function.	[6]
2.	**8085 Instruction Set:** Addressing modes of 8085, 8085 instruction set, data transfer arithmetic, logical and branch instructions, 8085 interrupt structure, limitations of 8085 microprocessor.	[8]
3.	**Interfacing:** Memory mapped I/O, I/O mapped I/O, address decoding, interfacing of memory with 8085, interfacing of I/O with 8085.	[8]
4.	**Advance Microprocessors:** 8086 microprocessor architecture, 8086 pin configuration & function, addressing modes of 8086, instruction set of 8086, 8086 interrupts, study of advance processors of the family (8088, 80286, 80386, 80486 and Pentium).	[10]
5.	**Assembly Language Programming:** Introduction, assembler directives, looping, condition and jump, subroutines, procedures, macros, parameter passing.	[8]

Outcome(s): On successful completion of this course, students will be able to:
- Draw block diagram of 8085/86 processor and know the pin function
- Know the instruction set and addressing modes
- Write the assembly language program for different problems and know the use of procedures and macros.
- Design interface of memory chips.

Text Books:

3. **Gaonkar R. S., "Microprocessor Architecture, Programming and Applications", 6th Ed., Penram International, 2013.**
4. **Hall D. V.,SSSP Rao, "Microprocessors and its Interfacing (SIE)", 3rd Ed., Tata McGraw-Hill Publishing Company Limited, 2012.**

Reference Books:

5. Stewart J, "**Microprocessor Systems- Hardware, Software and Programming", Prentice Hall International Edition, 1990.**
6. Short K. L., "Microprocessors and Programmed Logic", 2nd Ed., Pearson Education, 2008
7. Ray, A.K. and Bhurchandi, K.M., "Advanced Microprocessor and Peripherals Architecture, Programming and Interfacing", Tata Mc-Graw Hill, 2006
8. Chhabra, "The Intel 8086/8088 microprocessor architecture programming design & interfacing", Dhanpat Rai Publication

CS 14.315 **Python Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language (CS 14.101)

Objective(s): Python is a general-purpose, versatile and popular programming language. It's great as a first language because it is concise and easy to read, and it is also a good language to have in any programmer's stack as it can be used for everything from web development to software development and scientific applications.

1.	**Introduction**: The basic elements of python, python syntax, compiled vs interpreted languages, formal and natural languages, built in python types, python as a calculator, basic input, branching programs, control structures, strings, tuples, lists and input iteration.	[6]
2.	**Functions and Abstraction**: Functions and scoping flow of execution, specifications, recursion, global variables, modules, stack diagrams, files, system functions and parameters, input and output, making your own module.	[7]
3.	**Structured Types and Higher-Order Functions**: Mutability strings, tuples, lists and dictionaries, lists and mutability, functions as Objects.	[5]
4.	**Classes and Object-Oriented Programming and Data Structure**: Abstract data types and classes, inheritance, encapsulation and information hiding, simple algorithms and data structures, list, tuple, sequence, set, search algorithms, sorting algorithms, hash tables.	[8]
5.	**Testing and Debugging**: Exceptions and assertions, types of testing – black-box and glass-box, debugging, handling exceptions, assertions.	[6]
6.	**Advance Python:** Regular expressions – REs and Python, plotting using PyLab, networking and Multithreaded Programming – sockets, threads and processes, chat Application, security – encryption and decryption, classical cyphers, graphics and GUI programming – drawing using Turtle, Tkinter and Python, Other GUIs.	[8]

Outcome(s): Upon completion of this course students will be

- Familiar with Python syntax.
- Able to use python to implement a given logic.

Text Books:

3. John V Guttag, Introduction to Computation and Programming using Python, Prentice Hall of India, 2nd Edition, 2013.
4. Swaroop C H. , A Byte of Python, URL: https://python.swaroopch.com

Reference Books:

4. Zed A. Shaw ,Learn Python the hard way: a very simple introduction to the terrifyingly beautiful world of computers and code, Third edition, 2014.
5. Richard L. Halterman,Learning to Program with python, 2011.
6. Allen Downey ,Think Python How to Think Like a Computer Scientist, Version 2.0.17, Green Tea Press Needham, Massachusetts,2012.

CS-14.316 **Computer Graphics** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.101 (Programming Languages), MA-14.101 Mathematics I

Objective(s):

- To introduce the students with the graphics mode, with the help of basic algorithms and methodologies.
- The objective of the course is to equip students with fundamental knowledge and basic technical competence in the field of computer graphics.
- Provide an understanding of how a computer draws the fundamental graphics primitives.
- To learn Computer Graphics methodologies/Algorithms and techniques and their implementations.

1. **Introduction to Computer Graphics and graphics primitives**: Overview of interactive graphics model, applications of computer graphics, graphics devices, random and raster scan systems, color models: RGB, YIQ, scan conversion: point, line, circle and ellipse. [7]
2. **2D Transformation and Viewing**: Basic transformations (translation, rotation, scaling), homogeneous coordinates, composite transformations, reflection and shearing, filling: scan line filling, flood filling, boundary filling, clipping: point clipping, line clipping, polygon clipping, and character generation. [7]
3. **Curves and Surfaces**: Introduction to curves, conic curves, polygon surfaces, tables, quadric surfaces, spline representation, cubic spline interpolation methods, Bezier curves and surfaces, B-spline curves and surfaces, fractals and its applications. [7]
4. **3D Transformation and Viewing**: 3D transformation, composite transformation, viewing pipeline, parallel and perspective projection, visible surface detection: classification of visible surface detection algorithms, back face detection, depth buffer method, A-buffer method, scan-line method, depth sorting method. [7]
5. **Illumination Model and Surface Rendering Techniques**: Basic illumination models, Halftone patterns and dithering techniques, polygon rendering methods, ray tracing methods. [6]
6. **Introduction to Animation and Multimedia:** Introduction to animation, key-frame animation, construction of an animation sequence, animation techniques, multimedia: introduction, features of multimedia system, components of multimedia systems and application of multimedia systems. [6]

Outcome(s): On successful completion of this course, students will be able to

- Understand basic concepts of computer graphics.
- Acquire knowledge about drawing basic shapes such as lines, circle ellipse, polygon.
- Perform processing of basic shapes by various processing algorithms /techniques.
- Implement two and three dimensional transformations.
- Apply various algorithms of clipping.
- Acquire knowledge about illumination models, color models and surface rendering.

Text Books:

3. Donald D. Hearn & M. Pauline Baker, Computer Graphics-C Version, Pearson Education, 2nd edition, 2002.
4. James D. Foley, Andries van Dam, Steven K Feiner, John F. Hughes, Computer Graphics Principles and Practice, 2nd Edition in C, Addison Wesley, 1995.

Reference Books:

3. Donald Hearn and M Pauline Baker, Computer Graphics with OpenGL, Pearson Education, 4th edition, 2010.
4. David F. Rogers, Procedural Elements for Computer Graphics, Tata McGraw Hill Publications, 2nd edition, 2001.

CS-14.317 **Advance Web Technology** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.207 (Computer Information System)

Objective(s):

- To learn the platform neutral fundamentals of secure, dynamic web application development.
- To learn how to implement a web application using one specific set of open source server side tools: PHP and MySQL.

1. **Introduction:** HTTP protocol : request and response, web browser and web servers, concepts of effective web design, web design issues including browser, bandwidth and cache, display resolution, look and feel of the website, page layout and linking, user centric design, sitemap, planning and publishing website, designing effective navigation. [4]

2. **JavaScript and XML:** Client side scripting with JavaScript, variables, functions, conditions, loops and repetition, pop up boxes, advance JavaScript: JavaScript and objects, JavaScript own objects, the DOM and web, browser environments, manipulation using DOM, forms and validations, Introduction to XML, uses of XML, simple XML, XML key components, DTD and Schemas, using XML with application, transforming XML using XSL and XSLT. [12]

3. **PHP:** Introduction and basic syntax of PHP, decision and looping with examples, PHP and HTML, arrays, functions, browser control and detection, string, form processing, files, advance features: Cookies and sessions, Object Oriented Programming with PHP. [12]

4. **PHP and MySQL:** Basic commands with PHP examples, connection to server, creating database, selecting a database, listing database, listing table names, creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PhpMyadmin and database bugs. [12]

Outcome(s): Upon completion of the course students will be able to:

- Use the JavaScript to develop the dynamic web pages.
- Use server side scripting with PHP to generate the web pages dynamically using the database connectivity.
- Develop the modern Web applications using the client and server side technologies and the web design fundamentals.

Text Books:

3. Luke Welling, Laura Thomson: PHP and MySQL Web Development, Pearson, 2016.
4. Robin Nixon: Learning PHP, MySQL, and JavaScript, O'Reilly Media, 2012.

Reference Books:

4. Elizabeth Naramore, Jason Gerner, Yann Le Scouarnec, Jeremy Stolz, MichaelK. Glass, Beginning PHP5, Apache, and MySQL Web Development, Wrox, 2005.
5. Developing Web Applications in PHP and AJAX, Harwani, McGrawHill, 2010.
6. W. Jason Gilmore: Beginning PHP and MySQL 5 From Novice to Professional, Apress, 2010.

CS-14.318 **Artificial Intelligence** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.101 (Programming Language), CS-14.207(Computer Information Systems)

Objective(s):

- To understand the basic problem solving in Artificial Intelligence.
- To learn different blind as well as heuristic search strategies.
- To understand the various ways of knowledge representation in Artificial Intelligence.
- To know the concepts of game theory and natural language processing.

1. **Overview of Artificial Intelligence:** Introduction to artificial intelligence and intelligent agents, brief history of artificial intelligence, related research fields, AI techniques, AI problems, applications of AI, future of AI, basic concepts of LISP and PROLOG. [6]
2. **Problem Solving and Search Techniques:** Basics of problem solving, Problem representation paradigms, defining problem as a state space representation, uninformed search, depth first search, breadth first search, heuristic search, heuristic functions, generate and test, hill climbing, best first search, A* algorithm, problem reduction, AND/OR graph, AO* algorithm. [10]
3. **Knowledge Representation and Logic:** Representation and mappings, procedural versus declarative knowledge, approaches and issues in knowledge representation, introduction to logic-based problem solving, Boolean logic, first order logic, higher order logic, unification and resolution for performing logical inference, fuzzy logic, probabilistic logic. [8]
4. **Game Theory:** Minimax search, alpha-beta cutoffs, iterative deepening, references on specific games. [5]
5. **Natural Language Processing:** Introduction to NLP, syntactic processing, semantic analysis, discourse and pragmatic processing. [5]
6. **Learning:** Learning from observation, rote learning, inductive learning, explanation basedlearning, statistical learning methods, supervised and unsupervised learning, basics of neural network, reinforcement learning discovery, analogy. [6]

Outcome(s): On successful completion of this course, students will be able to

- Solve the basic problems and apply searching techniques used in Artificial Intelligence.
- To select knowledge representations to solve AI problems.
- Apply various game playing algorithms.
- Work with natural language processing and apply learning techniques.

Text Books:

3. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 3rd edition, 2009.
4. Russell S., and Norvig P., Artificial Intelligence – A Modern Approach, Prentice-Hall of India, 3rd edition, 2014.

Reference Books:

8. Patterson D. W., Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall of India, 1st edition, 2015.
9. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 5th edition, 2009.

CS- 14.319 **Advanced Java** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.202 (Java)

Objective(s): This course extends the study of Web Programming Fundamentals. Advanced concepts of program design, implementation and testing will be introduced with J2EE framework. Student will learn various concept of advance Java for implementation of small to medium sized application programs that illustrate professionally acceptable coding and performance standards.

1.	**Introduction:** OOPS principle, class and objects, basics of HTML, web development introduction, web framework, J2EE building blocks, web application structure	[3]
2.	**Servlets:** Servlet needs, servlet request-response model, servlet life cycle (init, service, doGet, doPost), servlet configuration, scopes (session, request, page), servlet parameters, servlet context, forms processing (get, post), HTTP header processing, HTTP responses.	[5]
3.	**Java Server Pages**: JSP life cycle, JSP a servlets, creating dynamic content with use of JSP elements: expressions, scriptlets & declarations, JSP composition, redirecting, forwarding, accessing default objects (request, response, session, application, config, pageContext), error processing with use of JSP, Servlets vs. JSP pages	[8]
4.	**Session management**: Http session, the Http session interface session tracking: cookies, hidden fields, cookies and JSP, sending and receiving cookies.	[4]
5.	**Using Beans and tag libraries**: Separating presentation and business logic, JSP actions, JavaBeans, working with properties, <jsp:useBean>, <jsp:getProperty> and <jsp:setProperty>,using form parameters with Beans, custom tags, types of tags.	[10]
6.	**Web application:** Case study of a web application, the web.xml deployment descriptor, web.xml – document definition, web.xml – adding servlets, web.xml – mapping servlets, web.xml – sending parameters, web.xml – pre-loading servlets, web application archive, deployment of web application	[10]

Outcome(s): Upon successful completion of this course you should be able to:

- Demonstrate knowledge of the advance Java along with object oriented development process and apply this understanding to the analysis and design of solutions for small to medium scale problems.
- Implement web application using all the feature of J2EE covered in the course.

Text Books:

3. By Martin Bond, Debbie Law, Andy Longshaw, Dan Haywood, Peter Roxburgh, Sams Teach Yourself J2EE in 21 Days, 2nd Edition,SAMS , 2004.
4. Phillip Hanna , Osborne, JSP 2.0: The Complete Reference, 2nd edition, McGraw-Hill, 2003.

Reference Book:

3. Bryan Basham, Kathy Sierra & Bert Bets, Head First Servlets and JSP, 2nd Edition, , Oreilly publication, 2008.

CS-14.320 **Cryptography** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS-14.201 (Discrete Structures), CS-14.207 (Computer Information Systems)

Objective(s):

- To understand the classical encryption and decryption algorithms, their techniques as well cryptanalysis.
- To acquire basic knowledge of finite fields and number theory.
- To understand the various block ciphers, stream cipher models, principles of public key cryptosystems, hash functions and digital signatures.
- To understand the different authentication techniques.

1. **General Overview and Classical Cryptography:** General overview of threats, risks and consequences, sources of threats, attacks, classification and preventive measures, introduction to some simple ciphers such as shift cipher, substitution cipher, affine cipher, Vigener cipher, hill cipher, permutation cipher and stream ciphers, rigorous cryptanalysis of all the above ciphers. [8]
2. **Symmetric/Secret Key Cryptography:** Block ciphers and their principles- boxes, P-boxes, DES, 3 DES, AES. [6]
3. **Elementary Number Theory:** Euclid's algorithm, extended Euclid's algorithm, groups, solving modular linear equations, Chinese remainder theorem, modular exponentiation, discrete logarithm problem, prime numbers and primality testing, factorization problem, Fermat's and Euler's theorem, computation of generators of primes. [8]
4. **Key Exchange/Distribution Schemes:** Diffie - Hellman key exchange, man- in- the-middle attack, Fiat-Naor key distribution, Needham – Schroeder scheme and attack possible on it, Kerberos. [6]
5. **Asymmetric Key/Public Key Cryptosystems:** RSA description, different attacks on RSA and remedies, other public key crypto systems such as ElGamal and Rabin cryptosystems and possible attacks on them. [6]
6. **Digital Signature Schemes:** Security requirements for digital signatures, ElGamal digital signature scheme and its security analysis, the digital signature algorithm (DSA), Schnorr digital signature scheme, provably secure signature schemes and undeniable signatures. [6]

Outcome(s): On successful completion of this course, students will be able to :

- Analyze the security threats.
- Design robust cryptographic algorithms.

Text Books:

2. Douglas R. Stinson, Cryptography: Theory and Practice, (Discrete Mathematics and Its Applications) Chapman and Hall/CRC, 3rd edition, 2005.

Reference Books:

4. Jonathan Katz , Yehuda Lindell, Introduction to Modern Cryptography, (Cryptography and Network Security Series), Chapman and Hall/CRC; 2nd edition, 2014.
5. William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, 6th edition 2013.
6. Wenbo Mao, Modern Cryptography Theory & Practice, 1st edition, 2004.

CS-14.321 **Windows Programming** **Total Lectures:40**
Credit : 3-1-0-4

Prerequisite(s): CS-14.101(Programming Language)

Objective(s):

- To provide knowledge of windows programming using Visual Basic .NET.
- To focus on Visual Basic program structure, language syntax and implementation details.

1.	**Overview of Windows Programming:** The Windows environment, history of Windows, aspects of Windows, Windows programming options, APIs and memory models, programming environment	[4]
2.	**Visual Basic 2010:** The Visual Studio development environment, writing the code, building and deploying the application, working with Toolbox control, working with specific data types, working with operators, if…then structure, select case structure, the for…next loop, using counter variable, complex for…next loop, do loops, using timer object, processing errors by using try…catch statement, using finally clause, the exception object, using nested try…catch, the exit try statement.	[12]
3.	**Modules and Procedures:** Working with modules, creating public variables, creating procedures, writing sub procedure, passing arguments by value, working with array, using ReDim, the array class, working with object collections, for each…next loop, creating your own collection.	[8]
4.	**Designing User Interface:** Managing windows forms and controls at run time, adding graphics, the system drawing namespace, adding animation to your program, inheriting forms and creating base classes, working with printers.	[6]
5.	**Database:** Exploring text files, reading and writing text files, getting started with ADO.NET, SQL statements and LINQ, data presentation using Data Grid View control.	[6]
6.	**Web Programming:** Creating websites and webpages using Visual Web Developer and ASP.NET, difference between webpages and web forms, server controls, HTML controls, using webpage designer, adding server controls to a webpage.	[4]

Outcome(s): Upon completion of the course the student should be

- Able to analyze program requirements.
- Design/develop programs with GUI.
- Code program and develop interface using Visual Basic .NET.
- Perform tests, resolve defects and revise existing code.

Text Books:

1. Michael Halvorson, Microsoft Visual Basic 2010, Microsoft Press, 2010
2. Bradley and Millspaugh, Programming in Visual Basic 2010, Mcgraw-Hill, 2010

Reference Books:

1. Shelly Hoisington, Microsoft Visual Basic 2010 for Windows, Web, Office and Database Applications: Comprehensive, Cengage Learning, 2010.
2. Sheldon Bill et. al., Professional Visual Basic 2010 and .NET 4, John Wiley & Sons, 2010
3. Andrew Moore, Visual Studio 2010 All-in-one for Dummies, John Wiley & Sons, 2010

CS-14.322 **Data Mining** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS-14.204 (Database Management System), CS-14.301(Design and Analysis of Algorithms), MA-14.202 (Statistics and Probability Theory).

Objective(s):

- Understand the functionality of the various data mining and data warehousing components.
- Appreciate the strengths and limitations of various data mining and data warehousing models.
- Compare the various approaches to data warehousing and data mining implementations
- Describe and utilize a range of techniques for designing data warehousing and data mining systems for real-world applications.

1.	**Overview:** Evolution of the database system technology, concept of data mining and warehousing, data warehouse roles and structures, cost of warehousing data, approaches to data exploration and data mining, foundations of data mining, web warehousing, introduction to knowledge management and knowledge bases.	[5]
2.	**Data Warehouse:** Overview of data warehousing, data marts, data warehouse architecture, multidimensional data model, online analytical processing (OLAP), OLAP operations, data about data - metadata.	[4]
3.	**Data Mining and Data Visualization:** Data mining general approach, classification and clustering, introduction to DM tool (Weka, Rapidminer), techniques used to mine the data, current limitations and challenges to DM, data visualization, visualization tools.	[6]
4.	**Data Preprocessing:** Overview, data cleaning, data integration, data reduction strategies, principal component analysis, sampling, histograms, clustering, data cube aggregation, data transformation and discretization.	[6]
5.	**Machine Learning:** Supervised and unsupervised machine learning, market basket analysis (Apriori algorithm), fuzzy logic and linguistic ambiguity, artificial neural networks, genetic algorithms, genetically evolved networks, applications for machine learning.	[7]
6.	**Text Mining:** Information retrieval and search, text classification, text clustering, unsupervised learning, mining frequent patterns and correlations, classification concepts, back propagation, decision tree induction, rule based classification, clustering basic concepts and methods, K-means centroid based technique.	[6]
7.	**Web Based Statistical Analysis:** Delivering information over the web, query and reporting tools and business value, business value from analytical tools, statistical analysis applications, data discovery tools overview, data discovery applications, search engines and the web, search engine architecture, future of data mining.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Identify, formulate, and solve data science related problems by applying principles of the course.
- Understand both analysis and synthesis in the design process with the help of data mining and data warehousing tools.
- Develop and conduct appropriate experiments, analyze and interpret data, and use data visualization to draw conclusions.
- Function effectively on teams that establish goals, plan tasks, meet deadlines, and analyze risk and uncertainty.

Text Books:

4. George M Marakas, Modern Data Warehousing, Mining and Visualization, Pearson Education, 1st edition, 2002.
5. **Ian H. Witten and Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann, 3rd edition, 2011.**
6. Mattison R., Web Warehousing and Knowledge Management, Tata McGraw-Hill, 1st edition, 1999.

Reference Books:

4. W.H. Inmon, BuildingtheData Warehouse, Wiley Publishing Inc., 3rdedition, 2005.
5. Anahory and Murray, Data Warehousing in the Real World, Pearson Education/Addison Wesley, 1st edition, 1997.
6. Prabhu C.S.R., Data Warehousing, Prentice-Hall of India, 2ndedition, 2002.

CS -14.323 **Shell Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language (CS 14.101)

Objective(s):
- To familiarize students with the Unix/Linux environment
- To learn the fundamentals of shell scripting/programming
- To familiarize students with basic Unix/Linux administration

1. **UNIX-Basic Concepts:** Introduction, file systems, visual editors, Unix philosophy and features, understanding the Unix commands and general purpose utilities and navigating the file system, the shell and kernel. [8]

2. **UNIX-Advanced Features:** File and directory structures, file systems and peripheral devices, handling ordinary files, file attributes. UNIX system administration, data blocks and i-nodes. [8]

3. **Unix Editors and Filters:** Vi Editor, simple filters, regular expression and grep family, advanced filters: sed and awk, awk pattern scanning and processing, awk arithmetic, operators and variables. [8]

4. **Shell Fundamentals:** Command syntax, Shell variables, pattern matching, escaping, command substitution, input /output redirection, pipes, tees, [6]

5. **Shell Scripting:** Bourne shell, C shell; scripts, meta characters and environment, shell programming and scripts, logical operators, control and looping statements and programs. Shell reliability, maintainability, efficiency, portability and usability. [10]

Outcome(s): After completion of the course students will be able to
- Work confidently in Unix/Linux environment
- Write shell scripts to automate various tasks
- Master the basics of Unix/Linux administration
- Understand the basic difference between high level programming and shell programming

Text Books:
3. Sumitabha Das, UNIX, Tata McGraw-Hill Companies, 4th edition, 2011.
4. **Cameron Newham, Learning the bash Shell:Unix Shell Programming, 3rdedition,O'Reilly Media,2009.**

Reference Books:
1. Bill Rosenblatt , Learning the Korn Shell, O'Reilly Media, 2002.
2. Mark G. Sobell ,A practical guide to Linux commands, editors, and shell programming, 2nded. Prentice Hall, 2013.

CS-14.324 **Data Compression** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): MA-14.202 (Statistics and Probability Theory)

Objective(s):

- To develop theoretical foundations of data compression.
- To know the concepts and algorithms for lossy and lossless data compression.
- To understand signal modeling and its extension to compression with applications to speech, image and video processing.

1. **Introduction:** Compression techniques, measures of performance, modeling and coding, information theory, Shannon coding theory, physical models, probability models, Markov models, composite source model, fixed and variable length codes, uniquely decodable codes, prefix codes, Kraft's theorem. [10]

2. **Lossless Compression:** The Huffman coding algorithm: minimum variance Huffman codes, adaptive Huffman coding, Golomb codes, rice codes, Tunstall codes, coding a sequence, generating a binary code, comparison of binary and Huffman coding, diagram coding, dictionary based compression techniques, adaptive dictionary, LZ77, LZ78 and LZW approach, predictive coding, prediction with partial match, the Burrows-Wheeler transform, facsimile encoding, dynamic Markov compression. [10]

3. **Lossy Compression:** Distortion criteria, distortion measurement models, scalar quantization, uniform quantizer, adaptive quantization, non-uniform quantization, advantages of vector quantization over scalar quantization, the Linde-Buzo-Gray algorithm, tree structured vector quantizers, structured vector quantizers. [10]

4. **Multimedia Compression:** M-law and A-law commanding, DPCM and ADPCM audio compression, MPEG audio standard, frequency domain coding, lossless techniques of image compression, gray codes, transform coding, GIF**,** JPEG, predictive techniques, PCM and DPCM, video compression and MPEG industry standard, wavelet based compression. [10]

Outcome(s): On successful completion of this course, students will be able to

- Understand the concepts, applications and models of data compression.
- Apply the methods of lossy and lossless data compression.
- Apply the methods and standards of image, audio and video data compression.

Text Books:

2. **Khalid Sayood, Introduction to data compression, Morgan Kaufmann Publishers, 4th edition, 2012.**

Reference Books:

3. Mark Nelson and Jean-Loup Gailly: The Data Compression Book, M&T Books, 2nd edition, 1996.
4. David Salomon, Data Compression: The Complete Reference, Springer, 4th edition, 2006.

CS-14.332 **Software Engineering** **Total Lectures:40**

Credit:3-0-0-3

Prerequisite(s): CS-14.101 (Programming Language), CS-14.203 (Data Structures)

Objective(s):

- To understand the basic software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To know about software requirements specification, requirement elicitation, structured system analysis and introduction of object-oriented analysis and design, design techniques.
- To acquire knowledge on implementation issues such as modularity and coding standards.
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study web based-system and application, software re-use, software re-engineering, agile software engineering, software engineering and testing tools.
- To develop teamwork and have project based experience.

1. **Introduction:** Programs versus software products, software crisis, need for software engineering, attributes of effective software, software myths, software characteristics, and role of management in software development, overview of quality standards like ISO 9001, SEI-CMM. [6]

2. **Software Processes and Requirement Analysis:** Software engineering: a layered technology, the software process, software process models, component based development, problem analysis, requirement engineering, requirement elicitation, requirement analysis, software requirement and specifications, data flow diagrams, data dictionaries, entity-relationship diagrams. [8]

3. **Software Project Planning:** Responsibilities & skills of a project manager, project planning, and project size estimation: LOC, function point & feature point metric, project estimation techniques, COCOMO model, staffing level estimation, scheduling, risk management, software configuration management. [9]

4. **Software Design:** The design process, design principles, design concepts, effective modular design: cohesion & coupling, classification of cohesiveness & coupling, design notations, design techniques, structure charts, introduction to object-oriented design. [8]

5. **Coding and Testing:** Software testing fundamentals, test case design, white box testing:-basis path testing, control structure testing, black box testing: boundary value analysis, equivalence class testing, decision table testing, cause effect graphing, level of testing, debugging, testing tools &standards, testing for client/server architecture, real time systems and GUIs testing. Brief of software re-use, reverse engineering, software re-engineering, agile software engineering. [9]

Outcome(s):

On successful completion of this course, students will be able to

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Author a software requirements document and understanding of the proper contents of a software requirements document.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.
- Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

3. R. S. Pressman, Software Engineering – A practitioner's approach,Tata-McGraw- Hill Int. Ed., 8th edition, 2014.
4. K. K. Aggarwal, Yogesh Singh, Software Engineering, New Age International, 1st edition, 2008.

Reference Books:

4. Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publisher, 3rdedition, 2005.
5. Rajib Mall, Fundamentals of Software Engineering, Prentice-Hall, 2ndedition, 2004.
6. Robert C. Martin, Agile Software Development, Principles, Patterns and Practices, 1st edition, 2002.

CS-14.336 **Computer Networks** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.203 (Data Structures), CS-14.207 (Computer Information Systems)

Objective(s):

- To become familiar with layered communication architectures (OSI and TCP/IP).
- To understand the client/server model and key application layer protocols.
- To construct large-scale computer networks
- To understand fundamentals of computer networks and major protocols.
- To analysis and evaluate major Internet protocols.
- To program simple network applications using socket API
- To learn and adopt newly introduced computer network technologies by themselves.

1.	**Introduction to Network Model:** History and development of computer networks, networks topologies, MANET, categories of networks, layering and protocols.	[5]
2.	**Physical Layer:** Different types of transmission media, transmission impairments, encoding schemes (NRZ, NRZI, Manchester, 4B/5B, Manchester etc.), packet and circuit switching.	[5]
3.	**MAC Layer:** Aloha, CSMA/CA, CSMA/CD protocols, performance evaluation and characteristics.	[3]
4.	**Data Link Layer:** Framing concept, error detection (parity, CRC), sliding window, stop and wait protocols, stop performance and efficiency.	[5]
5.	**Local Area Network:** IEEE 802.3, 802.4, 802.5, 802.11, performance evaluation.	[5]
6.	**Network Layer:** IPv4, IP address classes, classless addressing, IPv6, ARP, RARP, DHCP, ICMP, routing algorithms: distance vector, metrics, RIP, OSPF, BGP, congestion control algorithms, leaky bucket, token bucket.	[8]
7.	**Transport Layer:** Duties of the transport layer, connection, TCP, TCP services, TCP header, UDP, evaluating protocol such as TCP/UDP using simulator like NS2.	[5]
8.	**Application Layer:** DNS, FTP, HTTP, SMTP, POP, basics of network security (cryptography, digital signature and firewall).	[4]

Outcome(s): On successful completion of this course, students will be able to

- Analyze computer network component and devices.
- Synthesize how communication works in a network and internet.
- Formulate the concept of topologies and their applications.
- Analyze protocol at different layers and how they play important role in network implementation.
- Identify and analyze the latest technology with existing one.
- Enumerate the layers of OSI and TCP/IP models.
- Configure network and wireless technology including client/server programming.

Text Books:

1. Tanenbaum A. S., Computer Networks, Prentice-Hall of India, 5th edition, 2010.
2. Stallings W., Data and Computer Communications, Prentice-Hall of India, 10th edition, 2013.

Reference Books:

3. Forouzan B. A., Data Communications and Networking, Tata McGraw-Hill, 5th edition, 2013.
4. Hayes J. F., Modeling and Analysis of Computer Communication Networks, Plenum Press, 1st edition, 1987.

CS-14.371 **Colloquium** **Credit: 0-0-0-1**

Prerequisite(s): NIL

Objective(s):

- To observe and analyze some popular technology and gain insights
- To comprehend the acquired knowledge.
- To present the acquired knowledge to larger audience.

Content: Students have to comprehend and present on some popular technology in the field of computing.

Outcome(s): On successful completion of this course, the students will be able to

- Communicate effectively to arrange of audience.
- Recognize the need for continuous learning.
- Recognize the social impact of engineering solutions.

CS-14.374 **Comprehensive-II** **Credit: 0-0-0-4**

Prerequisite(s): CS-14.220 (Comprehensive-I), CS-14.301 (Design and Analysis of Algorithms), CS-14.303 (Operating System), CS-14.305 (Logic in Computer Science), CS-14.309 (Microprocessor and Assembly Language Programming), CS-14.332 (Software Engineering), CS-14.334 (Compiler Design), CS-14.336 (Computer Networks)

Objective(s):

- To examine the understanding of the student in different fields of computer science in concise manner.

1. **Design and Analysis of Algorithms:** Sorting, divide and conquer, graph theory, greedy algorithms, dynamic programming, backtracking, NP complete.
2. **Operating System:** Batch processing, multiprogramming, multiprocessing, and multitasking, process management, CPU scheduling, I/O scheduling, resource scheduling, deadlock and scheduling algorithms. Banker's algorithm for deadlock handling, memory management: virtual memory, paging, segmentation, concurrent processing: mutual exclusion, critical regions lock and unlock, scheduling.
3. **Logic in Computer Science:** Propositional (Boolean) logic, predicate logic, well–formed–formulae (WFF), satisfiability and tautology.
4. **Microprocessor:** Introduction to microprocessor, microprocessor instruction set, architecture of microprocessor, register set, mapping of memory and I/O devices, addressing modes, counters and time delays.
5. **Software Engineering**: Information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.
6. **Compiler Design:** Context free languages and push-down automata, recursively enumerable sets and Turing machines, undecidability, lexical analysis, syntax and semantic analysis, intermediate code generation, code generation and optimization.
7. **Computer Networks:**ISO/OSI stack, LAN technologies (Ethernet, token ring), flow and error control techniques, routing algorithms, congestion control, TCP/UDP and sockets, IPv4, application layer protocols (ICMP, DNS, SMTP, POP, FTP, HTTP), basic concepts of hubs, switches, gateways, and routers, network security, basic concepts of public key and private key cryptography, digital signature, firewalls.

Outcome(s):

- At the end of this course students will be able to comprehend her knowledge gained in the entire year.

CS 14.401 **Soft Computing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 14.305(Logic in Computer Science)

Objective(s):

- To familiarize with soft computing concepts
- To introduce the idea of neural networks, fuzzy logic and use of heuristics based on human experience
- To introduce the concept of genetic algorithm and its applications to soft computing using some applications

1.	**Introduction**: Introduction of soft computing, types of soft computing, applications of soft computing, introduction of artificial intelligence, production system, various search techniques, hill climbing, best first search, knowledge representation, monotonic and non-monotonic reasoning.	[8]
2.	**Neural Networks:** Structure and function of a single neuron, definition of ANN, characteristics of ANN, applications of ANN, single layer networks, perceptron training algorithm, linear separability, various learning rules, delta rule, ADALINE, MEDALINE, multi-layer networks, activation functions, error back propagation algorithms, characteristics of EBPA.	[8]
3.	**Neural Network Architectures**: Counter propagation networks, architecture, functioning, characteristics, Hopfield network, configuration, associative memory, limitations and applications, Hopfield vs Boltzman machine, adaptive resonance theory, architecture, classification, implementation and training	[8]
4.	**Fuzzy Logic :**Fuzzy logic, fuzzy set theory, fuzzy set vs crisp set, crisp relation and fuzzy relation, introduction and features of membership functions, fuzzy rule based system, fuzzy propositions, formation, decomposition and aggregation of fuzzy rules, fuzzy reasoning, fuzzy interference system, fuzzy decision making, applications of fuzzy logic.	[8]
5.	**Genetic Algorithms :**Genetic algorithm, fundamentals, basic concepts, working principle, encoding, fitness function, reproduction, genetic modelling, inheritance operator, cross over, inversion and deletion, mutation operator, bitwise operator, generational cycle, convergence of GA, applications and advances in GA, difference and similarities between GA and other traditional methods.	[8]

Outcome(s): On successful completion the students will be able to:

- Identify and describe soft computing techniques and their roles in building intelligent machines
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
- Apply genetic algorithms to combinatorial optimization problems
- Apply neural networks to pattern classification and regression problems
- Evaluate and compare solutions by various soft computing approaches for a given problem

Text Books:

4. S. N. Sivanandan and S.N. Deepa, “Principles of Soft Computing”, Wiley India, 2007
5. J.S.R.Jang, C.T.Sun and E. Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, 2004
6. Pravir K. Chawdhry, Rajkumar Roy, Raj K. Pant “Soft Computing in Engineering Design and Manufacturing”Springer, 2012.

Reference Books:

4. S. Rajasekaran and G.A.V. Pai, “Neural Networks, Fuzzy Logic and Genetic Algorithms”, PHI, 2003
5. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, McGraw-Hill, 3rdEdition, 2009.
6. Davis E. Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Pearson Education , 2006

CS 14.402 **Distributed Systems** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): CS 14.202 (Java Programming), CS 14.303 (Operating Systems), CS 14.306 (Computer Networks)

Objective(s): To make students aware of:

- What a distributed system is, its example, use and utilities.
- Hardware and software requirements/constraints for implementation of distributed systems.
- Abstractions like, RMI, distributed objects, RPC, distributed shared memory etc.
- Notion of time in a distributed system.
- Databases in a distributed system.

1.	**Characterization of Distributed Systems:** Definition, distributed systems-Internet, intranet, mobile, ubiquitous computing, resource sharing and World Wide Web challenges-heterogeneity, openness, security scalability failure handling concurrency and transparency.	[3]
2.	**System Models:** Architecture models- software layers, system architecture, variations on client-server model, interfaces, design requirement for distributed architectures, fundamental and interaction models, and failure and security models.	[4]
3.	**Distributed Object and Remote Invocation:** Introduction to remote method invocation (RMI) and interface in distributed systems, communication between distributed objects-objects model, distributed objects, distributed objects model and design issues for RMI, implementation of RMI and distributed garbage collection, remote procedures call and sun RPC case study, events and notifications participants, JINI distributed event specification, Java RMI case study, building client and server programs, design and implementation of Java RMI.	[8]
4.	**Time and Global State:** Clocks, events and process states, synchronizing physical clocks-synchronization in a synchronous system, Cristian method for synchronizing clocks, Berkley algorithm, network time protocol, global state and consistent cuts.	[5]
5.	**Distributed Shared Memory:** Introduction, message passing versus DSM, implementation approaches to DSM, design and implementation issues-structure and synchronization model.	[5]
6.	**Distributed Database Systems:** Distributed DBMS architecture, distributed database design, alternate design strategies, distribution design issues, fragmentation, and allocation.	[5]
7.	**Processes and Processors in Distributed Systems:** Threads, system models, processor allocation, scheduling, fault tolerance.	[5]
8.	**Distributed File System:** Design, implementation, trends in distributed file system.	[5]

Outcome(s): On successful completion of the course the student will be able to:

- Understand the concept of distributed systems.
- Explain the principles underlying the functioning of distributed systems as well as how these principles are applied in distributed systems.
- Comprehend the problems and challenges of distributed systems.
- Understand and estimate the impact of different design choices, system features on distributed systems.

Text Books:

3. Colouris, “Distributed Systems Concepts and Design”, Addison Wesley, 5th edition, 2011.
4. George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair,"Distributed Systems" , Pearson Education Limited, 2013

Reference Books:

3. Pradeep K. Sinha,"Distributed Operating Systems",PHI Learning Pvt. Limited, 2011.
4. MukeshSinghal, NiranjanShivrathri, “Advanced Concepts in Operating Systems”, TMH, 2011.

CS 14.403 **Parallel Computing** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.208 (Computer Organization and Architecture)

Objective(s):

- To provide students with contemporary knowledge in parallel computing.
- To equip students with skills to design and analyze parallel applications.
- Describe the various design issues in a parallel computing System e.g. system performance and reliability, distributed file system etc.
- Describe and program the communication among processes at different hosts to facilitate parallel computing.

1. **Introduction**: scope and issues of parallel and distributed computing, taxonomy of parallel structures, control mechanism, address-space organization, interconnection connection networks: static and dynamic interconnection networks, evaluating static interconnection networks, embedding other networks (linear array, mesh, binary tree) into a hypercube, routing mechanisms for static interconnection networks: store and forward (SF) routing, cut - theory (CT) routing, cost-performance trade-off, architectural models for parallel algorithm design. [8]
2. **Basic Communication Operation**: Simple message transfer between two processors, one-to-all broadcast, all-to-all broadcast, reduction and prefix sums, one-to-all personalized communication, all-to-all personalized communication, circular shift. [7]
3. **Performance and Scalability of Parallel Systems**: Performance matrices for parallel systems: run time, speed up, efficiency and cost, the effect of granularity and data mapping on performance, scalability of parallel systems, ISO-efficiency metric of scalability. [7]
4. **Models of Distributed Computing**: Mini computer model, workstation pool model, client-server model, pool of processors model, hybrid model. [6]
5. **Inter Process Communication and Remote Procedure Calling**: Building blocks, client-server communication, group communication, case study: inter processor communication in Unix, design issues in remote procedure calling, implementation. [6]
6. **Parallel Computing Algorithms**: Various sorting and searching algorithms, performance metrics for parallel algorithm implementations. [6]

Outcome(s): At the end of this course, student will be able to accomplish following.

- Define terminology commonly used in parallel computing, such as efficiency and speedup.
- Describe different parallel architectures, inter-connect networks, programming models, and algorithms for common operations such as matrix-vector multiplication.
- Given a problem, develop an efficient parallel algorithm to solve it.
- Given a parallel algorithm, analyze its time complexity as a function of the problem size and number of processors.
- Given a parallel algorithm, an input to it, and the number of processors, show the steps performed by that algorithm on that input.

Text Books:

3. Vipin Kumar, Ananth Grama, Anshul Gupta and George Karypis, "Introduction to Parallel Computing", 2nd Ed, Pearson Education,2008.
4. George Coulouris, Jean Dollimore and Tim Kindberg," Distributed Systems Concepts and Design", 4th Ed., Pearson Education, 2009.

Reference Books:

5. S G Akl, "The Decision and Analysis of Parallel Algorithms", Prentice Hall, 1989.
6. Hwang, Kai, "Advanced Computer Architecture: Parallelism, Scalability, Programmability", 2nd Ed., McGraw Hill, 2011.
7. J Jaja, "An Introduction to Parallel Algorithms", Addison Wesley, 1992.
8. T G Lewis and H El Rewini, "Introduction to Parallel Computing", Prentice-Hall 1992.

CS-14.405 **Digital Image Processing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS-14.101 (Programming Language), MA-14.201(Applied Mathematics)

Objective(s):

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the image segmentation and representation techniques
- To study the image representation in form of features and descriptors

1.	**Digital Image Fundamentals:** Elements of digital image processing systems, elements of visual perception, brightness, contrast, hue, saturation, mach band effect, color image fundamentals - RGB, HSI models, image sampling, quantization, dither, two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD.	[7]
2.	**Image Enhancement and Restoration:** Histogram equalization and specification techniques, noise distributions, spatial averaging, directional smoothing, median, geometric mean, harmonic mean, contra harmonic mean filters, image restoration - degradation model, unconstrained restoration, inverse filtering, removal of blur caused by uniform linear motion.	[7]
3.	**Morphological Image Processing:** Basics, structuring element, erosion, dilation, opening, closing, hit-or-miss transform, boundary detection, hole filling, connected components, convex hull, thinning, thickening, skeletons, pruning, and reconstruction by dilation and erosion.	[7]
4.	**Image Segmentation:** Edge detection, edge linking via Hough transform, thresholding, region based segmentation, region growing, region splitting and merging, and segmentation by morphological watersheds, basic concepts, dam construction, and watershed segmentation algorithm.	[7]
5.	**Image Representation:** Boundary representation, chain code, polygonal approximation, signature, boundary segments, boundary description, shape number, Fourier descriptor, regional descriptors, and topological features.	[6]
6.	**Image Compression:**Need for data compression, Huffman, run length encoding, shift codes, arithmetic coding, vector quantization, transform coding, JPEG standard, MPEG.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Discuss digital image fundamentals.
- Apply image enhancement and restoration techniques.
- Use image compression and segmentation Techniques.
- Represent features of images.

Text Books:

10. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.
11. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011.
12. Bernd Jähne, Digital Image Processing, Springer Science & Business Media, 29-Jun-2013.

Reference Books:

13. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
14. William K Pratt, “Introduction to Digital Image Processing”, CRC Press, 13-Sep-2013.

CS 14.411 **Advanced Computer Architecture** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming languages), CS 14.208 (Computer Organization and Architecture)

Objective(s):

- To discuss the organization of computer-based systems and how a range of choices are influenced by application.
- To understand the organization and operation of current generation computer systems including multiprocessor and multicore systems.
- To understand the principles of I/O in computer systems including viable mechanism for I/O and secondary storage organization.

1.	**Introduction**: Overview of parallel processing and pipelining, study and comparison of uni-processors and parallel processors, architectural classification, applications of parallel processors, instruction level parallelism, performance matrices and measures, speedup.	[6]
2.	**Pipelining:** Principles and implementation of pipelining, classification of pipelining processors, pipeline architecture, general pipelining reservation table, design aspect of arithmetic and instructional pipeline, pipelining hazards and resolving techniques, advanced pipelining techniques, software pipelining, implementation issues.	[8]
3.	**Vector and Array Processors** : Vector and array processors, basic vector architecture, issues in vector processing, SIMD computer architecture, masking and data network mechanism, interconnection networks of SIMD, static vs dynamic networks, parallel algorithm for array processors, matrix multiplication, sorting, implementation issues.	[10]
4.	**Multiprocessor Architecture** : Multiprocessor architecture, loosely and tightly coupled multiprocessors, characteristics of multiprocessor, inter-processor communication network, memory contention and arbitration techniques, cache coherence, bus snooping, massively parallel processors, inter process communication and synchronization.	[10]
5.	**Parallel Algorithms:** Multithreading, synchronous and asynchronous message passing, shared memory, study of parallel programming concepts, parallel algorithm for multiprocessors, operating system for multiprocessors, message passing interfaces, parallel programming languages, Fortran 90, Occam, C-Linda, CCC.	[6]

Outcome(s): On successful completion of this course, students will be able to

- Describe the operation of performance enhancements such as pipelines, dynamic scheduling, branch prediction, cache, and vector processors.
- Describe modern architectures such as RISC, super scalar, multiprocessor and multicore systems.
- Develop applications for high performance computing systems.

Text Books:

3. Kai Hwang, Naresh Jotwani, “Advanced Computer Architecture”, McGraw-Hill Education, 2011.
4. John L Hennessey, David A Patterson, “Computer Architecture – A Quantitative Approach”, Morgan Kaufmann, Elsevier Publishers, 5th edition, 2012.

Reference Books:

3. Kai Hwang, Zhi Wei Xu, “Scalable Parallel Computing”, McGraw Hill,1998.
4. Kai Hwang, Faye A Briggs, “Computer Architecture and Parallel Processing”, McGraw Hill, 1984.

CS 14.412 **Software Project Management** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS 14.302 (Software Engineering)

Objective(s):

- To introduce the concepts of Software Project Management to the students.
- To make the students understand the requirement for project evaluation.
- To make the students understand the requirement for Software quality assurance and project management along with its tools.

1.	**Introduction to Software Project Management (SPM) : S**oftware Engineering problem and software product, software product attributes, definition of a Software Project (SP), SP vs. other types of projects activities covered by SPM, categorizing SPs, Project Management cycle, SPM framework, types of project plan	**[6]**
2.	**Project Evaluation:** Strategic assessment, technical assessment, cost benefit analysis, cash flow forecasting, cost benefit evaluation techniques, risk evaluation	**[5]**
3.	**Activity Planning:** Objectives, project schedule, sequencing and scheduling activities, network planning models, forward pass, backward pass, activity float, shortening project duration, activity on arrow networks, risk management, nature of risk, types of risk, managing risk, hazard identification, hazard analysis, risk planning and control	**[8]**
4.	**Monitoring and Control:** Introduction, creating the frame work, collecting the data, visualizing progress, cost monitoring, earned value, prioritizing monitoring, getting the project back to target, change control	**[6]**
5.	**Managing people and Organizing teams:** Introduction, understanding behaviour, organizational behaviour: a background, selecting the right person for the job, instruction in the best methods, motivation, the Oldman, Hackman job characteristics model, working in groups, becoming a team, decision making leadership, organizational structures, stress, health and safety, case studies	**[8]**
6.	**Software Quality Assurance and Testing:** Testing principles and objectives, test plan, types and levels of testing, test strategies, program verification and validation, software quality, SEI-CMM,SQA activities, QA organization structure, SQA plan	**[7]**

Outcome(s):

Upon completion of the course the student should be able to:

- Examine the fundamentals of the software project and the factors involved in using a methodology in the context of project management.
- Explain the risks, issues, and critical success factors associated with technology projects and software projects in particular.
- Create a project plan, including scope definition, risk assessment, task breakdown, team selection, estimates, communication mechanisms and progress evaluation and reporting using an appropriate project lifecycle.
- Present and justify a fully documented project plan.
- Employ appropriate software for project planning, estimation, monitoring and control, communication and reporting.

Text Books:

3. Bob Hughes, Mikecotterell, “Software Project Management”, Fourth Edition, Tata McGraw Hill, 2009.
4. Ashfaque Ahmed,"Software Project Management: A Process-Driven Approach",CRC Press, 2016.

Reference Books:

4. **Ramesh, Gopalaswamy, "Managing Global Projects", Tata McGraw Hill**, 2nd ed. 2005.
5. Royce, “Software Project Management”, Pearson Education, 1999.
6. Walker Royce, Software Project Management, 1998, Addison Wesley.

CS 14.413 **Foundations and Applications of IoT** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming Language), CS 14.303 (Operating System), CS 14.306 (Computer Networks)

Objective(s):
- To introduce the vision and impact of IoT.
- To understand IoT Market perspective.
- To understand the challenges that must be overcome by IoT technology.

1.	**M2M to IoT:** The vision-introduction, from M2M to IoT, M2M towards IoT-the global context, a use case example, differing characteristics.	[5]
2.	**M2M to IoT – A Market Perspective:** Introduction, some definitions, M2M value chains, IoT value chains, an emerging industrial structure for IoT, the international driven global value chain and global information monopolies, M2M toIoT-an architectural overview, building an architecture, main design principles and needed capabilities, an IoT architecture outline, standards considerations.	[9]
3.	**M2M and IoT Technology Fundamentals:** Devices and gateways, local and wide area networking, data management, business processes in IoT, everything as a service (XaaS), M2M and IoT analytics, knowledge management.	[7]
4.	**IoT Architecture- Introduction, State of the art:** Architecture reference model-introduction, reference model and architecture, IoT reference model.	[6]
5.	**IoT Reference Architecture:**IoT reference architecture- introduction, functional view, information view, deployment and operational view, other relevant architectural views, real-world design constraints- introduction, technical design constraints-hardware is popular again, data representation and visualization, interaction and remote control.	[8]
6.	**Implementation Examples:** Industrial automation, the smart grid, smart cities.	[5]

Outcome(s): On successful completion of this course, students will be able to
- Understand the vision of IoT from a global context.
- Determine the Market perspective of IoT.
- Understand the use of Devices, Gateways and Data Management in IoT.
- Build architecture in IoT
- Analyze, design and develop parts of IoT solution

Text Books:
3. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
4. Malcolm Frank, Paul Roehrig, Ben Pring,"What To Do When Machines Do Everything" ,John Wiley & Sons, 13-Feb-2017

Reference Books:
4. Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014.
5. Peter Waher, "Learning Internet of Things", Packt Publishing Ltd, 27-Jan-2015.
6. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013

CS 14.414 **Technologies of Big Data** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.415 (Data Science and Big Data and Analytics)

Objective(s): To understand and learn various technologies of Big Data Analytics and apply them to solve real world problems.

1.	**Hadoop and MapReduce**: Functional programming, MapReduce programming, running a MapReduce programs on Hadoop, word count, distributed sort, distributed grep.	[7]
2.	**Hive**: Hive, HiveQL vs SQL, Hive in Hadoop ecosystem, installation of Hive, query execution in Hive, data types and file formats, create table, alter table, drop table, loading data into tables, select-from clause, where clause ,group by clause, join statements, views and indexes.	[10]
3.	**Pig**: Pig , PigLatin, Pig on Hadoop, installing and running Pig, Grunt, Pig data models, load, store and dump, relational operations-foreach, filter, groupby, orderby, distinct, Join, user defined functions(UDFs),developing and testing PigLatin scripts.	[10]
4.	**Spark**: Spark, Hadoop versus Spark, Installation of spark, spark architecture, solving business problem with Spark, Spark streaming framework and processing models.	[7]
5.	**NoSQL Databases**: NoSQL, database scaling, CAP theorem, ACID versus BASE, key – value stores, column oriented databases, document databases, graph databases, NoSQL challenges.	[6]

Outcome(s): On successful completion of this course, students would be able to

- Apply learning and knowledge of Big Data technologies tosolve real world problems and acquire required skills set for industry.

Text Books:

3. Chuck Lam, “Hadoop in Action”, Manning Publications,2nd ed. 2015, ISBN: 9781935182191
4. Edward Capriolo, Dean Wampler, Jason Rutherglen,“Programming Hive”, O’Reilly Media,2016,ISBN: 978-1-449-31933-5

Reference Books:

3. Alan Gates, “Programming Pig”, O’Reilly Media,2011,ISBN: 978-1-449-30264-1
4. James A. Scott, “Getting Started with Apache Spark”, MapR Technologies,2015

CS 14.415 **Data Science and Big Data Analytics** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.204 (Database Management System)

Objective(s): To understand the fundamental concept of Data Science and Big Data Analytics and its application in various fields.

1.	**Data and its Classifications**: Data, information, knowledge and wisdom, digital and analog data, unstructured data, semi-structured data ,structured data, sources of data, dealing with unstructured data, data science and responsibilities of data scientist, database, data warehouse, data mining and big data.	[10]
2.	**Introduction to Big Data**: Big data, characteristics of big data-volume, velocity, variety, challenges with big data, applications of big data in healthcare, agriculture, education, scientific experiments, advertising, stock market etc., integrity and privacy of big data, big data and cloud computing, big data and IoT.	[10]
3.	**Classification of Analytics:** Descriptive, diagnostic, discovery, prescriptive and predictive analytics, big data analytics, semantic analytics, in-memory analytics, analytics and decision making, shared nothing architecture, CAP theorem, parallel and distributed system, massively parallel processing.	[10]
4.	**Hadoop and its Architecture**: RDBMS and Hadoop, master slave architecture, HDFS, name node, secondary name node, data node, HDFS client, replica placement strategy, MapReduce, job tracker, task tracker, map phase, reduce phase, shuffle phase, Hadoop 1.0 and Hadoop 2.0, YARN, Installation of Hadoop in pseudo distributed mode and full distributed mode.	[10]

Outcome(s): On successful completion of this course, students will be able to

- Apply learning and knowledge ofData Science and Big Data Analytics to solve real life problems in various areas of social importance.

Text Books:

4. Seema Acharya, SubhashiniChellapan, “Big Data and Analytics”, Wiley,,ISBN:978-81-265-5478-2, 2015
5. Tom White, “Hadoop: The Definitive Guide”, O’Reilly Media,2012,ISBN: 978-1-449-38973-4
6. Vincenzo Morabito, "Big Data and Analytics: Strategic and Organizational Impacts",Springer,2015

Reference Books:

3. Rick Smolan, Jennifer Erwitt,“The Human Face of Big Data”, Sterling, 2012, ISBN:9781454908272
4. EMC Education Services , “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, John Wiley & Sons, 05-Jan-2015, ,ISBN: 978-1-118-87613-8

CS 14.416 **Designing of IoT** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.101 (Programming Languages), CS 14.303 (Operating System), CS 14.306 (Computer Networks)

Objective(s):
- To understand IoT architecture and IoT design constraints
- To understand the vision and impact of IoT
- Understand IoT Market perspective.

1.	**Internet/Web and Networking Basics** : OSI Model, data transfer referred with OSI model, IP addressing, point to point data transfer, point to multi point data transfer & network topologies, sub-netting, network topologies referred with web, introduction to web servers, introduction to cloud computing	[5]
2.	**IoT Platform Overview:** Overview of IoT supported hardware platforms such as: raspberry pi, ARM cortex processors, arduino and intel galileo boards, network fundamentals: overview and working principle of wired networking equipment's – router, switches, overview and working principle of wireless networking equipment's – access points, hubs etc. linux network configuration concepts: networking configurations in linux accessing hardware & device files interactions.	[7]
3.	**IoT Architecture:** History of IoT, M2M – machine to machine, web of things, IoT protocols, remote monitoring & sensing, remote controlling, performance analysis, the layering concepts , IoT communication pattern, IoT protocol architecture, the 6LoWPAN, security aspects in IoT.	[8]
4.	**IoT Application Development**: MQTT, REST/HTTP, CoAP, MySQL, apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB object type database, HTML, CSS & jQuery for UI designing, JSON lib for data processing, security & privacy during development, application development for mobile platforms: overview of android / IOS app development tools.	[13]
5.	**Case Study & advanced IoT Applications:**IoT applications in home, infrastructures, buildings, security, Industries, home appliances, other IoT electronic equipments, use of big data and visualization in IoT, industry 4.0 concepts, sensors and sensor node and interfacing using any embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino)	[7]

Outcome(s): On successful completion of this course, students will be able to:
- Explain the current status and expected future directions of the internet of things.
- Identify and propose applications which advance the IoT.
- Develop applications which advance the IoT.

Text Books:

4. Dr.OvidiuVermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers,2013
5. Jean-Philippe Vasseur, Adam Dunkels, "Interconnecting Smart Objects with IP: The Next Internet", Morgan Kuffmann, 2010.
6. Zach Shelby, Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet", Wiley, 2011.

Reference Books:

3. Asoke K Talukder and Roopa R Yavagal, "Mobile Computing", 4th ed. Tata McGraw Hill, 2010.
4. F. Adelstein and S.K.S. Gupta, "Fundamentals of Mobile and Pervasive Computing", McGraw Hill, 2009.

CS 14.418 **Software Defined Networking** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.302 (Software Engineering), CS 14.306 (Computer Networks)

Objective(s):

- To explore the basics of SDN
- To discuss various types plane
- To list out various controllers
- To program a simple SDN

1.	**Control and Data Planes**: Introduction, evolution vs revolution, the control plane, data plane, moving information between planes, distributed control planes, convergence time, load balancing, creating the MPLS overlay, centralized control planes, logical vs literal, ATM.LANE, route servers.	[8]
2.	**SDN Controllers:** Wire protocol, replication, FAWG, hybrid approaches, SDN controllers, VMware, Nicira, OpenFlow, Mininet, NOX/POX, Trema, Ryu, L3VPN, RSPV-TE problem statement, bin-packing, deadlock, Plexxi, Cisco OnePK.	[8]
3.	**Network Programmability:** The management interface, the application-network divide, NETCONF and NETMOD, SNMP, modern programmatic interface, XMPP, JSON, I2RS, OpenStack, CloudStack, Puppet, virtual multitenant data center, SDN solution for data center networks.	[8]
4.	**Network Function Virtualization**: Virtualization and data plane I/O, services engineered path, service locations and chaining, NFV at ETSI, non-ETSI NFV work, network topology, LLDP, BGP-TE/LS, ALTO, I2RS topology.	[8]
5.	**Building an SDN framework:** Build code first, ask questions later, the Juniper SDN framework, IETF SDN framework, open daylight controller/framework, use cases for bandwidth scheduling, manipulation, data center overlays, big data, NFV, and traffic monitoring.	[8]

Outcome(s): On successful completion the students will be able to:

- Describe the key benefits of SDN
- Describe the data plane
- Configure an SDN friendly network emulator
- Program a simple SDN for a given task using a low level approach and high level approach
- Evaluate a sample SDNs performance and reliability

Text Books:

2. Ken Gray, Thomas D Nadeau, “SDN: Software Defined Networks”, O’Reilly, 2013.

Reference Books:

4. Paul Goransson, Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann, First edition, 2014 .
5. Vishal Shukla, “Introduction to Software Defined Networking – OpenFlow&VxLAN”, Createspace, 2013.
6. Patricia A Morreale, James M. Anderson, “Software Defined Networking: Design and Deployment”, CRC Press, 2014.

CS 14.422 **Software Testing and Quality Assurance** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.302 (Software Engineering)

Objective(s):

- To explore the basics and goals of software testing
- To discuss various types of software testing and its techniques
- To list out various tools that can be used for automating the testing process
- To introduce various software quality standards for establishing quality environment
- To discuss various methods and evaluation procedures for improving the quality Models

1.	**Basics of Software Testing**: Definition, test cases, insights from a Venn diagram, identifying test cases, error and fault taxonomies, levels of testing, examples: generalized pseudo-code, the triangle problem, the NextDate problem, the commission problem	[6]
2.	**Decision Table Based Testing:** Decision tables, test cases for triangle problem, test cases for Next Date problem, test cases for commission problem, data flow testing, use testing, slice based testing, guidelines and observation, traditional view of testing levels, alternative life-cycle models, separating integration and system testing, decomposition based, call graph based, path based integration, case study	[10]
3.	**System and Interaction Testing:** Threads, basic concepts of requirements specification, finding threads, structural strategies and functional strategies for thread testing, SATM test threads, system testing guidelines, interaction testing, a taxonomy of interactions, composition, and determinism, client-server testing, issues in object-oriented testing, inheritance and polymorphism, levels of object-oriented testing, GUI testing, dataflow testing for object-oriented software, examples and case study	[10]
4.	**Object-Oriented Integration Testing**: UML support for integration testing, MM paths for object-oriented software, GUI testing, unit testing, object-oriented system testing, UML based system testing, statechart based system testing	[6]
5.	**Quality Assurance:** Software quality, level of measurement, reliability and validity, Ishikawa's seven basic tools, cause and effect diagram, reliability models, quality and quality management metrics, software process maturity assessment	[8]

Outcome(s): On successful completion the students will be able to:

- Compare and pick out the right type of software testing process for any given real world problem
- Carry out the software testing process in efficient way
- Automate the testing process by using several testing tools
- Establish a quality environment as specified in standards for developing quality software
- Analyze and improve the quality procedures based on the past experience

Text Books:

3. Paul C. Jorgensen, "Software Testing: A Craftsman's Approach", Auerbach Publications, 4th Edition, 2016.
4. Stephen H Khan, "Metrics and Models in Software Quality Engineering", Pearson, 2nd edition 2013.

Reference Books:

4. CemKaner, Rebecca L. Fiedler,"Foundations of Software Testing" , Context-Driven Press, 2013
5. Aditya P Mathur, " Foundations of Software Testing", Pearson, 2008.
6. Mauro Pezze, Michal Young,"Software Testing and Analysis – Process, Principles and Techniques", John Wiley & Sons, 2008.

CS 14.424 **Machine Learning with Big Data** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 14.322 (Data Mining)

Objective(s): To learn the fundamental concept of machine learning and apply the concept of recommendations, clustering and classifications on large scale data sets using mahout.

1. **Introduction**: learning problems, designing learning system, perspectives and issues, concept learning, version spaces and candidate elimination algorithm, inductive bias, decision tree learning, representation, heuristic space search [8]
2. **Data Mining, Machine Learning** : Data mining ,machine learning, statistical modeling, feature extraction, computational approaches to modeling, statistical limits on data mining, statistical limits on data mining, Bonferroni's principle, recommendation engines, clustering and classifications, mahout : Mahout, installation and setting up of Mahout, tackling large scale data with mahout and Hadoop [8]
3. **Recommendations:** Defining recommendation, Running a recommender engine, Evaluating a recommender, Evaluating precision and recall, evaluating the GroupLens data set, representing preference data, in-memory data models, coping without preference values, user-based recommendation, item-based recommendation, similarity metrics, slope-one recommender, distributing recommendation computations [8]
4. **Clustering**: Clustering basics, measuring the similarity of items, running a simple clustering example, distance measures, representing data, visualizing vectors, representing text documents as vectors, generating vectors from documents, clustering algorithms in Mahout, k-means clustering, different kinds of clustering problems, fuzzy k-means clustering, model-based clustering, evaluating and improving clustering quality, real-world applications of clustering [8]
5. **Classifications**: Introduction to classification, Mahout for classification, differences between classification, recommendation, and clustering, applications of classification, working of classification, training a classifier, extracting features to build a Mahout classifier, preprocessing raw data into classifiable data, converting classifiable data into vectors, evaluating and tuning a classifier, deploying a classifier [8]

Outcome(s): Students would be able to apply learning and knowledge of machine learning techniques in the area of Big Data Analytics using Mahout to solve real life problems.

Text Books:

4. Sean Owen, Robin Anil, Ted dunning, Ellen friedman, "Mahout in Action",Manning Publications,2012,ISBN 9781935182689
5. Jared Dean,"Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners", Wiley,2014, ISBN: 978-1-118-61804-2
6. Tom M. Mitchell, "Machine Learning", McGraw Hill , 2013

Reference Books:

3. Suthaharan, Shan, "Machine Learning Models and Algorithms for Big Data Classification ", Springer,2016,ISBN 978-1-4899-7641-3
4. AnandRajaraman, Jure Leskovec, Jeffrey D. Ullman, "Mining of Massive Datasets", Cambridge University Press, 2015,ISBN:978-1-107-07723-2

CS 14.426 **Wireless and Sensor Networks** **Total Lectures: 40**
Credit: 3-1-0 -4

Prerequisite(s): CS 14.306 (Computer Networks)

Objective(s):

- To provide an overview about wireless and sensor networks and emerging technologies
- To study about the network architecture of sensor nodes and its execution environment
- To understand the concepts of communication, MAC and routing protocols in WSN
- To learn about topology control and clustering for localization services with sensor tasking and control
- To study about sensor node hardware and software platforms and understand the simulation and programming techniques

1.	**Overview of Wireless Sensor Networks**: Introduction, characteristics, challenges for WSN, emerging technologies for WSN, advantages of sensor networks, applications.	[8]
2.	**Architecture:** Single-node architecture, hardware components, energy consumption of sensor nodes, operating system and execution environment, network architecture, single hop vs multi hop, multiple sources and sinks, optimization goals and figures of merit, WSN gateway and tunneling.	[8]
3.	**Networking Sensors:** Physical layer, MAC protocols for WSN, low duty cycle and wakeup concept S-MAC, address and name management, assignment of MAC addresses, routing protocols, multipath unicast routing, energy efficient routing, geographic routing.	[8]
4.	**Infrastructure**: Topology control, clustering, multilayer clustering, time synchronization, localization and positioning, positioning in multihop environment, ranging techniques, range based localization, sensor tasking and control, information based sensor tasking, joint routing and information aggregation	[8]
5.	**Platforms and Tools:** Sensor node hardware, Berkeley motes, programming challenges, node level software platforms, TinyOS, nesC, TinyGALS, simulators, ns2, TOSSIM, state centric programming	[8]

Outcome(s): On successful completion the students will be able to:

- Compare and pick out the right type of software testing process for any given real world problem
- Carry out the software testing process in efficient way
- Automate the testing process by using several testing tools
- Establish a quality environment as specified in standards for developing quality software
- Analyze and improve the quality procedures based on the past experience

Text Books:

3. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2007.
4. Feng Zhao, Leonidas Guibas, Jie Liu, , “Wireless Sensor Networks- An Information Processing Approach", 2nd ed. Elsevier, 2016.

Reference Books:

3. KazemSohraby, Daniel Minoli, &TaiebZnati, “Wireless Sensor Networks- Technology, Protocols, And Applications”, John Wiley, 2007.
4. Anna Hac, “Wireless Sensor Network Designs”, John Wiley, 2003.

CY-14.101 **Engineering Chemistry** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- To purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers their preparation, properties and uses.
- To develop the basics of protecting engineering materials from the natural forces.
- To understand the present-day up-to-date knowledge of the contemporary energy sources.
- To build up the basis of the future Engineering materials like superconductors, conducting organic polymers, Nanomaterials etc.

1. **Water treatment**: Hardness, types of hardness, determination of hardness by complex metric (EDTA) method, degree of hardness, boiler troubles: corrosion, sludge and scale formation, prevention of sludge and scale formation in boilers, methods of boiler water treatment: lime-soda process, permutit (zeolite) process, ion exchange methods, numerical problems based on water treatment (lime-soda process). [10]

2. **Organic and Inorganic Polymers:** Classification, functionality, types of polymerization, mechanism of addition polymerization, plastics: thermoplastic and thermosetting resins, preparation, properties and uses of Polyamides, Bakelite, Polyesters, Rubber, vulcanization of rubber, synthetic rubber viz. Buna-S, Buna-N, Butyl and Neoprene rubbers, Silicones-polysiloxanes and Sulphur based polymers. [8]

3. **Electrochemistry and Corrosion**: Classifications (Galvanic cell, electrolytic cell), types of electrodes (reference electrodes-standard hydrogen electrode, indicator electrodes- glass electrode), theorigin of electrode potential, Nernst equation of electrode potential. electromotive force, electrochemical series. corrosion: definition and its significance, theories of corrosion, mechanism of corrosion, types of corrosion, Galvanic cell, and concentration cell, water line corrosion, pitting & stress corrosion (caustic embrittlement), protection against corrosion, corrosion control (corrosion inhibitors, cathodic protection - sacrificial anodic and impressed current cathodic protection),protective metallic coatings. [10]

4. **Fuels:** Classifications of fuels, Comparison of solid, liquid & solid fuels, Calorific value of a fuel, Bomb calorimeter, determination of LCV & HCV, petroleum: origin, composition, processing, cracking, synthetic petrol, refining, reforming, knocking, unleaded petrol, LPG as a gaseous fuel, numerical problems based on combustion. [6]

5. **New Engineering Materials**: Introduction: superconductors, high and low-temperature superconductors, organic electronic materials, fullerenes and nanomaterials, industrial applications of fullerenes and nanomaterials. [6]

Outcomes: The student will be able to understand the basis of the future Engineering materials like of superconductors, conducting polymers, Nano materials etc and purification of the most valuable natural resource of the future-water

Text Books:

1. O.G. Pananna, “Engineering Chemistry” 2nd Edition, McGraw Hill Education, 2017
2. Jain and Jain, “Engineering Chemistry,” 16th Edition, DhanpatRai Publishing Company, 2013.

Reference Books:

1. C. Housecroft, A.G. Sharpe, Inorganic Chemistry, 4th Edition, , Pearson Education Limited, England, 2012.
2. Atkins, “Physical Chemistry,” 8th edition,W. H. Freeman and Company New York, 2006.
3. William D. Callister, “Materials Science and Engineering: An Introduction, Eighth Edition,.John Wiley & Sons, Inc, 2010.
4. Bokris and Reddy, “Modern Electrochemistry,” 2nd Edition, Kluwer Academic Publishers New York, 2004.

CY-14.111 **Chemistry Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To provide students with practical knowledge of quantitative analysis of materials by classical and instrumental methods for developing experimental skills in building technical competence.

1. To determine the Total, Temporary and permanent hardness of water by EDTA method.
2. To determine the % of available chlorine in a sample bleaching powder.
3. To determine the alkalinity of given water sample.
4. To prepare urea formaldehyde resin.
5. To determine the Calorific value of a fuel by bomb calorimeter.
6. Determination of the strength of HCl by titrating it against NaOH pH metrically.

7.Determination of the strength of HCl by titrating it against NaOHconductometrically.

Outcome(s): On completion of this course, students will have the knowledge in

- Handling different types of instruments for analysis of materials using small quantities of materials involved for quick and accurate results.
- Carrying out different types of titrations for estimation of concerned in materials using comparatively more quantities of materials involved for good results.

EC-14.101 **Basics of Electronics Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course would facilitate the learner to acquire good exposure to electronics and communication engineering.

1. **Introduction:** Brief history of major inventions, scope, significance and job opportunities in electronics and communication engineering, Overview of various specializations in ECE, Electronic testand measurement equipment's, Specifications for electronic components. [3]

2. **Semiconductors:** Material and its properties, Formation of energy band diagram, Currents in semiconductors, Fermi-Dirac energy distribution, Types of semiconductors – Intrinsic and Extrinsic, Mass action law, Hall effect. [5]

3. **Diodes:** Introduction, Characteristic of ideal and real diode, Current components in thediode, load characteristics, Breakdown in thediode, Zener diode, Varactor diode, Tunnel diode, Clippers and Clampers, Rectifiers – Half and Full-wave rectifiers. [8]

4. **Transistors:** Introduction to PNP and NPN transistors, current components, active, cutoff and saturation regions, CC, CB and CE configuration, Operating point, Biasing circuits, Bias Stability, Thermal runway and thermal stability. [8]

5. **Signals:** Definition, Classification of signals – Analog and Digital, Deterministic and Random signals, Power and Energy of signals, Bandwidth, Bit and Baud rate. [4]

6. **Basics of Communication**: Definition, Block representation of communication system, Modulation – Definition, Need for modulation, Frequency translation, Types of modulation - Analog and Digital, Multiplexing – TDM and FDM. [6]

7. **Applications of Communication**: Introduction to - Optical Fiber, Transmission line, Waveguides, Satellite communication, and RADAR. [6]

Outcome(s):

- The learners are expected to have an overview of electronics and communicationengineering and learn the introductory concepts in each of the specializations in ECE.

Text Books:

1. George Kennedy, Bernard Davis, Electronics Communication Systems, 4th Edition, Tata McGraw-Hill, 2009.
2. Behrouz Forouzan, Data Communication, and Networking, 5th Edition, McGraw-Hill, 2012.
3. Robert L. Boylestad, Louis Nashelsky, Electronics Devices and Circuits Theory, 11th Edition, Prentice Hall,2013.

Reference Books:

1. David A. Bell, Electronics Devices, and Circuits, PHI, 4th edition, 2008.
2. Wayne, Tomasi, Advanced Electronic Communication Systems, 6th edition, PHI, 2013.

EE-14.101 **Elements of Electrical Engineering** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

1. **Introduction:** Background, major inventions, scope, significance and job opportunities in electrical engineering,brief overview of various energy resources. Apparatus used in generation, transmission, and distribution of electrical power and various industries. [3]

2. **D.C. circuits:** Review of circuit elements, voltage sources, current sources, ohms law,KVL, KCL, source transformation, mesh current and node voltage analysis of circuits. [5]

3. **Network Theorems**: Superposition theorem, Thevenin's theorem, Norton's theorem. Maximum Power Transfer theorem, star-delta transformation. [6]

4. **Single phase A.C. circuits:** Basic terminologies, average &RMS values of a.c. quantities, phasor representation, theresponse of R, L, C and their combination to a.c. excitation, theconcept of power and power factor in a.c. circuits. [6]

5. **Three phase A.C. circuits:** Three phase supply, phase sequence, star connection, delta connection, therelationship betweenphase andline quantities in 3-phase circuits, measurements of three-phase power underbalanced condition. [6]

6. **Magnetic Circuits & Transformer**: Magnetic circuit, mutually coupled circuit, Transformer: working principle, emf equation, ideal & practical transformer, equivalent circuits, transformer testing: open circuit and short circuit test, losses, voltage regulation and efficiency. [8]

7. **Rotating Machines:** Electro-mechanical energy conversion, introduction to rotating machines and applications [6]

Outcome(s):

- The students shall develop an insightful knowledge on various fundamental elements and devices of electrical engineering.

Text Books:

1.Nagrath& Kothari, Theory and Problems of Basic Electrical Engineering, 2nd edition PHI Publication,2017.
2. Fitzgerald & Kingsley, Basic Electrical Engineering, 6th edition TMH publication,2002.

Reference Books:

1. H.Cotton, Advanced Electrical Technology, CBS Publication,2005.

EE-14.111 **EEE Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- The objective of this course is to introduce the students to the basic concepts of Electronics Engineering.
- The aim of this course is to study the fundamental aspects of Electronics Engineering.
- To acquire the knowledge of hardware and verify the results on Multisim software.
- This lab facilitates the students to get a comprehensive exposure to operations of AC and DC machines, measurements of various parameters and applications of electrical machines.

Practical to be performed on Hardware:

1. Introduction to basic electronics components and study of breadboard, CRO, function generator, multimeter, and D.C. power supply.
2. To plot VI characteristics of p-n junction diode and Zener diode.
3. To design a half wave rectifier with and without filter circuit and find the ripple factor.
4. To design a full wave rectifier with and without filter circuitand find the ripple factor.
5. Study of clipper and clamper circuits and implement on abreadboard.
6. To perform soldering and de-soldering to make abanana probe, BNC probe, and connection on PCB.
7. To conduct open circuit test and short circuit test on single phase transformer and to determine equivalent circuit parameters.
8. Measurement of three-phase power by using two wattmeter methods.
9. Speed control of DC machine by field current control method.
10. To construct a fluorescent tube wiring and to measure thevoltage across tube rod, thevoltage across choke and current.

Practical to be performed using Multi-Sim Software:

1. An Introduction to Electronic Circuit Simulation using **Multi-Sim Software**.
2. To verify Ohm's law and Kirchhoff's law.
3. Simulate half wave and full wave bridge rectifier.
4. To plot VI characteristics of p-junction diode

Outcome(s): After completion of the course, students would be able to:

- To use the technique, skills, and modern engineering tools necessary for engineering practice.
- Able to explain the basic concepts of basic electronics components.
- Able to describe& explain Clipper and Clamper circuits, V-I Characterization of p- n junction & Zener diode.
- The students shall develop an insightful knowledge on various ac and dc machines with their industrial applications.

ET-362 **Mobile Apps Development** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CS 14.202(Java Programming)

Objective(s):

- To learn how mobile apps are different from others traditional apps by learning those aspects of mobile programming that make it unique from other platforms
- Program mobile applications for the Android operating system that use basic and advanced phone features
- Deploy applications to the Android marketplace for distribution.

1.	**Getting started with Mobility:** Mobility landscape, mobile platform, mobile apps development, overview of android platform, setting up the mobile app development environment along with an emulator, a case study on mobile app development.	[8]
2.	**Building blocks of mobile apps: Apps user:** Interface designing-mobile UI resources (Layout,UI elements, Draw-able,Menu), activity-states and life-cycle, interaction amongst activities. app-functionality beyond user interface- threads, async task, service –state and life cycle, notification, broad cast receivers, telephony and smsapis native data handling-on device file I/O, shared preferences, mobile database such as SQLite, and enterprise data access(via Internet/Intranet)	[15]
3.	**Sprucing up mobile apps:** Graphics and animation- custom views, canvas, animation APIs, multimedia-audio/video playback and record, location awareness, and native hardware access (sensor such as accelerometer and gyroscope).	[8]
4.	**Testing mobile apps:** Debugging mobile apps, white box testing, black box testing, and test automation of mobile app, JUnit for Android, Robotium, Monkey Talk.	[6]
5.	**Taking apps to market:** Versioning signing and packaging mobile apps, distributing apps on mobile market place.	[3]

Outcome(s): On successful completion of this course, students will be able to

- Understand the android operating system in details
- Create mobile application for various screens
- Deploy on play store market
- Use various sensors available in mobile

Text Books:

1. Barry Burd, Android Application Development All in One for Dummies, Johen Wiley & Sons Inc., Edition I , 2011.

2. Anubhav Pradhan ,Anil V Deshpandy, Mobile App Development, Edition I

Reference Books:

1. Lauren Darcey, Shane Conder, "Teach Yourself Android Application Development in 24 Hours",Sams Publishing, 2012, 2nd Edition , 2012.

ET 463 **Enterprise Computing – I** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS14.101 (Programming Language), CS 14.204 (Database Management System)

Objective(s):

- To define enterprise computing
- To provide an in-depth and comprehensive knowledge of the hardware and software architecture of enterprise system
- To introduce about the enterprise standards

1.	**Characteristics of Enterprise Computing:** Reliability, availability, scalability, capacity, access to large amount of data, integrity and security, system management, autonomic capabilities.	[5]
2.	**Introduction to TSO & ISPF:** Logging in a mainframe, understanding ISPF menus, understanding datasets & record length, sequential, partitioned VSAM, creation of a PDS for programs, JCL etc. vs Loadlib, creation of a sequential DS for application data, understanding catalog, using ISPF editor.	[10]
3.	**JCL & SDSF Basics:** Basic JCL programming, modifying an existing compile, link and execute JCL for specific use, JOBCARD, DD statements, understanding JOB-STEP, understanding JOBLIB and STEPLIB, understanding PARM to move data from JCL to program, understanding SDSF outputs.	[10]
4.	**Basic Application Programming:** Understanding logical file name (used in program) and physical file name (used in JCL) and how they are mapped, writing a simple COBOL program with data stored in a VSAM file or a flat file (intent is not to teach COBOL language, the student should be able to apply the language in the environment, student will be provided with sample JCLs & VSAM file that will be used in program).	[10]
5.	**Introduction to SPUFI:** Understanding how to use SPUFI environment to write and execute SQL statements.	[5]

Outcome(s): On successful completion of this course, students will be able to

- Describe the hardware and software architecture of an actual enterprise platform and explain the main functionality of the physical and virtual components.
- Perform basic administrative tasks in an enterprise computer system such as: the creation of new users, job monitoring and management, and back-ups and re- store operations.
- Possess basic practical knowledge regarding the process of installing, configuring and operating applications in an enterprise computer system as well as applying updates to the operating system

Text Book:

5. Alex Leon , IBM Mainframe Handbook, 1/e PB 1st Edition.
6. Alan Simon, "Network Re-engineering: Foundations of Enterprise Computing", Academic Press, 2012.
7. Mike Ebbers, John Kettner, Wayne O'Brien, Bill Ogden, IBM Redbooks, "Introduction to the New Mainframe: z/OS Basics", IBM Redbooks, 2012.

ET 465 **Agile Software Development** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS14.332 (Software Engineering)

Objective(s):

- To learn the fundamental principles and practices associated with each of the agile development methods.
- To learn how agile methods scale to large and distributed projects.
- To learn the essentials of collaboration as they apply to agile methods.
- To perform in-depth explorations into aspects of agile development that are particularly relevant to each student through detailed discussion sessions.

1. **Fundamentals of Agile:** The genesis of Agile, introduction and background, Agile manifesto and principles, overview of Scrum, extreme programming, feature driven development, lean software development, Agile project management, design and development practices in Agile projects, test driven development, continuous integration, refactoring, pair programming, simple design, user stories, Agile testing, Agile tools. [7]
2. **Agile Scrum Framework:** Introduction to Scrum, project phases, Agile estimation, planning game, product backlog, sprint backlog, iteration planning, user story definition, characteristics and content of user stories, acceptance tests and verifying stories, project velocity, burn down chart, sprint planning and retrospective, daily scrum, Scrum roles – product owner, Scrum master, Scrum team, Scrum case study, tools for Agile project management. [9]
3. **Agile Testing:** The Agile lifecycle and its impact on testing, test driven development (TDD), unit framework and tools for TDD, testing user stories – acceptance tests and scenarios, planning and managing testing cycle, exploratory testing, risk based testing, regression tests, test automation, tools to support the Agile tester, securing Agile software. [10]
4. **Agile Software Design and Development:** Agile design practices, role of design principles including single responsibility principle, open closed principle, Liskov substitution principle, interface segregation principles, dependency inversion principle, Agile design, need and significance of refactoring, refactoring techniques, continuous integration, automated build tools, version control. [10]
5. **Industry Trends:** Market scenario and adoption of Agile, Agile ALM, roles in an Agile project, Agile applicability, Agile in distributed teams, business benefits, challenges in Agile, risks and mitigation, Agile project on cloud, balancing Agility with discipline, Agile rapid development technologies. [4]

Outcome(s):

On successful completion of this course, students will be able to

- Understand concept of agile software engineering and its advantages in software development. Recognize various agile methods.
- Design and manage a project using Scrum.
- Write user stories for project requirements.
- Write test cases for developing features.

Text Books:

4. Ken Schawber, Mike Beedle, Agile Software Development with Scrum, Pearson, 2008.
5. Robert C. Martin, Agile Software Development Principles, Patterns and Practices, Prentice Hall
6. Lisa Crispin, Janet Gregory, Agile Testing: A Practical Guide for Testers and Agile Teams, Addison Wesley.

Reference Books:

3. Alistair Cockburn, Agile Software Development: The Cooperative Game, Addition Wesley, 2006
4. Mike Cohn, User Stories Applied for Agile Software, Addison Wesley, 2004

ET 471 **Cloud Computing (Infosys)** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s):
Objective(s):

1.	**Overview of Cloud Computing:** Brief history and evolution - History of Cloud Computing, Evolution of Cloud Computing, Traditional vs. Cloud Computing. Why Cloud Computing, Cloud service models (IaaS, PaaS & SaaS). Cloud deployment models (Public, Private, Hybrid and Community Cloud), Benefits and Challenges of Cloud Computing. Introduction to AWS Public Cloud Vendor. Cost optimization in AWS.	[10]
2.	**Virtualization**: Basics of virtualization, Virtualization technologies, Server virtualization, VM migration techniques, Role of virtualization in Cloud Computing. Introduction to EC2 service of AWS.	[8]
3.	**Working with Private Cloud:** Private Cloud Definition, Characteristics of Private Cloud, Private Cloud deployment models, Private Cloud Vendors - CloudStack, OpenStack, Eucalyptus Microsoft, Private Cloud – Benefits and Challenges. Private Cloud implementation in Amazon EC2 service.	[8]
4.	**Working with Public Clouds:** What is Public Cloud, Why Public Cloud, When to opt for Public Cloud, Public Cloud Service Models, and Public Cloud Players. Infrastructure as a Service Offerings, IaaS Vendors, PaaS offerings, PaaS vendors, Software as a Service. Demonstrating public cloud with AWS – Storage and Database services. Private vs. Public Cloud – When to choose.	[12]
5.	**Overview of Cloud Security:** Explain the security concerns in Traditional IT, Introduce challenges in Cloud Computing in terms of Application Security, Server Security, and Network Security. Security reference model, Abuse and Nefarious Use of Cloud Computing, Insecure Interfaces and APIs, Malicious Insiders, Shared Technology Issues, Data Loss or Leakage, Account or Service Hijacking, Unknown Risk Profile, Shared security model between vendor and customer in IAAS/PAAS/SAAS, Implementing security in AWS.	[8]
6.	**Future directions in Cloud Computing:** When and not to migrate to Cloud, Migration paths for cloud, Selection criteria for cloud deployment, Issues/risks in cloud computing, Future technology trends in Cloud Computing.	[4]

Text Books:

1. Cloud Computing: Principles and paradigms By Raj Kumar Buyya, James Broberg, AndrezeiM.Goscinski, 2011
2. Cloud Computing, By Michael Miller, 2008.
3. Cloud Computing for dummies, By Judith Hurwitz, Robin Bllor, Marcia Kaufman, Fern Halper, 2009.
4. Cloud Computing: A Practical Approach, By Anthony T. Velte, Toby J. Velte, and Robert Elsenpeter, McGraw Hill, 2010.
5.Handbook of Cloud Computing, By BorkoFurht, Armando Escalante (Editors), Springer, 2010.

Reference Books:

1.Cloud computing: Implementation, management and security By Rittinghouse, John, W.
2.Cloud Computing Bible, By Barrie Sosinsky, Wiley, 2011.
3.Cloud Computing Architected: Solution Design Handbook by Rhoton, John.
4.Cloud Security, A comprehensive Guide to Secure Cloud Computing by Krutz, Ronald L.; Vines, Russell Dean

ET 474 **Enterprise Computing – II** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 463 (Enterprise Computing – I)

Objective(s):

- To define advance JCL.
- To provide an in-depth and comprehensive knowledge of the hardware and software architecture of enterprise system.
- To introduce about the enterprise standards.

1. **Advanced JCL:** Coding a JCL, using PROCS (Catalog and In-Stream), using DFSORT, ICETOOL. [8]
2. **Advanced Datasets:** Understanding record length, allocation of SPACE, fixed and variable record length, VSAM, defining VSAM, understanding CI and CA, GDG, understanding usage of GDG, defining GDG. [12]
3. **Understanding CICS:** CICS fundamentals, understanding transactions, pseudo conversational programming, understanding CICS tables, coding BMS maps, compiling of a CICS program & NEWCOPY + CEMT entry for programs, writing simple CICS program to read key data (say StudentID) from user & display details obtained from a VSAM, CICS tables for VSAM/DB2 will be provided. [20]

Outcome(s): On successful completion of this course, students will be able to

- Describe the hardware and software architecture of an actual enterprise platform and explain the main functionality of the physical and virtual components.
- Perform basic administrative tasks in an enterprise computer system such as: the creation of new users, job monitoring and management, and back-ups and re- store operations.
- Possess basic practical knowledge regarding the process of installing, configuring and operating applications in an enterprise computer system as well as applying updates to the operating system

Text Book:

3. IBM Mainframe Handbook by Alex Leon.
8. Alan Simon, "Network Re-engineering: Foundations of Enterprise Computing", Academic Press, 2012.
4. Mike Ebbers, John Kettner, Wayne O'Brien, Bill Ogden, IBM Redbooks, "Introduction to the New Mainframe: z/OS Basics", IBM Redbooks, 2012.

CS-18.307	Big Data Programming	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	Basic knowledge of Linux • Basic SQL knowledge • Working knowledge with big data and Hadoop technologies • Have a basic understanding of notebook technologies for data science • Students can attend free courses at www.bigdatauniversity.com to acquire the necessary requirements • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	• To Understand what Big Data is • To understand how the growth of interconnected devices helps big data. • To Learning the tools that will enable to continue big data education after the course	
1.	**BIG DATA OVERVIEW**: Introduction to Big Data, Introduction to the Big Data Ecosystem, Introduction to Hortonworks Data Platform (HDP), Apache Ambari, Hadoop and HDFS, MapReduce and YARN, Apache Spark, Storing and quering data, ZooKeeper, Slider, and Knox, Loading data with Sqoop, Security and Governance, Stream Computing, Exercise: Exploration of the lab environment, Managing Hadoop clusters with Apache Ambar, File access and basic commands with HDFS, Running MapReduce and YARN jobs, Creating and coding a simple MapReduce job, Working with a Spark RDD with Scala, Using Hive to access Hadoop/HBase data, Explore Zookeeper, Moving data into HDFS with Sqoop,	[20]
2.	**Introduction to Data Science**: Data Science and Data Science Notebooks, Data Science with Open Source Tools, Exercise: Moving data into HDFS with Sqoop	[5]
3.	**Big SQL**: Using Big SQL to access data residing in the HDFS, Creating Big SQL schemas and tables, File formats and querying Big SQL tables, Managing the Big SQL Server, Configuring Big SQL security, Data federation with Big SQL, Exercise: Connecting to the IBM Big SQL Server, Creating and managing Big SQL schemas and tables, Querying Big SQL tables, Managing the Big SQL Server, Configuring Big SQL security, Configuring impersonation in Big SQL, Using Fluid Query with Big SQL.	[9]
4.	**IBM Watson Studio:** Introduction to IBM Watson Studio, Analyzing data with Watson Studio,Exersice: Getting started with Watson Studio, Analyzing data with Watson Studio.	[6]
Outcome(s):	On the successful completion of the course, the student will be able to: • Hadoop and the Hadoop Distributed File System•Analyze the time and space complexity of algorithms. • Apache Spark. • ZooKeeper, Slider, and Knox	
Text Books:	1. IBM Study Material	
Reference Books:		

CS-18.205	Application Development for Cloud	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	Basic knowledge of JavaScript. • Basic knowledge of Eclipse-based development tools • Basic understanding of HTML • Basic understanding of the IBM Skills Academy learning environment • Basic understanding of the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	To Define cloud computing • To Describe the choices that are available to developers when creating cloud applications • To Describe infrastructure as a service, platform as a service, and software as a service • To Describe IBM Cloud • To Describe the architecture of IBM Cloud	
1.	**CLOUD APPLICATION FOUNDATIONS**: Introduction to HTML5 and JavaScript Programming, JavaScript programming for web applications, HTML5 features,Exersices: Working with JavaScript in HTML documents, Working with HTML5 features	[8]
2.	**CLOUD APPLICATION DEVELOPER**: Essentials of Cloud Application Development, Introduction to cloud computing and IBM Cloud, Getting started with IBM Cloud, Developing IBM Cloud applications on a local workstation, Adopt a DevOps approach by using IBM Cloud Continuous Delivery, REST architecture and Watson APIs, Introduction to data services in IBM Cloud, IBM Cloud mobile backend as a service, Exercise: IBM Cloud command line interface (CLI), Develop IBM Cloud applications with Eclipse, Developing IBM Cloud applications with IBM Cloud Continuous Delivery, IBM Cloud with Cloudant,Build a mobile application by using Kinetise,	[20]
3.	**Developing Cloud Applications with SDK for Node.js**: Introduction to server-side JavaScript, Asynchronous I/O with callback programming, Express web application framework, Exercise :Developing a Hello World Node.js app on IBM Cloud, Understanding asynchronous callback, Creating your first express application, Understanding asynchronous callback Building a rich UI application by using AngularJS with Node.js	[12]
Outcome(s):	On the successful completion of the course, the student will be able to: •Understand asynchronous callbacks and be able to write the code in a Node.js application •Understand Express routing •Understand IBM Watson Natural Language Understanding service •Use the Fetch API to interact with back-end web services	
Text Books:	IBM Study Material.	
Reference Books:		

CS-18.338	Predictive Modeling Analytics	Total Lectures: 40
		Credit:3-0-0-3
Prerequisite(s):	• English Proficiency • Basic Internet and web browser usage experience • Basic analytics experience	
Objective(s):	□ To understand how analytics provided a solution to industries using real case studies □ To Explain what is analytics, the various types of analytics, and how to apply it □ To Improve efficiency, sample records, and work with sequence data □ To Integrate and collect data □ To Understand the principles of data mining	
1.	**Business Analytics Overview**: Analytics overview, Analytics trends, Towards a predictive enterprise, Analytics: Industry domains , Case studies and solutions. Business Intelligence and Analytics	[5]
2.	**Introduction to A Predictive Analytics Platform & Data Mining**: Introduction to data mining, Working with modeler, A Data-mining tour ,Collecting initial data , Understanding your data ,Setting the unit of analysis ,Integrating data ,Deriving and reclassifying fields, Looking for relationships ,Introduction to modeling , Exercise: On the basis of all above topics.	[10]
3.	**Advanced data preparation**: Using functions, Data transformations, Working with sequence data, Sampling records, Improving efficiency. Exercise on the basis of all above topics.	[10]
4.	**Automated Data Mining**: Introduction to data mining ,The basics of using a modeler ,Reading data files , Data exploration , Automated data preparation ,Data partitioning, Predictor selection for modeling ,Automated models for categorical targets , Model evaluation , Automated models for continuous targets ,Deploying models Exercise :Adding nodes and creating streams in the modeler ,Reading a data file and typing the data in the source node , Review missing values in modeler and use the data audit node on the charity data , Practice using the ADP node to prepare data for modeling ,Use a partition node to split the charity data for modeling ,Use the feature selection node to select fields and predict a response ,Using the auto classifier node to construct a model in order to predict a response, Evaluate the model created to predict the field response ,Develop a model to predict the total spending , Use a scoring stream to make predictions	[15]
Outcome(s):	On the successful completion of the course, the student will be able to: • Understand the principles of data mining • Use the user interface of modeler to create basic program streams • User a partition node to create training and testing data subsets • Use a model to score new data	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.409	Block Chain	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• Basic knowledge of JavaScript, Node.js, Angular.js, Golang, Docker, and Kubernetes • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	To Explain block chain and how it is applied across industries To Understand the benefits of a blockchain platform To Explain what is Hyperledger Composer, how it fits into blockchain, and its applications To Explain the elements of a business network, the role of channels, and how the world state is maintained To Understand block chain deployment, security and integration capabilities	
1.	**Blockchain overview**: What is Blockchain? The business backdrop, The problem area, Relation to Bitcoin, Difference between Bitcoin and Blockchain, Requirements for a blockchain in a business environment, Requirements deep dive, Apply blockchain to business, Why blockchain is relevant for business, Consensus: Shared Reference Data Example, Provenance: Supply Chain Example, Immutability: Audit and Compliance Example, Finality: Letter of Credit Example, Industry Use Cases, Hyperledger Composer, Hyperledger Fabric, Blockchain for Financial Services	[10]
2.	**Blockchain Foundations**: HTML5 overview, JavaScript programming for web applications, HTML5 features, Working with HTML 5 features, Node.js, Server-Side JavaScript, Creating a Node.js Web Application, Asynchronous I/O with callback programming, Refactor weather project, , Working with JavaScript in HTML documents.	[10]
3.	**Docker Essentials** : Introduction to Docker, Add value CI/CD with Docker Images, Introduction to Orchestration, Get started with Kubernetes, Virtual machines, containers, and Kubernetes, Relationship between Kubernetes and containers, Deploy an application with IBM Watson services.	[10]
4.	**Blockchain Developer:** Blockchain Overview, Introducing Hyperledger Composer, Understanding Blockchain Solution Architecture, Blockchain in-depth, Hyperledger Fabric Application Development, Understanding Blockchain Deployment Options, Understanding Blockchain Security, Blockchain Integrated, Applying blockchain concepts to the vehicle manufacture lifecycle use case, Developing a blockchain user application with Hyperledger Composer SDK, Developing a client application for Hyperledger Fabric, Integrating blockchain with other systems,	[10]
Outcome(s):	On the successful completion of the course, the student will be able to: • Understand blockchain and how it is applied across industries • Understand the role of a shared ledger • Understand the benefits of a blockchain platform • Understand what is Hyperledger Composer, how it fits into blockchain, and its applications • Understand the blockchain solution architecture	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.216	Application Security	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• Basic web development knowledge • Basic knowledge on HTML and HTTP • Basic knowledge of application security • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform
Objective(s):	• To Describe the emerging threats and leaks as the world is becoming digitalized • To Understand the security dynamics of securing the enterprise • To Understand relational database concepts and how to work with database objects • To Describe how to work with select statements, DML statements, and multiple tables • To Understand how to use JOINs in SQL • To Understand the basics of HTML5 (objectives, document types that are supported, browser support etc.) • To Understand glass box scanning, content based scanning, and troubleshooting

1.	**Cyber Security Overview**: Emerging threats and leaks as the world is becoming digitalized, The changing dynamics of securing the enterprise, A new approach to security, The foundation of approach to security the enterprise, IT Security Frameworks, Security Intelligence as a foundation of all security programs, IBM Security.	[5]
2.	**Application Security Foundations**: SQL Fundamentals, Relational database concepts, Working with database objects, Reading data, Inserting, updating, and deleting data, Working with multiple tables, exercises on Relational database exercise, Creating, modifying and deleting database objects ,Inserting, updating, and deleting data.	[9]
3.	**Introduction to HTML5 and JavaScript Programming:** HTML5 overview, JavaScript programming for web applications, HTML5 features, Working with JavaScript in HTML documents, Working with HTML5 features.	[9]
4.	**Web Application Security Fundamentals:** The web application security problem, Web application basics, Injection flaws, Broken authentication and session management, Cross-Site scripting, Insecure direct object reference, Security misconfiguration, Sensitive data exposure, Missing function level access control, Cross-site request forgery (CSRF), Using components with known vulnerabilities, Unvalidate redirects and forwards, Integrating security in the software development lifecycle	[9]
5.	**Web Application Security Solution Fundamentals:** Web application security overview, Installation and setup, Preparing for scan, Configuring first scan, Reviewing the results, Reporting, Logging in and managing sessions, Configuring explore options, Optimizing your scan, Glass box scanning, Content-based scanning, Reviewing scan coverage, Scanning web services, Extending the security web application solution, Troubleshooting,	[8]

Outcome(s):	• Understand relational database concepts and how to work with database objects • Describe how to work with select statements, DML statements, and multiple tables • Understand how to use JOINs in SQL • Understand the basics of HTML5 (objectives, document types that are supported, browser support etc.) • Understand the basics of JavaScript • Describe the web application security problem and web application basics
Text Books:	IBM Study Material.
Reference Books:	

CS 18.407	Advanced Artificial Intelligence	Total Lectures: 40
		Credit: 3-0-0-3

Prerequisite(s):	• English Proficiency • Exposure to the IBM Skills Academy Portal learning environment
Objective(s):	• To Describe the field of AI and its subfields machine learning, NLP and computer vision • To Describe the types of AI • To Describe the types of machine learning: Supervise learning, unsupervised learning, and deep learning • To Describe the purpose of training the various Watson services to adapt them to a closed-domain • To Use Watson API Explorer to interact with the Watson services REST API, to rest your calls to the • To Define chatbots • To Explain the factors that lead to the growing popularity of chatbots • To Identify applications that are good candidates to integrate with chatbots • To Describe the main components that are involved when building a chatbot and explain their purpose • To Describe how to build a chatbot by using the IBM Watson Conversation service

1.	**Artificial intelligence overview**: Introduction to Artificial Intelligence, Machine Learning, Natural Language Processing, Computer vision, Cognitive Computing.	[5]
2.	**Artificial intelligence foundations**: Introduction to IBM Watson, Evolution from DeepQA to Watson services on IBM Cloud, Build with Watson, Exploring Watson services with Watson API Explorer.	[10]
3.	**Artificial intelligence analyst:** Introduction to Natural Language Processing, Pipeline and concepts, NLP and IBM Watson, Exercises on Ingest, Convert, Enrich, and Query with Watson Discovery Service.	[10]
4.	**Chatbots:** Introduction to Chatbots, Chatbot fundamentals, IBM Watson conversation service.	[8]
5.	**Computer Vision:** Introduction to Computer Vision, Computer Vision fundamentals, IBM Watson Visual Recognition service, Exercise on Classifying images with Watson Visual Recognition.	[7]

Outcome(s):	Understand the relationship between AI and NLP Know the history and advancement of Computer Vision Understand Computer Vision components Learn about the Vision services that are available from IBM Watson.
Text Books:	IBM Study Material.
Reference Books:	

CS 18.210	Business Intelligence	Total Lectures: 40
		Credit: 3-0-0-3
Prerequisite(s):	• English proficiency • Microsoft Windows operating system basic experience • Basic Internet and web browser usage experience • Knowledge of an organization's business intelligence and reporting needs • Basic database background is preferred • Basic knowledge of XML is preferred • Exposure to the IBM Skills Academy portal learning environment • Exposure to the IBM Skills Academy cloud hands-on labs platform	
Objective(s):	• To Understand how analytics provided a solution to industries using real case studies • To Explain what is analytics, the various types of analytics, and how to apply it • To Understand how a business analysis software works, and its architecture • To Describe a reporting application, its interface, and the different report types • To Create different types of advanced reports • To Understand Active Reports and how to create them	
1.	**Business Analytics Overview**: Analytics overview, Analytics trends: past, present & future, Towards a predictive enterprise, Analytics: Industry domains, Case studies and solutions.	[5]
2.	**Business Intelligence and Analytics 101 and Business analytics foundations**: Business Intelligence and Analytics 101, IBM Cognos Analytics for Consumers, Business analysis solution for consumers.	[7]
4.	**Business intelligence analyst:** IBM Cognos Analytics: Author Reports Fundamentals, Introduction to IBM Cognos Analytics, Create list reports, Focus reports using filters, Create crosstab reports, Present data graphically, Focus reports using prompts, Extend reports using calculations, Use additional report building techniques, Customize reports with conditional formatting, Drill-through definitions, Enhance report layout, Overview of IBM Cognos Analytics	[12]
5.	**IBM Cognos Analytics: Author Reports Advanced:** Create query models, Create reports based on query relationships, Create advanced dynamic reports, Design effective prompts, Create additional advanced reports, Examine the report specification, Distribute reports through bursting, Enhance user interaction with HTML.	[11]
6.	**IBM Cognos Analytics: Author Active Reports:** Introduction to IBM Cognos Active Reports, Use Active Report connections, Active Report charts, visualizations, and decks.	[5]
Outcome(s):	• Describe a reporting application, its interface, and the different report types • Create different types of advanced reports • Understand Active Reports and how to create them	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.309	Security Intelligence	Total Lectures: 40
		Credit: 3-0-0-3
Prerequisite(s):	• Basic understanding of the security fundamentals • Basic understanding of the IT infrastructure and IT security fundamentals • Basic understanding of Linux, Windows, TCP/IP networking and Syslog • Exposure to the IBM Skills Academy Portal learning environment • Exposure to the IBM Skills Academy Cloud hands-on labs platform	
Objective(s):	Identify enterprise business and IT drivers that influence the overall IT Security Architecture Define the role of a centralized Security Intelligence solution and how it integrates with other IT enterprise security components Explain how a Security Intelligence solution can be used to investigate and stop advanced threats and address IT governance and regulatory compliance Describe how QRadar SIEM collects data to detect suspicious activities Navigate and customize the QRadar SIEM dashboard Investigate suspected attacks and policy breaches Search, filter, group, and analyze security data Investigate the vulnerabilities and services of assets Locate custom rules and inspect actions and responses of rules Use QRadar SIEM to create customized reports Use charts and apply advanced filters to examine specific activities in your environment	
1.	**Cyber Security Overview**: The status quo of IT Security, Security intelligence and operations,	[5]
2.	**Cyber Security Foundations**: Security Intelligence Fundamentals, Designing a security intelligence solution, Security intelligence functional components,	[10]
3.	**SECURITY INTELLIGENCE ENGINEER:** Security Intelligence Solution Foundations, Introduction to Security Intelligence Solution SIEM, How Security Intelligence Solution SIEM collects security data, Using the Security Intelligence Solution SIEM dashboard, Investigating an offense that is triggered by events, Investigating the events of an offense, Using asset profiles to investigate offenses, Investigating an offense that is triggered by flows, Using rules and building blocks, Creating Security Intelligence Solution SIEM reports, Perform advanced filtering	[10]
Outcome(s):	Understand the relationship between AI and NLP Know the history and advancement of Computer Vision Understand Computer Vision components Learn about the Vision services that are available from IBM Watson.	
Text Books:	IBM Study Material.	
Reference Books:		

CS 18.214	Developing IoT based Applications	Total Lectures: 40
		Credit: 3-1-0-4
Prerequisite(s):		
Objective(s):	An introduction the idea of collaborative devices working together to achieve a larger goal is not new. Beginning from the simple operational definition, the session will outline the historical perspective right from pre-internet era, specific machine-to-machine communication context aware computing to wearables. It will conclude architecture of Internet of Things (IoT).	
1.	**Unpacking Internet of Things**: What is IoT,Why IoT,Journey of IoT, Business Use cases of IoT, Brainstorming on various IoT use cases on any two Domains like- (Manufacturing , Buildings , Agriculture , Energy & Utilities , Worker Safety),Available programming languages for IoT enabled applications,Basic commands and board configurations,Integration IoT on Arduino.	[5]
2.	**Introduction to basic hardware interfaces and proteus simulation:** Describe a development platform, Describe the architecture of a development platform, Introduction to sensor and hardware (LED, ultrasonic Sensor, Flame sensor, DHT sensor, LCD etc.), Introduction and installation of proteus, Introduction to LED, Writing of LED blinking program on Arduino IDE with hardware implementation,Introduction to seven segment display and its working,Introduction to LCD and describing how digital display works, Writing code for LCD to display sensors results,Descriptive explanation of analog and digital conversion in electronics,Descriptive explanation of Pulse Width Modulation in electronics	[9]
3.	**Introduction to various sensors and their interface with Arduino:** Introduction to ultrasonic sensor and describing how ultrasonic sensors works, Writing code for ultrasonic sensor and display result in Serial Monitor,Introduction to Flame sensor and describing how Flame works, Writing code for Flame sensor to calculate ppm value and display result in Serial Monitor,Introduction to DHT sensor and describing how DHT sensors works, Writing code for DHT and display result in Serial Monitor,Introduction to LDR and describing how it works, writing code it,Introduction, to IR and describing how it works, Writing code for it,Introduction to LM35 and its application	[9]
4.	**Advanced Modules Interfacing And Assignments:** Introduction to Bluetooth and describing how Bluetooth works, Writing code for HOME AUTOMATION,Introduction to GSM and introduction to AT commands, write a code to call/message other phone using AT commands through arduino,write code to upload temperature sensor value on Cloud ,Introduction to Wi-Fi and new modules avail in the market, Write some code on ARDUINO for ESP8266 to upload sensors value on web,Introduction to Acc. describing how it works, Writing code for it	[9]
5.	**ASSIGNMENTS:** Displaying text on LCD ,Scrolling text on LCD,Displaying numbers on LCD ,IOT based agricultural field monitoring and controlling,IOT Based office home security with auto capture on intruder and sending alert,IOT based digital notice board for college ,IOT based contactless liquid level monitoring with empty and full alert ,IoT based home automation with fault switch,IoT based agricultural field monitoring and controlling, Project discussion.	[8]
Outcome(s):	• Unpacking Internet of Things • Getting introduced to IoT • Business Use cases of IoT • Embed various sensors with iot platform and simulate them on virtual simulation software proteus • Creating account on iot cloud platform and setting up communication between arduino and cloud platform.	
Text Books:	IBM Study Material.	
Reference Books:		

CS 17.302 **Advanced RDBMS** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): Database Management System

Objective(s): To acquire fundamental knowledge of Software designing using UML.

1.	Overview of DB2 9 on Linux, UNIX and Windows, Command Line Processor (CLP) and GUI usage, The DB2 environment.	[12]
2.	Creating databases and data placement, Creating database objects, Moving data.	[10]
3.	Backup and recovery, Locking and concurrency, Investigating DB2 locking.	[10]
4.	Problem determination, Application issues and performance, Application performance tools, Security.	[8]

Outcome(s): After completion of this course student get the understandings of advance concepts of Database design and security.

Text Books:

1. RamezElmasri, Shamkant B. Navathe, "Fundamentals of Database Systems",Pearson Education, 7th Edition, 2015.

Reference Books:

2. AviSilberschatz , Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2011.

1. Jeffrey A. Hoffer, Mary B. Prescott and Fred R. McFadden, "Modern DatabaseManagement", Prentice Hall, 8th Edition, 2006.

CS 17.208 **Essentials of Software Engineering (OOAD & SW Lifecycle)** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): Object Oriented Technologies

Objective(s):

- To acquire fundamental knowledge of Software designing using UML.

1. **Software Engineering Overview:** Best Practices of Software Engineering Concepts of Object Orientation Essentials of Visual Modeling Requirements Overview [12]
2. **Requirement analysis**: Analysis and Design Overview Architectural Analysis Use-Case Analysis Identify Design Elements [10]
3. **Design analysis**: Identify Design Mechanisms Describe the Run-time Architecture Describe Distribution Use-Case Design Objectstore Mechanism Security Mechanism. [10]
4. **UML and mapping**: UML to C++ Mapping UML to Java Mapping UML to Visual Basic Map UML to Visual Basic Map [8]

Outcome(s):

- After completion of this course student get the understandings of object-oriented analysis and design concepts, as well as hands-on practical experience applying the techniques within a use-case-driven, architecture-centric, and iterative development process.

Text Books:

1. Pressman R.S., "Software Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Sommerville, Ian "Software Engineering", Pearson Education

Reference Books:

1. Jalote Pankaj, "An Integrated Approach to Software Engineering", NAROSA.
2. Fairely, R.E., "Software Engineering Concepts", McGraw-Hill

CS 17. 204 **R Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Language(CS 14.101)

Objective(s):

- To understand and learn programming concepts of R
- To Apply R programming to solve various statistical, graphics and modeling problems

1. **Fundamentals of R** : Evolution of R, Features of R, R environmental Setup, R Script file, Data types- Vectors, Lists, Matrices, Arrays, Factors, Data Frames, Variables, finding and deleting variables, Operators in R. [6]
2. **Control Statements in R**: if-else statement, switch statement, Repeat loop, while loop, for loop, break statement, next statement [8]
3. **Functions, Strings and Vectors :** Function Definition , Function Components Built-in Function, User-defined Function, Calling a Function, Lazy Evaluation of Function, Strings and Strings Manipulation, Vector creation, accessing vector elements, vector manipulation, [10]
4. **Lists, Matrices and Arrays :** List Creation, Naming list elements, Accessing list elements, Manipulating list elements, Merging list, Converting list to Vector, Accessing elements of matrix, matrix computations, Naming row and column of array, accessing array elements, manipulating array elements, calculation across array elements [10]
5. **Data frames, factors and packages:** Extract data from data frame, expand data frames, factors in data frames, changing the order of levels, generating factor levels, packages [6]

Outcome(s): After completing the course the student is expected to

- be able to use and program in the R programming language
- be able to use R programming to solve statistical problems
- be able to apply R Programming concept to solve real world problems

Text Books:

1. Hadley Wickham, Garrett Grolemund, R for Data Science, O'Reilly, January 2017.
2. John Maindonald and John Braun, Data Analysis and Graphics Using R, Cambridge University Press, Cambridge, 2007.

Reference Books:

1. Peter Dalgaard, Introductory Statistics with R, Springer Verlag, 2008.
2. Phil Spector. Data Manipulation with R. Springer, New York, 2008.

CS 17. 254 **R Programming Laboratory** **Credit: 0-0-2-1**

Prerequisite(s): CS14.111(Programming Language Laboratory)

Objective(s):

- To learn R programming constructs
- To learn use R for statistical analysis
- To learn R for modeling.

Contents: Lab manual based upon the theory course CS 17.204 and to achieve the listed course objectives and outcomes.

Outcome(s): On successful completion of this course, the students will be able to

- Write programs using R programming
- Use R programming for statistical analysis of data
- Use R programming for data visualization
- Use r programming for problem modeling

MA-14.101 **Mathematics-I** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

1. **Calculus:** Review of basic concepts, partial differentiation, Euler's theorem on homogeneous functions, Taylor's series and Jacobian, maxima and minima of functions of two variables, asymptotes, tracing of simple Cartesian curves, length of plane curves, area bounded by the curves, multiple integrals (double and triple integrals, change of order of integration), physical interpretations and applications. [16]

2. **Three-dimensional Geometry**: Direction cosines and direction ratios of a straight line, equation of a plane,plane passing through intersections of two planes, equations of astraight line, theshortest distance between two skew lines, theequation of a sphere, intersection of plane and sphere. [10]

3. **Matrix Theory**: Rank of matrix, linear dependence and independence of vectors, solution of system of simultaneous linear equations, Eigen values, Eigenvectors of a matrix, statement of Cayley-Hamilton theorem (without proof) , reduction of a matrix to diagonal form, quadratic forms, linear transformation of a quadratic form, and applications. [10]

4. **Theory of Equations**: Introduction of polynomials, therelation between roots and coefficients, Cardon's method. [4]

Outcome(s):

- After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj, New Delhi, 43rd Edition, 2013.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 3rd Edition 2008.

Reference Books:

1. Kreyszig Erwin, Engineering Mathematics, John Wiley and Sons, New York, ISBN: 04717289777/0471726478, 9th Edition, 2005.
2. Veerarajan T., Engineering Mathematics (for first year), TMH Publishing Company Limited, New Delhi, 2nd Edition 2006.

MA-14.102 **Mathematics-II** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): MA-14.101

Objective(s):

- To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

1. **Computational Methods**: Introduction and importance of numerical analysis, calculus of finite differences, interpolation schemes for equal and unequal intervals (Newton's forward and backward interpolation formulae), divided difference, interpolation for unequal intervals (Newton's divided difference and Lagrange interpolation formulae), solution of algebraic and transcendental equations by Newton-Raphson method, applications to Engineering. [13]

2. **Ordinary Differential Equations:** First order and first-degree differential equations (variable separable, homogeneous, linear, exact equations, linear differential equations of second order with constant and variable coefficients (complementary functions and particular integrals) and applications. [12]

3. **Partial Differential Equations**: Formation of partialdifferential equations, Lagrange's multipliers method for thesolution of first order differential equations, separation of variables for nonlinear differential equations and applications. [5]

4. **Vector calculus**: Vector and scalar point functions, conservative fields, gradient of scalar point functions, divergence and curl of vector point functions (Solenoidal and irrotational vectors), directional derivative of scalar point functions, work done along a curve, integration of vectors, line integral (work done), surface integral, volume integral, physical interpretations and applications. [10]

Outcome(s):

- After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj,New Delhi, 40th Edition, 2007.
2. B. V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill Publishing Company Limited,New Delhi, 2nd Edition 2007.

Reference Books:

1. Kreyszig Erwin, Engineering Mathematics, John Wiley and Sons, New York, , 10th Edition, 2010.
2. Veerarajan T., Engineering Mathematics (for first year), TMH Publishing Company Limited, New Delhi, 5th Edition 2015.

MA 14.201 **Applied Mathematics** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): None

Objective(s):

- To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1. **Linear Programming:** Introduction, graphical method (bounded & unbounded solutions), Simplex method, artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). [12]
2. **Numerical Methods:** Solution of system of equations (Gauss elimination and Gauss – Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods), solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector Runge-Kutta methods) [10]
3. **Complex Analysis:** Function of complex variable, analytic function, Cauchy- Riemann equations (without proof), integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula (without proof), zeros and singularities of complex functions, residues. [6]
4. **Integral Transform**: Laplace transform and inverse Laplace transform, first and second shifting theorems, convolution theorem (without proof), solution of ordinary differential equations with initial conditions by Laplace transforms, Fourier series of periodic functions, even and odd functions, Fourier half-range series, basics of Fourier transform. [12]

Outcome(s):

- After completion of the course, students would be able to apply the knowledge of linear programming, numerical methods, complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH,2nd 2007.
2. Grewal B.S. & Grewal J.S., Higher Engineering Mathematics, Khanna publishers, 40th Edition: 2007.
3. Taha H.A., Operation Research: An Introduction, Pearson,8th edition 2006.
4. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.

Reference Books:

1. Jain R.K. & S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 5th Edition 2016.
2. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
3. James B. Scarborough, Numerical Mathematical Analysis, Oxford & IBH Publishing Co. Pvt. Ltd.
4. Babu Ram, Engineering Mathematics, Pearson, Year 2010.

MA 14.202 **Statistics and Probability Theory** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): Nil.

Objective(s):

- To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

1.	**Introductory Ideas:** Recapitulation of Basic Probability theory; Law of addition and law of multiplication ;conditional probability; total probability; Bayes' theorem and it's applications.	[6]
2.	**Random Variables and Distribution:** Discrete and continuous random variables; types of distribution; probability mass and density functions; mean, variance and standard deviation of distribution.	[4]
3.	**Theoretical Probability Distribution:** Discrete types (Binomial) and Continuous type (Normal, Student's't'); applications of basic ideas to these distributions	[8]
4.	**Sampling Theory:** Sampling distribution of mean and variance; central limit Theorem.	[4]
5.	**Testing of Hypothesis:** Simple and Composite hypothesis; Type I and Type II errors; tests of significance and level of significance.	[4]
6.	**Correlation and Regression:** Simple, partial and multiple correlations; linear regression.	[6]
7.	**Queuing Theory and Queuing Models:** Birth and death process; pure birth and pure death process; Classification of queuing models: M/M/1, M/M/1/N, M/M/S and M/M/S/N.	[8]

Outcome(s):

- After completion of the course, students would be able to apply the knowledge of Statistics and Probability in engineering and solve curriculum problems.

Text Books:

1. A.P.Baisnab and Manoranjan Jas, Elements of Probability and Statistics, TMH, 2003.
2. Pugalararasu, Probability and Queuing Theory, TMH, 2011.
3. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, 2002.
4. Gupta & Kapoor, Fundamental of Applied statistics, SCS Publisher, 2001.
5. B.V. Ramana, Higher Engineering Mathematics, TMH, 2006.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH, 2002.
2. Palaniammal, Probability and Random Processes, PHI, 2012.
3. Spiegel, Probability and Statistics (Schaum's outline Series), TMH, 2004.
4. Miller and Freund's, Mathematical Statistics with Applications, 7th Edition, Pearson, 2003.
5. Richard A. Jonson, Probability and Statistics for Engineers, Pearson, 2005**.**

ME-14.101 **Applied Mechanics** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- This course will help the student to acquire knowledge of basic engineering mechanics concepts and enhance their ability to solve open-ended engineering problems.
- To provide the student with a clear and thorough understanding of the theory and applications of engineering mechanics, covering both statics and dynamics.
- To provide the student with a thorough understanding of the concept, drawing, and the use of free-body diagrams.
- To be able to determine the Centre of Gravity and Moments of Inertia of simple geometric shapes and understand the physical applications of these properties.
- To understand the use and be able to perform calculations related to friction forces in engineering applications.

1. **Introduction:** Idealization of Mechanics, theconcept of Rigid Body, External Forces (Body forces & surface forces), Laws of Mechanics. [3]

2. **Force Systems and Equilibrium**: Introduction to vector, Statically Equivalent Force systems,Free Body Diagram, Equations of equilibrium and their applications to thevarious system of forces. [8]

3. **Distributed Forces and Moment Of Inertia**: Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, Principle axes and Principle Moment of Inertia. [5]

4. **Friction:** Introduction of friction, Laws of friction, wedge, screw, belt, rolling friction. [5]

5. **Tension,Compression, and Shear:** Normal stress and strain, Linear elasticity, Hooke's Law and Poisson's Ratio, Shear stress and shear strain, Relationship between modulus. [4]

6. **Beams:** Different support & load conditions, SFD, BMD [5]

7. **Kinematics of Particles**: Introduction, Rectilinear motion, Plane curvilinear motion, Rectangular coordinates, Tangential and normal coordinates, polar coordinates, Relative motion (Translating Axes), constrained motion of connected particles. [5]

8. **Kinetics of Particles:** Introduction, Force, Mass and acceleration, Newton's second law of motion, Equation of motion and solution of problems, Work and Energy, Impulse and Momentum. [5]

Outcome(s):

- The students shall develop the ability to identify, formulate, and solve engineeringproblems related to forces and motion.

Text Books:

1. Timoshenko, S, Young, D.H, Rao, J.V, Engineering Mechanics, 4th edition TMH, 2010.
2. Merian, J.L, Kraige, L.G., Engineering Mechanics Vol I & II, 7th edition Wiley India 2015.

Reference Books:

1. Hibbeler, Gupta R. C., Engineering Mechanics, 11th ed.,Pearson India, 2010.

ME-14.111 **Computer Aided Engineering Drawing** **Total Lectures: 40**

Credit: 0-0-4-2

Prerequisite(s): NIL

Objective(s):

- To improve the visualization skills.
- To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
- To impart the knowledge of understanding and drawing of simple engineering products.

1. **Introduction to Computer Aided Sketching**: Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and freehand practice. Board Drawing vs. Computer- Aided Drawing. Introduction to Solid works Environments. Computer screen, thelayout of the software, standard toolbar/menus and description of most commonly used toolbars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP &LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, dimensioning, line conventions, material conventions and lettering. [8]

2. **Orthographic Projections**: Horizontal planes, Vertical planes, Front view, Top view, Side view, Projections, theFirst and Third angle of projection, Projections of points, Principles of orthographic projections, Sketching of different views of given objects. Introduction to sketching in Solid works : 2-Dimensional Sketching, Sketching in Solid works, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination, and perpendicularity. [12]

3. **Projections of Lines, Planes, and Solids**: Lines inclined to both the principal planes, theprojection of Lamina inclined to both principal planes, Projections of solids: Axis inclined to both the reference planes and Intersection of solids. Introduction to thepart module in Solid works: Extrude, Revolve, Sweep, Hole, Filleting, and Chamfering features. [12]

4. **Sections of solids and sectional orthographic views:** Sectional orthographic projections - Full,Half, Partial, revolved and removed surfaces. Introduction to drawing module in Solid works:Standard 3 views, Auxiliary view, Section View, Projected view. [12]

5. **Isometric Projection:** Terminology, Isometric scale, Box method, Coordinate or offset method, Four-center method, theisometric projection of arcs. Solid models practice using Solid works partmodule. [8]

Outcome(s):

- Students will be able to improve their visualization skills so that they can apply these skills in developing new products.
- Students will be able to know and understand the conventions and the methods of engineering drawing using Solid works.
- Students will be able to prepare simple drawings of engineering products.

Text Books:

1. N.D. Bhatt, "Engineering Drawing",Charotar Publishing House, 2017.
2. Prof. Sham Tickoo, Sandeep PremDass Solid works 2013 for Engineers and Designers Wiley Publication, 2017.

Reference Books:

1. Randy H. Shih, Solid works 2017 and Engineering Graphics: An Integrated Approach, SDC Books: Publications. 2017
2. David Planchard, "Engineering Graphics with Solid Works 2014 and Video Instruction", SDC Publications, 2013.

ME-14.112 **Mechanical Workshop** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To learn various hand tools used in fitting, carpentry and sheet metal shop.
- To learn about lathe and drilling machine and their operations.
- To learn how various joints are made using wood and other metal pieces.

1. Fitting Shop: Prepare job that contains various fitting operation like filing, marking, measuring, cutting, drilling etc.

2. Carpentry Shop: Making of carpentry joint (T, L joint etc).

3. Sheet Metal Shop: Making job from thesheet (funnel, tray etc).

4. Machine Shop: Perform various operations like turning, step turning, facing, chamfering, knurling etc. on Lathe.

Outcome(s): Students will able to:

- Understand use of tools of Fitting, Carpentry & Sheet Metalworking operations
- Study and practice on lathe and drilling machine and their operations
- Acquire engineering skills in Fitting, Carpentry & Sheet Metalworking operations

MT 201 **Engineering Economics** **Total Lectures: 24Credit: 2-0-0-2**

Prerequisite(s): NIL

Objective(s):

- To know about the basic concepts of Engineering Economics and its role in Indian economy.
- To understand about the elements of economics with application to the industrial sector and its impact on Economy.
- To discuss about the market demand analysis, production analysis and pricing mechanism for decision making.
- To find the role of consumer perception in market demand and its features and infrastructure development in India.
- To discuss about cost analysis and optimization techniques with multiple objectives.

1.	**Introduction to Engineering Economics:** Origin, principles, engineering economics and design process, engineering for economic competitiveness, engineering economy and the engineer.	[3]
2.	**Elements of Economics:** Definition, demand and supply, income, equilibrium, utility.	[3]
3.	**Economics applied to Industries:** Market demand analysis, production analysis for decision Making, cost analysis, pricing techniques in regards of goods and services, break even analysis, interest, annuities and profits.	[12]
4.	**Replacement Analysis:** Capital recovery, depreciation methods for replacement studies.	[2]
5.	**Optimization Techniques:** Economics and optimization, price mechanism and optimal resource allocation, optimization under constraints, optimization under risk and uncertainty,	[4]

Outcome(s): Students would

- Be able to perform and evaluate payback period and capitalized cost on one or more than one economic alternatives.
- Be able to carry out and evaluate the benefit/cost, break even analysis on one or more alternatives.
- Have the knowledge of fundamentals of Engineering Economics for the purpose of economic condition of the country.

Text Books:

3. **Salvetore Dominick, Managerial Economics, Prentice Hall of India,6th Edition, 2008.**
4. **Christopher Thomas, S Charles Maurice, Managerial Economics, Mc-Graw Hill,11th Edition, 2012.**

Reference Book:

2. **Van Horne,James C., Fundamentals of Financial Management, Pearson Education,13thEdition, 2009.**

PY-14.101 **Engineering Physics** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To make a bridge between the physics in school and engineering courses.

1. **Modern Physics**: Introduction to black body radiation spectrum, photoelectric effect, Compton effect. Wave-particle Dualism, deBroglie hypothesis, de Broglie wavelength, extension to electron particle, Davisson and Germerexperiment,matter waves and their characteristic properties, phase velocity, group velocity and particle velocity, relation between phase velocity and group velocity, relation between group velocity and particle velocity,expression for deBr;oglie wavelength using group velocity. [8]

2. **Quantum Mechanics:** Heisenberg's uncertainty principle and its physical significance, application of uncertainty principle (non-existence of electron in the nucleus, explanation for decay and kinetic energy of electron in an atom), wave function, properties and physical significance of wave function, probability density and normalization of wave function,setting up of one dimensional time independent Schrodinger wave equation, eigenvalues and eigenfunctions, application of Schrodinger wave equation, energy eigenvalues for a free particle,energy eigenvalues and eigenfunctions for a particle in a potential well of infinite depth. [7]

3. **Electrical Conductivity in Metals**: Free–electron concept, classical free electron theoryAssumptions, drift velocity, mean collision time and mean free path, relaxation time,expression for drift velocity, expression for electrical conductivity in metals,effect of impurityand temperature on electrical resistivity of metals,Quantum free electron theory assumptions, Fermi – Dirac statistics, Fermi-energy, Fermifactor, density of states (No Derivation),expression for electrical resistivity / conductivity,temperature dependence of resistivity of metals, electron in a periodic potential, origin of theenergy gap, band theory of solids, distinction of solids into metals, semiconductors andinsulators. [8]

4. **Dielectric & Magnetic Properties of Materials**: Dielectric constant and polarization of dielectric materials, types of polarization, equation for internal field in liquids and solids (one dimensional), Ferro and Piezoelectricity,frequency dependence of dielectric constant, important applications of dielectric materials,classification of dia, para and ferro-magnetic materials, hysteris in ferromagnetic materials, soft and hard magnetic materials,applications. [7]

5. **Lasers and Optical Fibers**: Einstein's coefficients (expression for energy density), requisites of a Laser system, condition for laser action, principle, construction and working of CO_2 laser and semiconductor laser, applications of laser – Laser welding, cutting and drilling, measurement of atmospheric pollutants, holography–principle of recording and reconstruction of images, applications of holography, propagation mechanism in optical fibers, angle of acceptance, numerical aperture, types of optical fibers and modes of propagation, attenuation, application, block diagram discussion of point to point communication. [10]

Outcome(s):

- The student will be able to understand many modern devices and technologies based on lasers and optical fibers. A student can also appreciate various material properties which are used in engineering applications and devices.

Text Books:

1. S. O. Pillai, Solid State Physics, 8th Edition, New Age International, 2018.
2. V. Rajendran, Engineering Physics, TMH,2nd edition 2010.

Reference Book:

1. G. K. Shivkumar, Engineering Physics, Prism Book Pvt. Ltd,2011.

PY-14.111 **Physics Lab** **Credit: 0-0-2-1**

Prerequisite(s): NIL

Objective(s):

- To make the students gain practical knowledge to co-relate with the theoretical studies.

1. To study the material constant, temperature coefficient of current and Planck's constant.
2. To determine the specific resistance of a given wire by using the Carey Foster's bridge.
3. To determine the ballistic constant, K of a moving coil ballistic galvanometer with a standard capacitor of known capacity.
4. To determine the high resistance by the method of leakage of a condenser with the help of ballistic galvanometer.
5. To study the variations of resistivity with temperature and hence determines the energy band gap of the given semiconductor with help of four probe method.
6. To convert a galvanometer into a voltmeter of a given range.
7. To convert a galvanometer into an ammeter of a given ranges.
8. To plot graph showing the variation of magnetic field with distance along the axis of a circular coil carrying current and to estimate from it the radius of the coil.

Outcome(s):

- After completion of the course, students would be able to develop the skills necessary to perform experiments in physics and acquire an experience of the methods used and analysis needed in experimental physics.

RM 17.101 **Research Methodology** **2-0-0-2**

1. **Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research. [2]

2.**Problem Formulation:** Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature, Research Gaps. [4]

3. **Research Design:** Research Framework, Meaning & Significance of Research Designs, Features of a good Research Design, Types of Research Design. [4]

4. **Data for research:** Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis. [4]

5. **Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [8]

6. **Report Writing:** Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [4]

TextBooks:

1. R.Pannershelvam, "Research Methodology" Prentice Hall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"Research Methodology: Methods and Techniques", New Age International (p) Limited, Publishers New Delhi, 4ndedition, 2018.

References –

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013.
4. Dr. A.K. Phophalia, “Modern Research Methodology: New Trends and Techniques” Paradise Publishers Jaipur, 1st edition, 2012.
5. Pankaj Madan, “Research Methodology”, Global Vision Publishing House, New Delhi, 2nd edition, 2016.

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College of Engineering & Technology

Department of CSE

Course structure for

BCA

CA 16. 101 **Computers Fundamentals** **3-0-0-3**

Total Lectures: 40

1. **Introduction to Computers:** Definition, Block Diagram, characteristics, Applications in Modern Society, History, Classification of computers and Generation of computers. [6]
2. **Functional Units of Computer Processing System:** Hardware, CPU, Memory and secondary storage devices, Input devices, Output Devices, Information Concept and Processing: Data, Information, Knowledge and Wisdom. [8]
3. **Data representation:** Representation of Data, Bits and Bytes, Number System: Decimal, Binary, Octal, Hexadecimal, Conversions b/w number system, Arithmetic Operations in Binary Number, ASCII, EBCDIC and BCD Codes. [8]
4. **Software Concepts:** Types of Software, Generation of Programming Language: Machine Language, Assembly Language, High Level Language, Translator: Assembler, Interpreter, Compiler, Operating System**:** Functions, types of operating system: Batch Processing, Multiprogramming, Multiprocessing, Multitasking, Time Sharing and Real Time System, MS-DOS, MS-Windows. [9]
5. **Data Communication and Computer networks:** The Basic Communication System, Data Transmission Modes, Network types, Network Topologies, Internet and its Applications: E-mail, World Wide Web, Intranet, Extranet, Computer Threats: Virus, Worm, Trojan horse, Malware. [9]

Text Books:

1. Sinha , Pradeep K. and Sinha, Priti, “Computer Fundamentals”, BPB Publications, Third Edition.

Reference Books:

1. ITL Education Solutions Limited, “Introduction to Computer Science”, Pearson Education, Third Edition, New Delhi.
2. Rajaraman, V., “Introduction to Computer”, PHI, New Delhi.
3. Thareja, Reema, “Fundamentals of Computers”, Oxford University Press India, Second Edition.

CA 16.102 **Operating System** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Definition and types of operating systems, Batch Systems, multi programming, time sharing, distributed and real-time systems, Operating system structure, Operating System Components and Services, System calls, System Programs, Virtual Machines. [4]
2. **Process Management:** Process Concept, Process States, Process Control Block, Operations with examples from UNIX (fork, exec) and/or Windows, Inter-process communication (shared memory and message passing), Scheduling Algorithms, Performance Evaluation. [7]
3. **Threads:** multithreaded model, scheduler activations, examples of threaded programs. Scheduling: multi-programming and time sharing, scheduling algorithms, multiprocessor scheduling, thread scheduling. [5]
4. **Process synchronization and Deadlocks:** critical sections, classical two process and n-process solutions, hardware primitives for synchronization, semaphores, monitors, classical problems in synchronization (producer-consumer, readers-writer, dining philosophers, etc.). Deadlocks-System model, Characterization, Deadlock prevention, Avoidance and Detection, Recovery from deadlock, Combined approach to deadlock handling. [8]
5. **Memory Management:** Logical and Physical Address Space, Swapping, Contiguous Allocation, paging and segmentation, demand paging, virtual memory, page replacement algorithms. [5]
6. **File Management:** Directory systems, File System Implementation issue, access methods, Allocation Methods, Free Space Management. [4]
7. **I/O Management:** Disk Structure, Disk Scheduling, Disk Management, Control of Various Devices, Device Drivers, Interrupt Driven and Poll Driven Data Transfer. [4]
8. **Security and Protection Mechanism:** Computer Security classification, Authentication, System threats, Goals of Protection, Access Matrix. [3]

Text Books:

1. Silbersachatz A.H. and Galvin P.B., "Operating System Concepts", Pearson Education.
2. Tannenbaum Andrew S., "Operating Systems", PHI, New Delhi

Reference Books:

1. Stallings William, "Operating Systems: Internals and Design Principles", Prentice-Hall, New Delhi
2. Dhamdhere D. M. "System Programming and Operating System", TMH New Delhi
3. Godbole Achyut S, "Operating Systems", TMH, New Delhi

CA 16.103 **C- Programming** **3-0-0-3**

Total Lectures: 40

1. **Introductory Concepts:** Introduction to computers, Computer characteristics, Types of programming languages, Introduction to C, identifiers and keywords, Data types: declaration and definition, Type conversion. [6]
2. **Operators:** Arithmetic, relational, logical, bitwise, unary, assignment, Increment and Decrement operators, conditional operators and their hierarchy, associativity, Data input/output. [8]
3. **Control Structure:** Introduction, Conditional Statements; Simple If-Else; Nested Statements, switch, Loops- For, While, Do-While; Break, Continue, Go-To Statements, Labels, Printf, Scanf function. [7]
4. **Array:** Defining an array, processing an array, passing arrays to functions, Multidimensional arrays, Arrays and strings. [6]
5. **Function and Pointer:** A brief overview, Defining a function, accessing a function, function prototypes, passing arguments to a function, recursion. Pointers: Declaration, operations on pointers, array of pointers, pointers to arrays. [7]
6. **Advance C Concepts:** Structure, Union, storage classes in C, Concept of files file access in different modes, reading from and writing into a file, Library Functions. [6]

Text Books:

1. Kernighan, Brain W. and Ritchie, Dennis M., "The C Programming Language," Second edition 2013, Pearson Education.
2. Gottfried ,Byron S. and Schaum's, "Programming with C," 2nd Edition, Tata McGraw-Hill, 2006.

Reference Books:

1 Schildt ,Herbert, "C: The Complete Reference," Fourth edition, McGraw- Hill Education, 2000.

2 Kanetkar ,Yashwant, "Let us C," Fifth Edition BPB Publication,2006.

3 Balagurusamy , E, "Programming in ANSI C," Tata McGraw-Hill Education.

CA 16. 104 **Data Structures** **3-0-0-3**

Total Lectures: 40

1. **Introduction**: Overview of data structure, types of data structures and operations. Applications of data structures [2]

2. **Pointer and dynamic memory allocation:** Pointer declaration and initialization, accessing a variable through its pointer, meaning and advantages of dynamic memory allocation, Memory allocation functions. [3]

3. **Array:** Representation of single and multidimensional array. [2]

4. **Sorting and Searching Techniques:** Insertion Sort, Selection Sort, Merge Sort, quick sort, Linear Search, Binary Search [8]

5. **Stack :** Definition and representation of stack, operations on stack, Infix, Postfix, Prefix Expressions, Conversion from Infix to Postfix (Algorithms only). [7]

6. **Queue**: Introduction and types of queues, Primitive Operations on Queues. [7]

7. **Linked List:** Introduction to Linked List, implementation of Linked List, operations on linked list: creation, deletion, search and display [7]

8. **Tree:** Introduction and Terminology, Traversal of Binary Trees [4]

Text Books:

1. Schaum Series, "Data Structures", TMH, New Delhi.

Reference Books:

1 Langsam , Augenstein and Tannenbaum, "Data Structure Using C and C++", PHI, New Delhi.
2 Horowithz and Sahani, "Fundamentals of Data Structure", Galgotia Book Source Pvt. Ltd. , New Delhi.
3 Kanitker Y., "Let us C", BPB Publication New Delhi.
4 Balagurusamy, E , "Programming in C", TMH, New Delhi.

CA 16.105 **Management Accounting** **2-0-0-2**

Total Lectures: 26

1. **Basics of Accounting:** Nature of accounting information, accounting principles – concepts and conventions, accounting equation and financial statements – sole trade, corporate entities (P&L account, balance sheet including adjustments). [6]
2. **Computerized Accounting:** Uses of Microsoft Excel in accounting, analyses of balance sheet with Excel, Tally software - application. [2]
3. **Analysis and Interpretation of Financial Statements:** Ratio analysis as a tool of decision-making; fund flow statement, cash flow statement. [5]
4. **Basic Cost Concepts:** Meaning, nature, classification; inventory valuation, marginal costing and its usage in managerial decision-making. [7]
5. **Long Term Financing and Capital Budgeting:** Sources of long term finance- shares, debentures, capital budgeting – types of projects, non-discounted and discounted cash flow techniques – payback period, internal rate of return and net present value method. [6]

Text Books:

1. Maheshwari S.N., Management Accounting & Financial Control, Sultan Chand & Sons, 14th Ed., 2003
2. Bodhanwala R. J., Understanding and Analyzing Balance Sheets Using Excel Worksheet, Prentice-Hall of India, 2004.

Reference Books:

1. Horngren C. T., Sundem G.L. and Stratton W. O., Management Accounting, Prentice-Hall of India, 12th Ed., 2003.
2. Narayan S. R., Financial Accounting- A Managerial Perspective, Prentice-Hall of India, 2004.
3. Banerjee A., Financial Accounting – A Managerial Emphasis, Excel Publishing House, 2004.

CA 16.106 **System Analysis and Design** **3-0-0-3**

Total Lectures: 40

1. **Introduction to system:** Definition, characteristics and elements of system, types of system, System development life cycle, Role of system analyst. [6]

2. **System Planning and Initial Investigation**: Introduction, bases for planning in system analysis, initial investigation, fact finding, information gathering, information gathering tools, fact analysis, determination of feasibility. [6]

3. **Structured Analysis:** Tools of structured analysis: DFD, data dictionary, flow charts, Gantt charts, decision tree, decision table, structured English, pros and cons of each tool. [7]

4. **Feasibility Study**: Objective, types, Steps in feasibility analysis, feasibility report, oral presentation, cost and benefit analysis, classification of costs and benefits. [5]

5. **System Design**: Objective, logical and physical design, design methodologies, structured design, form-driven methodology (IPO charts), structured walkthrough. [6]

6. **Input/ Output and Form Design**: Objectives of input and output design, form design, classifications of forms, requirements of form design. [5]

7. **System Testing and Implementation**: Objectives of testing, test plan, testing techniques/types of system tests, quality assurance goals in system life cycle, System implementation. [5]

Text Books:

1. Awad Elias M, "System Analysis and Design", Galgotia Pub.(P) Ltd.,2nd Edition,2008

Reference Books:

1 Hawayszkiewyez Igor, "Introduction To System Analysis and Design" PHI, New Delhi

2 Mark Lejk and Deeks David , "An Introduction to System Analysis Techniques" PHI, New Delhi.

3 Whitten , Jeffrey L and Lonnie, D Bentey, "System Analysis and Design Methods", TMH. New Delhi

CA 16. 107 **Mathematics** **3-1-0-4**

Total Lectures: 40

1. **Matrix and Determinant:** Definition, types of matrices, addition, subtraction, scalar multiplication and multiplication of matrices, adjoint, inverse, rank of matrix, dependence of vectors, Eigen values and vectors of a matrix, Cayley-Hamilton Theorem (without proof), solution of system of simultaneous equations, definition of determinant, minors, cofactors, properties of determinants. [12]
2. **Differentiation:** : Limit at a point, properties of Limit, computation of limits of various types of functions, continuity at a point, derivative, derivatives of sum, differences, product and quotients, chain rule, derivatives of composite functions, logarithmic differentiation, maxima and minima of functions of single variable. [12]
3. **Integration:** Indefinite integrals, methods of integration substitution, by parts, partial fractions, integration of algebraic and transcedental functions, definite integrals and properties. [8]
4. **Ordinary Differential Equations:** Definition, order and degree of equation, solution of ordinary differential equations of first order and first degree, equations in which variables are separable, homogeneous and reducible to homogeneous equations, linear and reducible to liner equations, exact and reducible to exact equations.. [8]

Text Books:

1. Narayan, Shanti “Integral Calculus”, S. Chand & Company, 19993.

2 Dass, H.K., “Advanced Engineering Mathematics”, S. Chand & Company.

Reference Books:

1 Zill, Dennis G. ,Warren Jones, S. ,Wright and Barlett Learning “Advanced Engineering Mathematics”, Student Edition, Canada,2011

2 Ramana B. V., “Higher Engineering Mathematics”, McGraw Hill, New Delhi,2006.

CA 16. 108 **Digital Electronics** **3-1-0-4**

Total Lectures: 40

1. **Number System:** Binary, octal, Hexadecimal Number, their addition and substraction, Base conversions, Number code: 8421, Other BCD codes, Grey, ASCII, EBCDIC. Boolean Algebra: Laws and theorems of Boolean algebra. De Morgan's theorem, XOR and XNOR gates, Half and Full Adder and Subtractor circuits. [10]
2. **Fundamentals**: Products, Sum of products and Product of sums, Form of Boolean expressions, Truth Tables and Karnaugh maps, pair reads octets and Karnaugh simplification. Mltiplexers BCD to Decimal to BCD decoders and, decoders' characteristics of digital integrated digitals. [10]
3. **Flip Flop:** RS Flip Flop, Clocked, RS Flip Flop, Edge trigger D Flip Flop. Flip Flop Switching time, OK Flip Flop. JK Master Slave Flip Flop, Clock wave forms, Shift registers: Serial in and serial out, Parallel in and parallel out, Counters: Asynchronous counters Synchronous counters, ring counter. [10]
4. **Memories for Digital:** System: Semiconductor Memories, Memory organization and expansion, classification of memories on' the basis of principles of operation, physical characteristics and fabrication technology, ROM and basic memory cells. [10]

Text Books:

1. Moris Mano, "Digital Logic and Computer Design", PHI Publications, 2002
2. R. P. Jain, "Modern Digital Electronics", TMH, 3rd Edition, 2003.

Reference Books:

1. R.L. Tokheim, "Digital Electronics, Principles and Applications", Tata McGraw Hill, 1999.
2. W. Gothman, "Digital electronics", PHI.
3. S. Salivahanan & S. Arivyhgan. "Digital circuits and design", Vikas Publication, 2001

Testing:

- MS Word

Programs:

- Working with Documents.
- Formatting Documents.
- Setting Page style.
- Creating Tables.
- Drawing.
- Tools.
- Printing Documents.

Testing:

- MS Excel

Programs:

- Spread Sheet & its Applications, Opening Spreadsheet, Menus.
- Entering & Deleting Data.
- Setting Formula.
- Formatting Spreadsheets.
- Working with sheets.
- Creating Charts.
- Using Tools.

Testing:

- MS Access

Programs:

- Starting Access, Access Screen, Creating a New Database.
- Creating Tables.
- Working with Forms.
- Creating queries.
- Finding Information in Databases.
- Creating Reports.
- Types of Reports.
- Printing & Print Preview – Importing data from other databases viz. MS Excel etc.

Testing:

- MS Power Point

Programs:

- Creating a presentation.
- Formatting a Presentation.
- Adding Effects to the Presentation.
- Printing Handouts.

Testing:

- One Dimensional Array
- Two Dimensional Array

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of Linked List
- Operations on Linked list

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of stack using array and Link List.
- Operations on stack.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Implementation of Queue using array
- Operations on queue.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

- Searching
- Sorting

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

CA 16.135 **C Programming Laboratory** **0-0-4-2**

1. Introduction to C
Testing:
• Data Types & Operators
• Type Conversions

Programs:
• Significant number of programmes in order to cover all contents of unit 1 (at least 6)

2. Operators
Testing:
• Arithmetic, Relational, logical operators
• Bitwise, unary, assignment operators
• Increment and Decrement operators
• Conditional operators
Programs:
• Significant number of programmes in order to cover all contents of unit 2 (at least 10)

3. Control Structure
Testing:
• If-Else statements
• Nested If-Else statements
• Switch
• Loops- For, While, Do-While
• Break, Continue, Go-To Statements, Labels
Programs:
• Minimum 12 programmes to cover all contents of unit 3

4. Array
Testing:
- Processing an array
- Passing arrays to functions
- Multidimensional arrays
- Strings

Programs:
• Minimum 6 programmes to cover all contents of unit 4

5. Function and Pointer
Testing:
- Function prototypes and passing arguments to a function
- Recursion
- Pointers declaration, operations on pointers
- Array of pointers, pointers to arrays

Programs:
• Minimum 6 programmes to cover all contents of unit 5

6. Advance C Concepts

Testing:

- Structure
- Union
- Storage classes in C
- Reading and writing from/to a file

Programs:

• Minimum 6 programmes to cover all contents of unit 6.

1. Process and Thread Creation

Testing

- Creation of Process and Thread
- Operations with Process

Programs

- A process to be created with structure or class containing parameters like process- id, arrival time, starting time, end time etc.

2. CPU Scheduling Algorithms

Testing

- Average Waiting Time
- Average Turnaround Time
- Response Time
- Multithreading

Program

- FCFS (with and without arrival time)
- SJF (Preemptive and non-preemptive)
- Round Robin (with and without context switch time)
- Priority scheduling (With and without arrival time)
- Demonstrating time sharing

3. Memory Management Techniques

Testing

- External Fragmentation
- 50% Rule for Fragmentation

Program

- First Fit
- Best Fit
- Worst Fit.

4. Page Replacement Algorithms

Testing

- Belady's Anomaly
- No. of page hits and misses

Program

- FIFO
- LRU
- Optimal Page Replacement Algorithm

5. Deadlock

Testing

- Safety algorithm
- Request algorithm

Program

- Deadlock Avoidance (Banker's Algorithm) for multiple instances of different resource types.
- Deadlock Detection Algorithm for multiple instances of different resource types.

6. I/O

Testing

- Disk Scheduling

Programs

- FCFS algorithm
- Scan algorithm
- C-Scan algorithm

CA 16. 201 **Computer Architecture** **3-1-0-4**

Total Lectures: 40

1. **Design of Simple Computer**: Micro Operation, Macro Operation, Bus and Memory Transfers, Arithmetic and Logic Micro Operations, Shift Micro Operation, Instruction and Instruction Types. [8]
2. **Instruction Cycle**: Timing and Control Instruction Cycle, Memory Reference Instructions, Input Output and Interrupts, Machine Language Instructions. [5]
3. **Computer Arithmetic**: Hardware algorithm and implementation for Addition, Subtraction, multiplication and division operations, floating point arithmetic operations. [6]
4. **Central Processing Unit**: General Register Organization, Stack Organization, Addressing Modes, Risc vs Cisc Pipeline and Vector Processing, Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, Risc Pipeline, Pipeline Difficulties. [8]
5. **Input Output Organization**: Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Programmed I/O, Interrupt I/O Direct Memory Access. [5]
6. **Memory Organization**: Memory Hierarchy, Main Memory, Auxiliary Memory, Associative, Cache Memory, Virtual Memory and Memory Management Hardware. [8]

Text Books:

1. Mano Morris, M., "Computer System Architecture", 3rd edition, Pearson.
2. Stallings William , "Computer Organization and Architecture", 9th Edition, Pearson

Reference Books:

1. Hwang Kai and Jotwani ,Naresh, "Advanced Computer Architecture", 2nd Edition, Tata McGraw Hill.
2.Blanchet ,Gérard, Dupouy, Bertrand, "Computer Architecture", 1st Edition, Wiley Publication.

CA 16.203 **Database Management System** **3-0-0-3**

Total Lectures:40

1. **Introduction**: An Overview of Database Management System, Comparison of Database System and File System, Characteristics of Database Approach, DBMS Architecture, Data Models, Schema and Instances, Data Independence. Data Modeling Using Entity Relationship Model: Entity, Entity Types, Entity Set, Notation for ER Diagram, Attributes and Keys, Concepts of Composite, Derived and Multivalued Attributes, Super Key, Candidate Key, Primary Key, Relationships, Relation Types, Weak Entities, Inheritance, Specialization and Generalization. [10]

2. **Relational Data Model:** Relational Model Terminology: Domains, Attributes, Tuples, Relations, Characteristics of Relations, Relational Constraints: Domain Constraints, Key Constraints, Relational Database Schema, Relational Database Design By ER To Relational Mapping. Introduction to SQL. [11]

3. **Normalization:** Functional Dependencies, Armstrong's Inference Rule, Normal Form up to Boyce Codd Normal Form. [4]

4 **Relational Algebra:** Selection, Projection, Set Theoretic Operations Union, Intersection, Set Difference And Division, Inner, Outer, Left Outer, Right Outer and Full Outer Join. [8]

5. **Transaction Processing And Concurrency Control:** Definition of Transaction, Desirable ACID Properties, Serializable And Non Serializable Transactions, Concurrency, Lost Update, Dirty Read, Concurrency Control Techniques: Locking, 2PL [7]

Text Books:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamentals of Database Systems", Pearson Education, 7th Edition, 2015.

Reference Book:

1. Jeffrey A. Hoffer, Mary B. Prescott and Fred R. McFadden, "Modern Database Management", Prentice Hall, 8th Edition, 2006.

2. Avi Silberschatz , Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw-Hill, 6th Edition, 2011.

CA 16. 204 **Computer Networks** **3-1-0-4**

Total Lectures:40

1	**Introduction:** Computer networks; Network topologies, protocols and standards, Network devices: repeaters, bridges, gateway, Routers; categories of networks- LAN, WAN and MAN.	[7]
2	**OSI and TCP/IP Model:** Layers and their function, OSI reference model, TCP/IP model, Comparison of models.	[5]
3	**Physical layer:** Transmission Media: guided and unguided; Attenuation, Distortion, Noise, Propagation, Switching, ISDN & its service, Multiplexing: Time division & frequency division multiplexing	[8]
4	**Data Link Layer:** Functionality, Design Issue, Error Detection & Correction Codes, MAC, Static & Dynamic Channel Allocation, Introduction to IEEE standards.	[6]
5	**Network Layer:** Routing Algorithms, Flooding, Broadcast & Multicast routing, congestion Control & internetworking, Quality of services	[7]
6.	**Application Layer :** Network Security & Privacy, Data Compression & Cryptography, Electronic Mail, The WWW, Multimedia, Audio, Video, DNS, FTP, HTTP, SMTP, telnet etc.	[7]

Text Book

1. Tanenbaum A. S., "Computer Networks", Prentice-Hall of India, 4th Ed., 2002.
2. Stallings W., "Data and Computer Communications", Prentice-Hall of India, 5th Ed., 2003.

References Books

1. Forouzan B. A., "Data Communications and Networking", Tata McGraw-Hill, 3rd Ed., 2004.
2. Hayes J. F., "Modeling and Analysis of Computer Communication Networks", Khanna Publishers, 1987.

CA 16. 205 **Management Information System** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Elements, characteristics, objectives and importance, relationship between MIS and Computer, role of MIS in the functions of management. [7]

2. **Information Concept:** Classification of information, levels of information, techniques of data collection, quality aspect of information, value of Information. [7]

3. **Decision Making:** Decision making concepts, rationality in decision making, decision support system, MIS as a technique for programmed decisions, structured Vs Un-structured decisions, formal vs. informal systems, model of decision making, methods, MIS and role of decision making. [8]

4. **Manager and Computers:** Database concept, database models, database design, RDBMS, MIS and RDBMS, network topology, LAN, MAN, WAN and data communication. [6]

5. **Development of MIS:** Strategic and project planning for MIS, conceptual system design, detailed design, implementation, evaluation and maintenance of the MIS, pitfalls of MIS. [6]

6. **Applications of MIS:** MIS for marketing, financial, production management, human resource management. [6]

Text Books:

1. Jawadekar,W. S. "Management Information System", Tata McGraw- Hill Publishing Co. Ltd., New Delhi

Reference Books:

1 Murdick, R, G, Ross J E and Clagget, J,R, "Information Systems for Modern Management", PHI, New Delhi

2 Sadagopan, "Management Information System", PHI, New Delhi.

3 Parker, Case Thomas, "Management Information System: Strategies and Action", Tata McGraw- Hill Publishing Co. Ltd., New Delhi

CA 16. 206 **Computer Graphics** **3-1-0-4**

Total Lectures:40

1	**Basic Concepts:** Application Areas of Computer Graphics, Graphical User Interface, RGB Color model, CMY color models, Advantages of Computer Graphics.	[8]
2	**Graphics Hardware:** Random Scan Displays, Raster Scan Display (with Introduction to Flickering, Interlacing, American Standard Video), Color CRT Monitors, Flat Panel Display (Plasma Panel, Liquid Crystal Display, Electroluminescent Display).	[7]
3	**Raster Graphics Algorithms:** Line Drawing Algorithms-DDA, Bresenham's Algorithm, Circle and Ellipse Drawing Algorithms, Filling (Scan-Converting Polygon Filling, Inside Outside Tests Boundary Fill and Area Fill Algorithm). Cohen- Sutherland Algorithm of clipping	[12]
4	**Transformations:** 2-D Transformations (Rotation, Reflection, Shearing, Scaling), Homogeneous Coordinate Representation, and Translation.	[8]
5	**Animation Introduction:** Conventional and Computer-Assisted Animation, Animation languages, methods of controlling Animation, basic rules of Animation.	[5]

Text Books:

1. Zhigang X. and Plastock R.A., “Theory and Problems of Computer Graphics (Schaum's Outline)”, Tata Mc Graw Hill, New Delhi.

Reference Books:

1 Hearn Donald D. and Baker M.Pauline, “Computer Graphics” , Prentice Hall India, New Delhi.

2 Krishnamurthy N, “Introduction to Computer Graphics”, Tata Mc Graw Hill Edition, New Delhi.

CA 16. 207 **C++ Programming** **3-0-0-3**

Total Lectures:40

1. **Object Oriented Programming:** Basic concepts of object–oriented programming, Structured versus object- oriented programming, merits and demerits of object oriented methodology. [5]

2. **Beginning with C++:** Preprocessor directives, Variables, data types, constants, operators, scope resolution operator, memory management operators, decision and loop control structures, arrays, strings, functions. [7]

3. **Classes and Objects:** Class definition, Structure versus class, accessing member functions within a class, data hiding, arrays within a class, static data and member functions, objects, friend functions and friend classes, constant member functions, pointers to members, constructors and destructor. [8]

4. **Overloading and Exception Handling:** Definition, unary operator overloading, binary operators overloading, overloading of new and delete operators, manipulation of string using operators, type conversion, overloading with friend functions, function overloading, error and exception handling. [8]

5. **Inheritance and Overriding:** Derived and base classes, type of inheritance, derived class constructors and destructor, overriding member functions, public and private inheritance, virtual base classes, abstract classes, this pointer, virtual functions and pure virtual functions, static and dynamic bindings. [8]

6. **Introduction of I/O Streams and the Standard Library:** Header files, I/O stream library, stream I/O for objects, file I/O. [4]

Text Books:

1. Lafore Robert, "Object-Oriented Programming in C++", 4th edition, SAMS.
2. Balagurusamy E., "Object Oriented Programming With C++", 6th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Reference Books:

1 Stroustrup Bjarne,"Programming -Principles and Practice Using C++", Addison-Wesley.

2 Schildt Herbert, "C++: The Complete Reference", 4th edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

CA 16. 208 **Electronic Commerce** **3-0-0-3**

Total Lectures:40

1. **Electronic Commerce**: Overview and Scope, Traditional Commerce vs. Electronic Commerce, Impact of E-Commerce, Electronic Markets, Internet Commerce, e-commerce in perspective, Application of E Commerce in Direct Marketing and Selling, advantages and disadvantages, and future of E-commerce. [9]

2. **Business strategy in an Electronic Age:** Value Chains, Supply chain, Porter's value chain Model, Inter Organizational value chains, Strategic Business unit chains and industry value chains. [7]

3. **Business to Business E-Commerce**: Inter-organizational Transitions, Credit Transaction Trade Cycle, a variety of transactions. Electronic Data Interchange (EDI): Introduction, Benefits of EDI, EDI Technology, EDI standards, EDI Communication, EDI Implementation, EDI agreement, EDI security. [9]

4. **Electronic Payment System:** Introduction, Online Payment System, Prepaid Electronic Payment System, Post Paid Electronic System, E-Cheques, Credit Cards, Smart Cards, E-Purses, Debit Cards, Legal Risk of E-Payment System. [8]

5. **Securing Network Transaction:** Security Policy, Procedures and Practices, Transaction Security, Cryptography Algorithm, Public Key Algorithm, Authentication Protocol, Digital Signature, E-Mail Security. [7]

Text Books:

1. Whitely David, "E-commerce Strategy, Technology and application", Tata McGraw Hill Publications, New Delhi.

Reference Books:

1 Kalakota ,R. and Whinston, A. B. "Readings in Electronic Commerce", Addison Wesley.
2 Schneider, Gary P. and Perry ,Jame, "Electronic Commerce" Thomson Publication.
3 P.T. Joseph, S.J., "E-Commerce An Indian Perspective", PHI.

CA 16. 209 **Discrete Mathematics** **3-1-0-4**

Total Lectures:40

1. **Progressions:** Arithmetic Progression, Arithmetic mean, Harmonic Progression Harmonic mean, Geometric Progression, Geometric mean. [6]

2. **Set Theory:** Definition of Sets, Subsets, Cardinality of Sets, types of sets: Equal Sets, Universal Sets, Finite and Infinite Sets, proper set, power sets, Operations on Sets: Union, Intersection, Complement of Sets, set difference, Cartesian Product, Venn Diagrams, and Algebra of sets, duality, counting principle. [10]

3. **Relations and Functions:** Definition, types of relation, Ordered Pairs, properties of relation, equivalence relations, partial ordering relation. Function: Domain and Range, Onto, Into, and One to One Function, Composite and Inverse Functions. [8]

4. **Prepositional Calculus:** Propositions, Logical Connectives: conjunction, disjunction and negation, Truth Tables, Tautologies and Contradictions, Conditional and Bi-conditional statements. [8]

5. **Group Theory:** Definition of a group, properties of group, different types of group, subgroup, finite, infinitely, countable and Cyclic Groups. [8]

Text Books:

1. Lipschutz, Seymour and Lipson, Mar c “Discrete mathematics”, Tata Mc Graw-Hill Publications, Second Edition.

Reference Books:

1 Rremblay, J.P. and Manohar, R., “Discrete Mathematical Structures with Applications to Computer Science”, The McGraw Hill Companies.
2 Ross, Kolman Busby, “Discrete Matheamatical Structures”, Prentice Hall International.
3 Vasishtha, A. R., “Abstract Algebra” , KRISHNA Prakashan Media (P) Ltd.

CA 16. 210 **Java Programming** **3-1-0-4**

Total Lecture:40

1. **Basic Concepts:** Importance of Java, Java Byte code, Java and HTML, the Java buzzwords, using blocks of code, lexical issues, Java Class Libraries. [4]
2. **Java Programming:** Constants, Variables, Data Types, Operators, Type Conversion in Expression, Mathematical Functions, Decision Control Structure, Loop Control Structure, Arrays. [8]
3. **Classes:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, the this keyword, garbage collection, the finalize () method, overloading methods, using objects as parameters, returning objects, recursion, introducing access control, understanding static, introducing final, arrays revisited, introducing nested and inner classes, exploring the string class, using command-line arguments, Vector, Wrapper Classes. [5]
4. **I/O and String Handling:** I/O basics, reading console input, writing console output, the PrintWriter class, reading and writing files, string constructors, string length, special string operations, character extraction, string comparison, searching strings, modifying a string, data conversion using valueOf (), changing the case of characters within a string, StringBuffer. [6]
5. **Inheritance:** Inheritance basics, using super, create a multilevel hierarchy, constructors, method overriding, dynamic method dispatch, abstract classes, final with inheritance, object class. [5]
6. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, creating your own exception subclasses, using exceptions. [7]
7. **Applet Programming:** Applet life cycle, Creating executable application, Designing a web page, Applet Tag, Parameter passing in applets, Graphic Class, lines, rectangles, circle and ellipse, polygons. [5]

Text Books

1. Herbertz Shildt ,"Java The Complete Reference,", 7th ed.,TMH, New Delhi
2. Balagurusamy E, "Programming With Java " , TMH, New Delhi

Reference Books

1. Borror A. B., "Object-Oriented Programming with Java-an ultimate Tutorial", Dreamtech Press, 2000.
2. Budd T., "Understanding Object-Oriented Programming with Java", Pearson Education Asia, 2001.
3. Arnold K., Gosling J. and Holmes D., "The Java Programming Language", Addision-Wesley, 3rd ed., 2000.

CA 16.233 Database Management System Laboratory 0-0-4-2

Unit 1: Basic Commands

Testing: Create Table, Insert, Update, Alter, Delete, Where

Queries based on the above elements.

Unit 2: SQL Scalar functions

Testing: UCASE, LCASE, MID, LEN, NOW

Queries based on the above elements.

Unit 3: Aggregate functions

Testing: Max, Min, Sum, Count, Avg , First, Last

Queries based on the above elements.

Unit 4: Clauses

Testing: Distinct, Alias, Order by, Group by, Having

Queries based on the above elements.

Unit 5: Logical Operators

Testing:

OR, AND, Not, Between, Like, All, Any

Queries based on the above elements.

Unit 6: SQL Constraints

Testing: Not NULL, Check, Primary Key, Foreign Key, Cascade delete, Default

Queries based on the above elements.

CA 16. 234 **Internet Laboratory** **0-0-4-2**

UNIT I: Evaluate e-mail software and Web-based e-mail services

Testing: Mail configuration on different mail sites

Programs:

- Main features of e-mail and how it works
- Describe the Thunderbird and Opera e-mail clients
- Describe and use Web-based e-mail services
- Configure and use Outlook Express to send, receive, and print e-mail messages
- Create and maintain an address book in Outlook Express
- Configure and use Hotmail to send, receive, and print e-mail messages
- Create and maintain an address book in Hotmail

UNIT II: Use search engines and directories effectively

Testing: Web search tools **(**google, Google Scholar, DuckDuckGo**,** Metasearch engines**)**

Programs:

- Determine whether a research question is specific or exploratory
- How to formulate an effective Web search strategy to answer research questions
- Uses of Web search engines, Web directories, and Web meta search engines effectively
- Use Boolean logic and filtering techniques to improve your Web searches
- Use advanced search options in Web search engines
- Assess the validity and quality of Web research resources
- Describe the future of Web search tools

UNIT III: Use FTP and other services to transfer and store data

Testing: File Transfer Protocol

Programs:

- Describe what FTP is and how it works
- Demonstrate how to use an FTP client program and Web browser to transfer files
- Demonstrate navigation of an FTP site using a Web browser
- Demonstrate how to compress and decompress files and how to check them for viruses
- Download an FTP client program using a Web browser
- Install and use a compression program
- Trace the connection between your computer and a remote computer

UNIT IV: Important features of electronic commerce

Testing: E-Business

Programs:

- Important sites that conduct electronic commerce
- Basics of electronic commerce
- How companies generate revenues online
- Companies reduce costs and improve operational efficiency using Internet technologies
- New ways of doing business on the Web such as online auctions etc.
- International, legal, and ethical concerns for electronic commerce

CA 16. 235 **C++ Programming Laboratory** **0-0-4-2**

1. Introduction to C++
Testing:
• Data Types & Operators
• Control Statements
• Arrays
Programs:
• Significant number of programmes in order to cover all contents of unit 1 (at least 6)

2. Classes and Object
Testing:
• Class with function printing hello
• Class with default constructor
• Class with parameterized constructor
• Destructor
• Static and constant data
Programs:
• Apt number of programmes preferably based upon real life examples hotel billing, fee submission etc. (at least 6)

3. Inheritance and Polymorphism
Testing:
• Inheritance
• Function Overloading
• Operator overloading
• Overriding
• Comparisons between private, public and protected
• Virtual function and virtual class
• This pointer
• Exception handling
• Abstract class
Programs:
• Minimum 12 programmes to cover all contents of unit 3

4. I/O handling
Testing:
• Reading and writing from/to a file
• Output formatting
Programs:
• Programmes related with basic file operations (at least 5)

CA 16.236 Java Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types & Operators
- Control Statements
- Arrays

Programs

- Apply logic to print different patterns(at least 3)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- Implementing matrix operations
- Searching and Sorting

2. Classes, Object & Inheritance

Testing

- Objects and reference variables
- Constructors and parameterized constructors
- this, static, command line arguments
- Inheritance, overloading and overriding
- super, abstract classes and Dynamic method dispatch

Programs

- Write a program to illustrate super .
- Show method overloading to calculate the area of different shapes.
- Manipulate the above program to illustrate run time polymorphism.

3. I/O and String Handling

Testing

- Reading console input and writing console output
- BufferedReader class and PrintWriter class
- String operations and comparisons

Program

- Write a program to print the last characters of all the strings given from command line
- Change the case of characters within a string.
- Write an applet to print "HELLO"**.**

4. Package, Interfaces and Exception Handling

Testing

- importing packages
- interfaces and multiple inheritance
- exception-handling fundamentals
- built-in exceptions and creating one's own exception subclasses

Programs

- Write and execute a program which is inside a package "MyPacK".
- Write a program which imports a package.
- Write a program in which implements the concept of multiple inheritance.
- Write a program that handles two Exceptions, each at different run.

- Write a program in which an user defined exception is created.

5. Applet

Testing

- Applet Life Cycle
- Applet tag

Programs

- Write an applet to print “HELLO”**.**
- Write an applet to print different shapes.
- Write an applet to which works according to values passed through html page.

CA 16.301 **Web Technology** **3-0-0-3**

Total Lectures: 40

1. **Introduction:** Clients, Servers, and Communication, The Internet Basic Internet Protocols, The World Wide Web, HTTP request message, response message, Web Clients Web Servers. [5]

2. **HTML:** HTML Document, Markup Tags (HTML, HEAD, TITLE, BODY, PRE, LIST, HR, BR), Formatting Tags (MARQUEE, BOLD, ITALICS, SUBSCRIPT), Linking, URL, Relative Path Vs Absolute Path names, Images, Tables, Frames, Form Elements (Text, Buttons, List, Reset, Submit, Radio buttons, Checkbox); DHTML: Cascading Style sheets, Dragging, Dropping, Layers, Div tag. [8]

3. **JavaScript:** Declaration and Expressions, Control Structure and Functions, Variable scope Global Vs Local, Object in Java Script: Properties and Methods, Array Object, Date Object, Math Object, String Object, Events in java Script: Onblur, Onclick, on change, on focus, Design of Interactive forms; [9]

4. **VBScript:** Fundamentals, Variables, String, Constant, Date and Time, Arrays, control Structure, Design making, looping, Sub procedure, Object Methods and events, data validation. [7]

5. **XML:** Overview, Comparison of XML and html, components of XML, XML document, XML declaration, Root element, An empty element, attributes, Markup Delimiters, Element Mark Up, Attribute Mark Up, Naming Rules, Character References, Predefined Entities, Entity References, Cdata Sections, Processing Instructions, Document Type Declaration, Welformed and Valid Document, DTD and Validation, Internal DTD Subset, External DTD, Developing DTD, Elements and Attributes Of DTDs:- Empty Element, Only Element, Mixed Elements, Any Element, Creating a valid document from a DTD. [11]

Text Books:

1. Young M .L, " Internet Millenum Edition" TMH, New Delhi.
2. Jackson Jeffrey C., "Web Technologies -A Computer Science Perspective", Pearson Education, 2006.

Suggested Reading

1. Noel Jerkr, " Techunedia VB Scraper VB Script Interleave course", New Delhi 1998
2. Marlin Webb, "Java Scraper, Instant JavaScript", Tata McGraw-Hill, New Delhi.
3. Eathier Kay and Houser Alan **,** **"**XML programming in 2 ½ days," IDG Books India (P) Ltd

CA 16. 303 **Software Engineering** **3-0-0-3**

Total Lectures: 40

1. **Introduction:** Software Characteristics, Components and Applications, Software Engineering a layered Technology, Software life cycle models, Waterfall, Prototype, Evolutionary and Spiral Models. [8]

2. **Software Project Management:** Basic Concepts, Project Management: Core functions, support functions, Project Integration Management. [8]

3. **Software Project Planning:** Objectives, decomposition techniques: software sizing, problem based estimation, lines of code based estimation, and function point based estimation, process based estimation, Cost Estimation Models:- COCOMO, Risk Management. [8]

4. **Software Design:** Design Principles, Design Concepts:- abstraction, refinement, modularity, software architecture, structured partitioning, information hiding, effective Modular Design:- functional independence, cohesion and coupling, Object Oriented analysis and Design. [8]

5. **Software Testing:** Testing Fundamentals, Design of Test Cases, White box testing, Basis Path testing, Control structure Testing, Black box testing. [8]

Text Books:

1. Pressman R.S., "Software Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference Books:

1 Jalote Pankaj,"An Integrated Approach to Software Engineering", NAROSA.
2 Sommerville, Ian "Software Engineering", Pearson Education
3 Fairely, R.E., "Software Engineering Concepts", McGraw-Hill

CA 16. 304 **Multimedia Technology** **3-0-0-3**

Total Lectures: 40

1. **Overview** - Multimedia - Definitions, Basic properties, Temporal and non-temporal medium, Multimedia applications, Uses of Multimedia, Stages of multimedia project, requirements to make good multimedia, Multimedia skills and training.

[6]

2. **Multimedia-Hardware and Software**: Production Platforms, Hardware Peripherals, Connections, Memory and Storage devices, Media software tools, Multimedia Authoring tools, Production Standards.

[8]

3. **Multimedia building blocks**: Audio, basic sound concepts, music, speech, MIDI versus digital audio, audio file formats, sound for the web, images and graphics-basic concepts, Digital video production and editing techniques, animation-basic fundamentals, Kinematics, morphing , animation s/w tools and techniques, animation for the web.

[10]

4. **Data Compression:** Need of Compression techniques, Difference of lossless/lossy compression techniques. Storage space and coding requirements, classification of coding, compression techniques-JPEG and MPEG.

[9]

5. **Multimedia and Internet:** HTML and web authoring, Multimedia considerations for Internet, Design considerations for web pages ,Web Browsers, Web page makers and editors, Media Communication, Media Consumption, Media games.

[7]

Text Book:

1. Steinmetz R., and Nahrstedt K., Multimedia - Computing, Communications and Applications, Pearson Education Asia, 2nd Ed., 2003.

References Books:

1. Buford J. F. K., Multimedia System, Addison-Wesley, 3rd Ed., 1994.
2. Vaughan T., Multimedia - Making it Work, Tata McGraw-Hill, 3rd Ed., 2002.

Testing:

Flash editor and toolbox.
Frames and key frame concepts
Color schemes

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using shape tween and motion tween.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

concept of layers
Understanding guide ,mask layer.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using symbols (movie clip, graphic and buttons) and library.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation of text morphing.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Flash editor and toolbox.
Frames and key frame concepts
Color schemes

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation using shape tween and motion tween.

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Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Animation of text morphing.

Application programs based on above elements in different areas of computing like- Science, Business, Mathematics and other manual processes.

Testing:

Markup Tags
Formatting Tags
Frames
Form Elements

Programs:

Design web pages based on above Tags.
Design and formatting a form based on form elements

Testing:

Cascading Style sheets
Dragging
Dropping
Div tag.

Programs:

Based on above CSS formatting on HTML scripts.

Testing:

Java Script Declaration and Expressions
Control Structure and Functions
Java Script: Properties and Methods
Array Object
Date Object
Math Object
String Object
Events in java Script: Onblur, Onclick, on change, on focus.

Programs:

Form validation through JavaScript
Program for Event handling
Working with Date and Time Functions
Program for calculator

Testing:

VBScripts String
Date and Time
Arrays
Control Structure
Looping
Methods and events
Data validation

Programs:

Form validation through VBScript
Program for Event handling
Working with Date and Time Functions

Testing:

XML components
DTD
Creating a Valid Document from a DTD

Programs:

Basic XML Document
Access XML document elements through programs

CA 17. 208 **Electronic Commerce** **3-1-0-4**

Total Lectures:40

1. **Electronic Commerce**: Overview and Scope, Traditional Commerce vs. Electronic Commerce, Impact of E-Commerce, Electronic Markets, Internet Commerce, e-commerce in perspective, Application of E Commerce in Direct Marketing and Selling, advantages and disadvantages, and future of E-commerce. [7]

2. **Business strategy in an Electronic Age:** Value Chains, Supply chain, Porter's value chain Model, Inter Organizational value chains, Strategic Business unit chains and industry value chains. [6]

3. **Business to Business E-Commerce**: Inter-organizational Transitions, Credit Transaction Trade Cycle, a variety of transactions. Electronic Data Interchange (EDI): Introduction, Benefits of EDI, EDI Technology, EDI standards, EDI Communication, EDI Implementation, EDI agreement, EDI security. [7]

4. **Electronic Payment System:** Introduction, Online Payment System, Prepaid Electronic Payment System, Post Paid Electronic System, E-Cheques, Credit Cards, Smart Cards, E-Purses, Debit Cards, Legal Risk of E-Payment System. [8]

5. **Securing Network Transaction:** Security Policy, Procedures and Practices, Transaction Security, Cryptography Algorithm, Public Key Algorithm, Authentication Protocol, Digital Signature, E-Mail Security.

6. **Case Study:** Different case studies of E commerce [5]

CA 17. 362 **Knowledge Management** **3-1-0-4**

Total Lectures: 40

1. **Introduction:** Definition, Evolution, Types, Implication for Knowledge Management [6]

2. **Life Cycle:** Challenges, Difference, Knowledge management system Life Cycle, Comparative Studies Between SDLC and Knowledge Management System Development, Role of Knowledge Developer. [8]

3. **Knowledge Creation and Architecture:** Knowledge Codification, Need of Codification, and Knowledge Tools for Codification, Developer Skills Set. [9]

4. **Knowledge Transfer and Internet:** Internet and Knowledge, E-Business, Ethical and Legal Issues in Knowledge Management. [8]

5. **Executive Information and support Systems**: Business Expert System and AI, OLTO & OLAP; Data Warehousing; Data Marts, Data Warehouse architecture; Tools for data warehousing. [9]

Text Books:

1. Awad, Elias M., "Knowledge Management", TMH, New Delhi

Reference Books:

1 Inmon, W. H., "Building Data Warehousing", Wiley, New Delhi

2 Han, Jiawei, Kamber, Michelinal, "Data Mining Concepts & Techniques", Harcourt India, New Delhi

CA 17. 363 **System Software** **3-1-0-4**

Total Lectures: 40

1. **Overview:** Language processors, data structures for language processors, assemblers, macros and macro processors, compilers, interpreters, linkers and loaders. [5]

2. **Operating System:** Functions of Operating System, Kernel, Shell, Process, Process state diagram, System Calls. [5]

3. **Assemblers:** Design of an assembler ,one pass and two pass Assembler, Databases of Assemblers, table processing [7]

4. **Macro Processors:** Importance of Macro, Macro Definition, Macro call, Macro Expansion, Conditional Macro expansion, Nesting of Macros, Functions of Macro Processor . [8]

5. **Loaders and Linkers:** Function of Loaders, loader schemes - compile and go, general, absolute, subroutine linkages, relocating loaders, direct linking loaders, binders, linking loaders, overlays, dynamic binders. [9]

6. **Compilers :** Types of Compilers, Phases of compiler design, recursion, call and return statements. [6]

Text Books:

1. Donovan J.J., "Systems Programming", New York, Mc-Graw Hill, 1972.

Reference Books:

1 Leland L Beck,"System Software, An Introduction to System Programming", Pearson Education, 13th Indian Reprint, New Delhi, 2003.

2 Dhamdhere, D.M., "Introduction to Systems Software", Tata Mc-Graw Hill 1996.

CA 17. 364 **Artificial Intelligence** **3-1-0-4**

Total Lectures: 40

1. **Overview of A.I.:** Introduction to AI, Importance of AI, AI and its related field, AI techniques.

[4]

2. **Problem space and search**: Defining the problem as a state space search, Production system and its characteristics, Issues in the design of the search problem.

[5]

3. **Heuristic search techniques** : Generate and test, hill climbing, best first search technique, problem reduction, constraint satisfaction

[6]

4. **Game Playing** : Minimax , alpha-beta pruning.

[4]

5. **Predicate logic**: Definition, representation of simple facts in logic, well formed formula, resolution.

[8]

6. **Knowledge representation**: Definition and importance of knowledge, Knowledge representation, Various approaches used in knowledge representation, Issues in knowledge representation.

[8]

7. **Learning:** Introduction learning, Types of learning, Introduction to neural networks.

[5]

Text Book:

1. Rich Elaine and Knight Kevin , Artificial Intelligence, Tata McGraw – Hill, 3rd edition, 2012

Reference Books:

1. Russell Stuart and Norvig Peter, Artificial Intelligence: A Modern Approach, Prentice Hall; 3 edition,2009

2. Patterson D.W., "Introduction to AI and Expert Systems", PHI, 1999

CA 17.365 **Internet Technologies** **3-1-0-4**

Total Lectures: 40

1.	**Introduction:** Layering, TCP/IP Layering, Internet Addresses, The Domain Name System, Client Server Model, Port Numbers, Implementations and Application, Programming interfaces.	05
2.	The Link Layer Ethernet and IEEE 802 Encapsulation Trailer Encapsulation, **SLIP:** Serial Line IP, Compressed SLIP, **PPP**: Point-to-Point Protocol.	04
3.	**IP**: The Internet Protocol, IP Header, IP Routing, Subnet Addressing, Subnet Mask, Special Case IP Addresses.	06
4.	**Introduction to ARP**: Address Resolution Protocol and RARP: Reverse Address Resolution Protocol, ARP Packet Format, Proxy ARP, RARP Packet Format.	07
5.	**ICMP**: Internet Control Message Protocol Introduction, ICMP, Message Types, ICMP Address, Mask Request and Reply , IP Routing, Routing Principles, Introduction to Dynamic Routing; **UDP**: User Datagram Protocol UDP Header, UDP Checksum; **DNS**: The Domain Name System DNS Basics, DNS Message Format, security.	10
6.	**TCP**: Transmission Control Protocol TCP Services, TCP Header TCP Connection, Establishment and Termination, TCP Timeout and Retransmission, Repacketization; Telnet and Rlogin Remote Login Rlogin Protocol, SMTP Protocol; **FTP**: File Transfer Protocol and SMTP: Simple Mail Transfer Protocol.	08

Text Books:

1. Tannenbaum A. S., “Computer Networks”, Prentice-Hall India. New Delhi
2. Forouzan Behrouz A, “Data Communication and Networking”, TMH, New Delhi

Reference Books:

1 Sybex, “Networking Complete”, BPB Publication, New Delhi

2. Stallings Willam, “Data and Computer Communication”, Pearson Education, New Delhi

CA 17. 366 **Information Security** **3-1-0-4**

Total Lectures: 40

1.Introduction: Information, Characteristics of Information, Security Attacks, NSTISSC security model, Concepts of Policies; procedures; Guidelines and Standards. [8]

2.Cryptography: Conventional Encryption Principles, Conventional encryption algorithms, cipher block modes of operation, location of encryption devices, Public key cryptography principles, public key cryptography algorithms, digital signatures, digital Certificates. [10]

3.IP Security: IP Security Overview, Architecture, Authentication Header, Encapsulation Security Payload, Combining Security Association, Key Management, Pretty Good Privacy, S/Mime and Types. [7]

4.Web Security and E-Commerce: Web Security Requirement, SSL and Transport Layer Security, Secure Electronic Transactions, Introduction to E-Commerce, Transactions on E-Commerce, Requirement of Security on E-Commerce. [7]

5. System Security: Recognized Security Threats, Virus, Trojan horse, Worm, Spyware, Adware, Key Logger, Denial of Services, Firewall Design Principles, Trusted Systems, Common criteria for information technology security and evaluation. [8]

Text Book:

1. William Stallings ,"Cryptography and Network Principles and Practice", Fourth Edition, , Pearson.

2. William Stallings, "Network Security Essentials (Applications and Standards)" Pearson.

Reference Books:

1. Forouzan, Mukhopadhyay ,"Cryptography & Network Security", , McGrawHill
2. Godbole "Information Systems Security", , Wiley-India
3. Shah Deven "Information Security Principles and Practice", , Wiley-India

CA 17.367 **Network Security** **3-1-0-4**

Total Lectures: 40

1 **Introduction:** Attacks, Services and Mechanisms, Security Attacks, Security Services, Integrity check, digital Signature, authentication, has algorithms. [3]

2 **Secret Key Cryptography:** Block Encryption, DES rounds, S-Boxes IDEA: Overview, comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB, CBC, OFB, CFB, Multiple encryptions DES. [8]

3 **Hash Functions and Message Digests:** Length of hash, uses, algorithms (MD2, MD4, MD5, SHS) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages. digest computation.) SHS: Overview, padding, stages. [7]

4 **Public key Cryptography:** Algorithms, examples, Modular arithmetic (addition, multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption. Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures [7]

5 **Authentication:** Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs offline guessing, storing. Cryptographic Authentication: passwords as keys, protocols, KDC's Certification Revocation, Interdomain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution, smart cards, biometrics. [6]

6 **Example System:** Kerberos: purpose, authentication, serer and ticket granting server, keys and tickets, use of AS and TGS, replicated servers. Kerberos V4: names, inter-realm authentication, Key version numbers. Kerberos V5: names, realms, delegation, forwarding and proxies, ticket lifetimes, revoking tickets, multiple Realms. [4]

7. **Network Security:** Electronic mail security, IP security, Network management security. Security for electronic commerce: SSL, SET. System Security: Intruders and Viruses, Firewalls, Intrusion Detection. [4]

Text Books:

1. Atul Kahate," Cryptography and Network Security", TMH, New Delhi

2. Kaufman, C., Perlman, R., and Speciner, M., "Network Security, Private Communication in a public world" , PHI.

Reference Books:

1 Stallings, W., "Cryptography and Network Security: Principles and Practice", Prentice Hall.

2. Stallings, W., "Network security Essentials: Applications and standards", Prentice Hall.

3. Behrouz A Forouzan, "Cryptography and Network Security"; McGraw Hill;.

CA 17. 368 **Cyber Law** **3-1-0-4**

Total Lectures:40

1. **Fundamentals of Cyber Law**: Jurisprudence of Cyber Law- Overview of Computer and Web Technology- Introduction to Indian Cyber Law- Overview of General Laws and Procedures in India; Freedom of Expression on the Internet. [10]

2. **E-commerce-Legal Issues:** Electronic Commerce –Digital Signature- Meaning; Creation of Digital Signature; Understanding how digital signatures work, Role in Information Technology; technical issues; legal issues; Crimes relating to digital signature certificates. [10]

3. **Cyber Crimes:** Meaning of Cyber Crimes –Cyber crimes under IPC, Cr.P.C and Indian Evidence Law - Cyber crimes under the Information Technology Act,2000 - Cyber crimes under International Law - Hacking Child Pornography, Cyber Stalking, Denial of service Attack, Virus Dissemination, Software Piracy, Internet Relay Chat (IRC) Crime, Credit Card Fraud, Net Extortion, Phishing etc - Cyber Terrorism - Violation of Privacy on Internet - Data Protection and Privacy ;Concept of Social Networking – Legal Implications of Social Networking [12]

4. **Intellectual Property Issues and Cyberspace : The Indian Perspective;** Overview of Intellectual Property related Legislation-Copyright law & Cyberspace; Trademark law & Cyberspace; Law relating to Semiconductor Layout & Design. [8]

Text Books:

1. Rodney D. Ryder, Guide to Cyber Laws, 2nd Edit, Wadhwa and Company, Nagpur
2. Sharma,Vakul. Information Technology law and Practice. Universal law Publishing,2011
3. Rattan, Jyoti. Cyber law. New Delhi: Bharat law House,2011.

Reference Books:

1 Seth,Kanika. Cyber Law in the Information Technology Act. Nagpur : Lexis Nexis Butterworth Wadhwa,2009
2. Rodney D.Ryder,Guide of Cyber Law,2nd Edition.
3. Faruq Ahmed,Cyber law in India.

CA 17. 369 **E-Business** **3-1-0-4**

Total Lectures:40

1. **Internet as a Business Driver:** Internet, WWW, Benefits of Internet and WWW, Difference between e-Commerce and e-Business, Mobile Internet, Internet Consumers. [8]
2. **Introduction to e-Business Trends:** Trends Driving e-Business, Customer Oriented Trends, e-Service Trends, Organizational Trends, Enterprise Technology Trends and General Technology Trends. [7]
3. **E-Business Models:** Disruptive Technology, e-Business Models, Internet Pricing, e-Cash, Online Retailing, Constructing e-Business ICT Framework. [10]
4. **Leveraging the Web for Marketing:** Business Enhancement, Framework for Web Marketing, Web Usability, Content Management, and Impact of Internet on Marketing. [9]
5. **Online Resources and Deployment:** Meta Search Engines, Boolean Searching on Internet, Best Practice Web Searching, The Invisible Web, [6]

Text Books:

1.Ravi Kalakota, Marcia Robinsion, "E-Business 2.0: Roadmap For Success", 2nd Edition, Pearson.
2.Paul Phillips, "E-Business Strategy", 1st edition, TMH.

Reference Books:

1.Colin Combe, "Introduction to e-Business", 1st Edition, Routledge
2.Azhar Kozami**, "**Business Policy and Strategic Management", 2nd Edition, Tata McGraw Hill.

CA 17. 373 **Software and CASE Tools** **3-1-0-4**

Total Lectures: 40

1. **Software Engineering Fundamentals :** Definition of software product and process, Software Characteristics, Components, Applications, Layered Technologies, Processes and Product, Methods and Tools, Generic View of Software Engineering, Software Crisis and Software development paradigms, [5]

2. **Software Requirements Analysis & Specification:** System specification, Software requirements specification (SRS) standards, Analysis Modeling: Difference between Data and Information, ER Diagram, Dataflow Model, Control Flow Model, Control and Process Specification, Data Dictionary [8]

3. **Software Design:** Software architecture, Modular design - cohesion and coupling, Process-oriented design, Data-oriented design, User-interface design, Real-time software design, introduction to Object Oriented Design. [7]

4. **CASE Tools, Coding and Testing** Computer-aided software engineering, Introduction to CASE, Building Blocks of CASE, Integrated Case Environment, Characteristics of good Programming languages, Introduction to Testing Process, Testing Activities like Unit, Integration & System Testing. [7]

5. **Software Reengineering:** Business Process Reengineering, Reverse Engineering, Software re-engineerin.. [5]

6. **Software Quality and Metrics:** SQA-Software Quality Assurance, Software Reliability, Software quality metrics, SQA plan, ISO 9000 and 9001 Quality Standards. [8]

Text Books:

1. Pressman R.S. , “Software Engineering”, TMH.
2. Rumbaugh James ,Object Oriented Modeling and Design, Prentice Hall- Gale
3. The Unified Modeling Language User Guide - Grady Booch, James Rumbaugh, Ivar Jacobson.

Reference Books:

1 Pankaj Jalote,“An Integrated Approach to Software Engineering”, NAROSA.
2 Designing Flexible Object Oriented systems with UML - Charles Ritcher
3 Fairely, R.E., “Software Engineering Concepts”, McGraw-Hill
4 Object-Oriented Analysis and Design: using UML Mike O'Docherty Wiley Publication

CA 17. 375 **Bioinformatics** **3-1-0-4**

Total Lectures:40

1. **Introduction to Networking:** Definition and scope of networking, Basic network topology, Concept of LAN, MAN and WAN, Introduction to Internet and data transfer protocol (TCPI/P, FTP) [5]

2. **Biological Information Resources:** Introduction to biological data and database management, Biological databases – Protein databanks (Primary and Secondary databank; Sequence and structure databank), Genomic databanks (Sequence and specialized databanks). [5]

3. **Sequence Alignment:** Introduction to biological sequence alignment, Database searching, Algorithm for sequence alignment, Pairwise alignment (Needleman and Wunsch algorithm, Smith-Waterman algorithm), Multiple Sequence Alignment, Concept of Gaps, Gap penalties and scoring matrices. [7]

4. **Tools for Sequence Alignment:** FASTA, BLAST, Variations of BLAST, Alignment scores and statistical significance of database searches. [8]

5. **Genomics:** Genome, Gene structure of prokayotes and eukaryotes, Concept of ORFs, GC-content, Codon Usage, cDNAs and ESTs, Serial analysis of gene expression (Microarrays). [9]

6. **Proteomics:** Introduction to proteome and proteome analysis (2D electrophoresis, Mass spectrophotometry, Protein microarray and X-ray crystallography), Algorithm for modeling protein folding. [6]

7. **Phylogenetics:** Introduction to phylogenetics, Parsimony, Molecular phylogenetics, Methods of phylogenetic tree construction

Text Books:

1. Peruski and Peruski: The Internet and the new Biology: tools for Genomic and Molecular Research, ASM Publishing House, India.

Reference Books:

2 Higgins and Taylor, Bioinformatics, Oxford University Press, US.

CA 17. 377 **Geographical Information System** **3-1-0-4**

Total Lectures: 40

1. **Genesis and Progression:** Basic Concepts, Benefits of Computerization of Information, Users of GIS, Introduction to Real World and Data Model, Geometric Representation of objects, Levels of Measurement, Applications of GIS. [8]

2. **Vector Data Models:** Introduction, Spaghetti Model, Topology Model, Data Compression, Storing Vector Data. [7]

3. **Raster Data Models:** Necessity and Characteristics, Coding and Storage of Raster Data, Compression of Raster Data, Run Length Encoding, Chain Codes, Block Codes, Quad Tree Model, Conversion and Contrast between Vector and Raster Models. [10]

4. **Hardware and Software Requirements for GIS:** Basic Hardware Devices viz Computer, VDU, Quantizers, Printers, Plotters, etc. DBMS, Structure of Databases, Multimedia, WWW. [9]

5. **Basics of Data Collection:** Digitizing Maps, Scanning, Manual Digitizing, Arial Photographs, Photo Interpretation, Remote Sensing, Correction, Surveying. [6]

Text Books:

1. Bernhardsen Tor, "Geographic Information System: An Introduction", 3rd edition, Wiley Publication.
2. Longley Paul, "Geographic Information Systems and Science", 2nd Edition, Wiley Publication.

Reference Books:

1 Bjarne Stroustrup ,"Programming -Principles and Practice Using C++", Addison-Wesley.

2 Herbert Schildt , "C++: The Complete Reference", 4th edition, TMH.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech CS

Total Lectures: 40

CS 509 High Performance Computer Architecture 3-1-0-4

1. Overview: Necessity of high performance, Constraints of conventional architecture, Parallelism in uniprocessor system, Evolution of parallel processors, future trends, Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture, Performance Metrics and Measures, Speedup Performance Laws. [6]

2. Pipeline Architecture: Principles and implementation of Pipelining, Classification of pipelining processors, General pipelining reservation table, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Job sequencing and Collision, Advanced pipelining techniques, loop unrolling techniques, out of order execution, software scheduling, trace scheduling, Predicated execution, Speculative loading, Register Stack Engine, Software pipelining. [8]

3. Vector and Array Processor: Basic vector architecture, Issues in Vector Processing, Vector performance modeling, vectorizers and optimizers, SIMD Computer Organization Masking and Data network mechanism, Inter PE Communication, Interconnection networks of SIMD, Static Vs Dynamic network, cube, hyper cube and Mesh Interconnection network. Parallel Algorithms for Array Processors. [8]

4. Multiprocessor Architecture: Loosely and Tightly coupled multiprocessors, Processor characteristics of multiprocessors, Inter Processor communication network, Time shared bus, Crossbar switch, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP), Processor, Inter Processor Communication and Synchronization. [8]

5. Multithreaded Architecture: Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions. [4]

6. Parallel Programming Techniques: Message passing program development, Synchronous and asynchronous message passing, Message passing parallel programming, Shared Memory Programming, Data Parallel Programming. [6]

Text Books:

1. Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing", McGraw Hill International Edition, 2004.
2. Kai Hwang, "Advanced Computer Architecture", Tata McGraw Hill Edition, 2001.

Reference Book:

1. William Stallings, "Computer Organization and Architecture, Designing for performance" Prentice Hall, Sixth Edition, 2003.1

Total Lectures: 40

CS 511 Adhoc Sensor Networks 3-1-0-4

1. Ad hoc Networks: Introduction and Definitions, Ad hoc Network Applications, Design Challenges. [3]

2. Routing in Mobile Ad hoc Networks: Introduction, Flooding, Proactive Routing, On Demand Routing, Proactive Versus on demand Debate, Location based Routing. [4]

3. Multicasting in Ad hoc Networks: Introduction, Classifications of Protocols, Multicasting Protocols, Broadcasting. Protocol Comparisons, Overarching Issues. [4]

4. Transport layer Protocols in Ad hoc Networks: Introduction, TCP and Ad hoc Networks,Transport Layer for Ad hoc Networks: Overview, Modified TCP, TCP-aware Cross-layered Solutions. Ad hoc Transport Protocol. [5]

5. QoS Issue in Ad hoc Networks: Introduction, Definition of QoS, Medium Access Layer, QoS Routing, Inter- Layer Design Approaches. [4]

6. Security in Mobile Ad hoc Networks: Vulnerabilities of Mobile Ad hoc Networks, Potential Attacks, Attack Prevention Techniques. Intrusion Detection Techniques. [4]

7. Overview of Wireless Sensor Networks (WSNs): Introduction, Constraints and Challenges, Advantages of Sensor Networks, Sensor Network Applications. [2]

8. Routing Protocols: Geographic, Energy-Aware Routing – Unicast Geographic Routing, Routing on a Curve, Energy-Minimizing Broadcast, Energy-Aware Routing to a Region; Attribute-Based Routing – Directed Diffusion, Rumor Routing. [8]

9. Security in WSNs: Introduction: IEEE 802.11b Security Mechanisms, WEP Security Issues, WEP Improvements, Wireless Security Threats and Risks: Types of Security Threats, Physical Security of Wireless Devices, WLAN Attacks. Risk Mitigation and Countermeasures: Basic Countermeasures, AAA Infrastructure Solutions, Additional Enhancements. [6]

Text Books:

1. Prasant Mohapatra and Srihanamurthy, “Ad Hoc Networks Technologies and Protocols”, Springer, Springer International Edition, 2009.
2. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks”, John Wiley & Sons, Inc., Publication, 2007.
3. Zhao, Guibas, “Wireless Sensor Networks” , Elsevier, 2004.

Reference Book:

1. A.Boukereche, “Handbook of Algorithms for Wireless Networking and Mobile Computing”, Chapman and Hall/CRC Computer and Information Science Series, 2007.

Total Lectures: 40

CS 513 Cryptography and Information Security 3-1-0-4

1. Introduction: Elements of Information Security, Category of computer securities, types of attacks and services. [4]

2. Cryptographic Techniques: plain text and Cipher text, Encryption and Decryption, Stenography, Symmetric and Asymmetric key Cryptography, Blowfish, Data encryption standard, (DES), Advanced Encryption Standard(AES) [6]

3. Number Theory: Introduction to ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms. [4]

4. Public key Cryptography: Public Key Cryptography and RSA, Key Management, Diffie-Hellman key Exchange, Elliptic Curve Architecture and Cryptography. [5]

5. Message Authentication and Hash Function: Authentication requirements, authentication functions, MAC, hash functions, MD5, SHA, Digital Signatures: Digital Signatures, authentication protocols, Digital certificates, Kerberos, Certificate authority. [9]

6. Information attacks: Recognizing Security Threats and countermeasure for Phishing, Virus, Trojan Horse, Worms, Spyware, Adware, Key logger, Denial of Service, Spamming, Port Scanning and Password cracking [4]

7. Web and IP Security: Secure Socket Layer(SSL), Secured Hyper Text Transfer Protocol (SHTTP), S/MIME, IP security overview, Authentication Header(AH), Encapsulating Security Payload(ESP), IP key management . [6]

8. Case study: IP spoofing attack, Cyber Laws. [2]

Text Book:

1. William Stallings, "Cryptography and Network Security – Principles and Practices", Prentice-Hall of India, 4/E edition, 2003.

Reference Books:

1. VK Pachghare, "Cryptography & Information Security", PHI, 2009
2. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill, 2003.

CS 517 Adhoc Sensor Networks Laboratory 0-0-2-1

1. Basics of Network Simulation
2. Simulating a Local Area Network
3. Measuring Network Performance
4. Simulation of a Satellite Network
5. Simulating a Wi-Fi Network
6. Simulating a Wi-MAX Network
7. Simulating a Mobile Ad-hoc Network
8. Simulating a Wireless Sensor Network
9. Setting up a Bluetooth Network
10. Setting up a Zig-Bee Network

CS 519 Cryptography and Information Security Lab 0-0-2-1

1. Implementation of Ciphers
a) Play fair
b) Hill cipher

2. Implementation of the concepts from number theory
a) Fermat's & Euler's Theorem
b) Primality testing
c) Chinese Remainder Theorem

3. Implementation of Symmetric key algorithms like AES/ DES

4. Implementation of Asymmetric key Algorithms like RSA/ DSA.

5. Implementing hash code using MD5/SHA. And generate digital signature

6. Generation of Virus.

Total Lectures: 40

CS 530 Network Security 3-1-0-4

1. Introduction to Security in Networks: Characteristics of Networks, Intrusion, Kinds of security breaches, Plan of attack, Points of vulnerability, Methods of defense, Control measures, Effectiveness of controls [6]

2. Sniffers: Passive Sniffing, Active Sniffing, Ethereal tool, Man-in-the-Middle Attacks, Spoofing and Sniffing Attacks, ARP Poisoning and countermeasures. [6]

3. Denial of Service: Denial of Service, Goal of DoS (Denial of Service), different types of attacks and their impacts, securing from these attacks. [10]

4. Secure Sockets: IPsec overview – IP security architecture, IPsec-Internet KeyExchanging (IKE), IKE phases – encoding , Internet security, Threats to privacy , Packet sniffing ,Spoofing - Web security requirements, Real Time communication security, Security Standards–Kerberos.X.509 Authentication Service. [9]

5. Security Protocols: Transport layer protocols – SSL, Electronic mail security – PEM and S/MIME security protocol, Pretty Good Privacy , Web Security, Firewalls design principles , Trusted systems-Electronic payment protocols, Intrusion detection, password management Viruses and related Threats, Virus Counter measures, Virtual Private Networks. [9]

Text Book:

1. William Stallings, "Cryptography and Network Security: Principles and Standards", Prentice Hall India, 3rd Edition, 2003.

Reference Books:

1. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security: Private Communication in a public world", Prentice Hall India, 2nd Edition, 2002.

2. Charles P. Pleeger, "Security in Computing", Pearson Education Asia, 5th Edition, 2001.

Total Lectures: 40

CS 532 Cyber Forensic 3-0-0-3

1. Incident and Incident Response : Introduction to Incident - Incident Response Methodology – Steps - Activities in Initial Response Phase after detection of an incident. [10]

2. Initial Response and Forensic Duplication: Initial Response & Volatile Data Collection from Windows system – Initial Response & Volatile Data Collection from Unix system - Forensic Duplication: Forensic duplication: Forensic Duplicates as Admissible Evidence, Forensic Duplication Tool Requirements, Creating a Forensic Duplicate/Qualified Forensic Duplicate of a Hard Drive. [10]

3. Storage and Evidence Handling: File Systems-FAT,NTFS - Forensic Analysis of File Systems – Storage Fundamentals-Storage Layer, Hard Drives Evidence Handling-Types of Evidence, Challenges in evidence handling, Overview of evidence handling procedure. [10]

4. Network Forensics: Collecting Network Based Evidence - Investigating Routers - Network Protocols - Email Tracing - Internet Fraud. [10]

Text Books:

1. Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGraw Hill, 2006.
2. Peter Stephenson, “Investigating Computer Crime: A Handbook for Corporate Investigations”, Sept 1999.

Reference Books:

1. Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Toolsand Technology", Academic Press, 1st Edition, 2001.
2. Skoudis. E., Perlman. R. Counter Hack: “A Step-by-Step Guide to Computer Attacks and Effective Defenses”, .Prentice Hall Professional Technical Reference. 2001.
3. Norbert Zaenglein, “Disk Detective: Secret You Must Know to Recover Information From a Computer”, Paladin Press, 2000.
4. Bill Nelson, Amelia Philips and Christopher Steuart, “Guide to computer forensics and investigations”, course technology, Cengage Learning; 4thedition, ISBN: 1-435-49883-6, 2009.

Total Lectures: 40

CS 534 Image Information Processing 3-1-0-4

1. **Introduction:** Basics regarding Digital Images, elements of digital image processing systems, different image formats, elements of visible perception ,image model, sampling, quantization, image enhancement, restoration and analysis. [10]
2. **Mathematical Preliminaries and Image Transforms**: Matrix theory, random signals, spectral density function, results from estimation and information theory, Introduction to DFT, 2-DFT, FFT and other transforms such as Walsh, Hadamard, discrete cosine, Haar, slant and KL . [10]
3. **Image Data Compression:** Basic compression techniques such as Huffman coding, arithmetic coding, LZ77, LZ78, Predictive techniques –PCM , DPCM, transform coding theory of images, hybrid coding and vector DPCM, Introduction to speech and video compression, MPEG ,packet video. [10]
4. **Visual Cryptography:** Introduction to information hiding, surveys of different Steganographic and Watermarking techniques, principles of Steganography and water marking techniques, Statistical Steganography- distortion code generation techniques. Detecting, extracting and disabling hidden information, Basic principles , applications, evaluation and benchmarking of water marking systems, Extension from still images to video, Fingerprints classification and analysis. [10]

Text Books:

1. R.C. Gonzalez , "Image Processing" Pearson education 4th edition , 2013.
2. A.K. Jain ,"Fundamentals of Digital Image Processing " PHI 2nd edition , 1995.

Reference Books:

1. Khalid Sayood, "Introduction to Data compression", Morgan Kaufmann Publishers, 2003 reprint.
2. Stefan Katzenbelsser and Fabial A.P. Petitcolas , "Information hiding techniques for Steganography and Digital watermarking " , Artech house publisher , January 2004.
3. Jessica Fridrich , "Steganography in Digital media : Principles ,algorithms and applications ,Cambridge university press,2010.
4. Ingemar Cox,M.Miller,J.Bloom, Jessica Fridrich and T.Kalker,"Digital Watermarking and Steganography", Morgan Kaufmann Publishers,Nov.2007.
5. David Solomon, "Data compression: The Complete Reference", Springer Verlag, 4e, 2007.
6. W.K.Pratt ,"Digital Image Processing",John Willey and Sons,1994 .

Total Lectures: 40

CS 536 Database Security 3-1-0-4

1. Introduction: Introduction to Databases Security, problems in Databases Security Controls. Security Models**:** Introduction, Access Matrix Model, Take-Grant Model, Acten Model, PN Model, Hartson and Hsiao'sModel, Fernandez's Model, Bussolati and Martella's Model for Distributed databases. [7]

2. Advanced Models: Bell and La Padula's Model, Biba's Model, Dion's Model, Sea View Model Jajodia and Sandhu's Model, The Lattice Model for the Flow Control. [6]

3. Security Mechanisms: User Identification/Authentication, Memory Protection, Resource Protection Control Flow Mechanisms, Evaluation Criteria [6]

4. Security Software Design: A Methodological Approach to Security Software Design, Secure Operating System Design, Secure DBMS Design, Security Packages, Database Security Design. [7]

5. Statistical Database Protection and Intrusion Detection System: Statistics Concepts and Definitions, Types of Attacks, Inference Controls evaluation, Criteria for Control, Comparison, IDES System, RETISS System, ASES System. [7]

6. New Generation Database Systems Protection Models: Model for the Protection of Frame Based Systems, Object Oriented Systems, SORION Model for Object-Oriented Databases. Orion Model, Jajodia and Kogan's Model. [7]

Text Books:

1. Database Security and Auditing, Hassan A. Afyouni, India Edition, CENGAGE Learning, 2009.

2. Database Security, Castano, Second edition, Pearson Education.

Reference Book:

1. Database security, Alfred Basta, Melissa Zgola, CENGAGE learning.

Total Lectures: 52

CS 563 Advances in Distributed Computing **4-0-0-4**

1. **Introduction:** Distributed Systems, Cluster Computing, Supercomputing, Cloud Computing. [6]
2. **Synchronous networks:** Leader election in synchronous ring networks. Leader election in rings. Basic computational tasks in general synchronous networks: leader election. [6]
3. **Fault-tolerant Systems:** Consensus, Link failures: the two generals problem. Process failures (stopping, Byzantine). Algorithms for agreement with stopping and Byzantine failures. Exponential information gathering. [6]
4. **Asynchronous distributed computing**: Formal modeling of asynchronous systems using interacting state machines (I/O automata). Proving correctness of distributed algorithms. [6]
5. **Non-fault-tolerant Systems:** Algorithms for asynchronous networks. Leader election. [4]
6. **Synchronizers**. Synchronizer applications. Synchronous vs asynchronous distributed systems. [6]
7. **Time, clocks and the ordering of events**: State-machine simulation. Vector timestamps. Stable property detection. Distributed termination. Global snapshots. Deadlock detection [6]
8. **Asynchronous shared-memory systems**: The mutual exclusion problem. Mutual exclusion algorithms. Bounds on shared memory for mutual exclusion. Resource allocation. The Dining Philosophers problem. [6]
9. **Locking:** Locking algorithms, optimistic algorithms, lock-free algorithms, lazy algorithms, Load scheduling and balancing techniques. [6]

Text Books:

1. Lynch, Nancy, "Distributed Algorithms", Burlington, MA: Morgan Kaufmann, 1996. ISBN: 9781558603486.
2. George Coulouris, Jean Dollimore, Tim Kindberg, "Distributed Systems, Concept and Design", 3rd Edition, Pearson Education, 2005.
3. Mukesh Singhal, Niranjan G. Shivaratri, Niranjan Shivaratri, "Advanced Concepts in Operating Systems", TMH, 1994.
4. Sunita Mahajan, Seema Shah, "Distributed Computing", Oxford University Press,2010.

Reference Books:

1. Sukumar Ghosh, "Distributed Systems: An Algorithmic Approach", Chapman &Hall / CRC, 2007.
2. Pradeep K. Sinha, "Distributed Operating Systems: Concepts and Design", PHI, 2007.
3. Randy Chow, Theodore Johnson, "Distributed Operating Systems and Algorithm Analysis",

Total Lectures: 52

CS 565 Advanced Compiler Construction 4-0-0-4

1. **Advanced Issues in Elementary topics:** Compiler, phases and passes, finite state machines, regular expressions and their applications to lexical analysis, implementation of lexical analyzer using LEX, CFG, bottom-up and top-down parsers, implementation of parsers using YACC. [10]

2. **Symbol Table Structure**: Storage classes, visibility and lifetime. Symbol attributes and symbol table entries, local symbol table management, and global symbol table structure, storage binding and symbolic registers. [6]

3. **Intermediate Representations**: Issues in designing intermediate languages, High level, medium level, low level and multi-level intermediate languages. Representing all intermediate languages in informal compiler algorithm notation (ICAN). [8]

4. **Code Optimization**: Introduction, early optimization, redundancy elimination. Loop optimization: Induction variable optimizations, bounds checking elimination.Procedure optimization: Tail-call optimization and Tail-recursion optimization, procedure integration, In-line expansion, leaf routine optimization and shrink wrapping. [8]

5. **Register Allocation**: Register allocation and assignment, local methods, graph coloring, priority based graph coloring. Code Scheduling: Instruction Scheduling, Speculative loads and boosting, speculative scheduling, trace scheduling, percolation scheduling. [8]

6. **Interprocedural Analysis and Optimization**: Call graph, interprocedural data flow analysis, constant propagation, alias analysis, optimizations and register allocation. [7]

7. **Automatic Code Generators**: Syntax directed technique, semantic directed parsing, tree pattern matching and dynamic programming. [5]

Text Book:

1. Steven S. Muchnik, “Advanced Compiler Design Implementation”, Morgan Kauffman publishers, 2005.

Reference Books:

1. Alfred Aho, Monica Lam, Ravi Sethi, Jeffrey Ullman, “Compilers: Principles, Techniques, and Tools”, Second edition, Addison-Wesley, 2006.

2. Fisher, Faraboschi, Young, “Embedded Computing - A VLIW Approach to Architecture, Compilers, and Tools”, Morgan Kaufmann, 2005.

Total Lectures: 52

CS 567 BioInformatics 4-0-0-4

1. Introduction to Bioinformatics: Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics Problems and Applications of Bioinformatics. [6]

2. Bioinformatics Databases: Introduction, Nucleotide sequence database - Protein sequence databases, Sequence motif databases, Protein structure databases, other relevant databases. [6]

3. Data storage and retrieval and Interoperability: Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search.The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts.General Introduction to XML, UMLS, CORBA, PYTHON. [13]

4. Sequence Alignments and Visualization: Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example),Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization. [12]

5. Bioinformatics Softwares: Clustal V, Clustal W 1.7, RasMol, Oligo, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip. [5]

6. Semantic Web Techniques: Bridging databases, browsing space of information, life sciences identifiers, RDF data representation. [5]

7. Bioinformatics and Distributed Computing: Java Distributed computing platform, DPRml, DSEARCH. [5]

Text Books:

1. Dan E. Krane ,"Fundamental Concepts of Bioinformatics", third edition, Pearson Education, 2009.
2. Claverie, J.M. and Notredame C. ," Bioinformatics for Dummies", Wiley Editor , January 2003.

Reference Book:

1. ShaliniSuri, "Bioinformatics", APH Publishing Corporation, 2006.

Total Lectures: 52

CS 569 Advanced Computer Graphics 4-0-0-4

1. **Animation:** Introduction of computer Animation, Principles of Animation, Key framing , Kino-dynamics Planning- motion blending, skinning-skeleton animation, rigid skinning ,linear skinning, dual skinning, physics modeling-Physics-based animation, rigid body systems, articulated rigid bodies, forward and inverse dynamics. [14]

2. **Rendering:** Basic concepts of graphics models-illumination& reflection models Shading-Scanning polygons, Gourad and Phong shading ,texture mapping- bump & environmental maps , mipmaps , shading languages-vertex shedders and fragment shedders. [12]

3. **Modeling:** Representation, Using homogeneous Coordinate systems, Modeling process, terrain-representation, methods , fault formation & weather, plants modeling , animals modeling. [12]

4. **Surface Representation:** 3 dimensional object representation –polygon representations, implicit representation , Beziers ,B-splines-basis function, knot insertion, conversion , rational B-splines (NURBS)-properties and examples , evaluators, subdivision surfaces-coarse mesh and subdivision rule,types of subdivisions , Voxels . [14]

Text Book:

1. Peter Shirley, Stephen Robert Marschner, "Fundamentals of Computer Graphics" , A K Peters Limited, 2009.

Reference Books:

1. Shreiner Dave, "Opengl Programming Guide: The Official Guide To Learning Opengl", Version 2.1, 6/E , Pearson Education India, 2008.
2. Francis S. Hill, Jr., Stephen M. Kelley , "Computer Graphics: Using OpenGL" , Pearson Prentice Hall, 2008
3. James D.Foley, Andries van Dam, Steven K. Feiner, John F. Hughes , "Computer Graphics ,Principles & Practice", 3rd Edition, Pearson Prentice Hall, 2013.
4. Edward Angel, "Interactive Computer Graphics a top-Down Approach using openGL", 5th Edition Pearson Prentice Hall, 2008.

Total Lectures: 52

CS 571 Advances in Algorithm Design 4-0-0-4

1. Pattern matching algorithms: Finite automata and regular expression, recognition of regular expression patterns, recognition of substrings, Two – way deterministic pushdown automata, position trees and substring identifiers. [11]

2. Computability theory: Turing machines, variants of Turing machines, Hilbert's problem, decidable languages, the halting problem, Un-decidable problems from language theory, mapping reducibility, the recursion theorem, decidability of logical theories, Turing reducibility, definition of information. [11]

3. Fast Fourier Transform and Polynomials: Representation of polynomials, the DFT and FFT algorithms, efficient FFT implementation, the FFT using bit operations, products of polynomials, the Schonhage – Strassen integer multiplication algorithm. [11]

4. Randomized Algorithm and Parallel Algorithm: Monte-Carlo algorithm, Las-Vegas algorithm, Game tree evaluation, De-randomization. Models for parallel computation basic techniques; Parallel matrix algorithms: matrix-vector multiplication, matrix multiplication, triangular system solution, sorting networks-parallel merging networks, zero –one principle. [8]

5. Complexity theory: Time complexity, the classes P, NP, NP complete and NP hard, Hierarchy theorems, Relativization, Circuit Complexity, approximation algorithms, probabilistic algorithms, circuit complexity, alteration, interactive proof systems, parallel computation, cryptography. [11]

Text Book:

1. Aho Alfred V., Hopcraft John E., Ullman Jefferey D. "The design and analysis of computer algorithms" Pearson education, tenth impression 2012.

Reference Books:

1. Cormen Thomas H. "Introduction to algorithms" PHI, Third edition – 2012.

2. MICHAEL SIPSER Sipser Michael, "Introduction to the theory of computation" Thomson press, Third edition 2012.

3. Brassard G. Fundamental of Algorithmcs, Prentice-Hall of India, 2003.

4. Horowitz E. Computer Algorithms, Galgotia Publications, 2002.

Total Lectures: 52

CS 572 Web Services Security 4-0-0-4

1. Introduction to web Service Technologies: Introduction to web services, Security for Web Services and Security Goals, Need of security and Privacy in web services, applications of web service security, SOA and Web Services Principles, Web Services Architecture, Web Services Technologies and Standards, SOAP, Web Services Description Language (WSDL). [10]

2. Web Service Threats Vulnerabilities, and Countermeasures: Threats and Vulnerabilities, Threats Modelling, Vulnerability Categorizations and Catalogs, Threats and Vulnerabilities Metrics. [10]

3. Standards for Web Service Security: The Concept of Standard Web Services Security, Standards Framework, An Overview of Current Standards, XML Data Security ,Security Assertions Markup Language (SAML), SOAP Message Security, Key and Trust Management standards, Standards for Policy Specification, Access Control Policy Standards, Implementations of Web Services Security Standards**.** [12]

4. Digital Identity Management and Trust Negotiation: Overview of Digital Identity Management, Overview of Existing Proposals Liberty Alliance, WS-Federation, Comparison of Liberty Alliance and WS-Framework, Other Digital Identity Management Initiatives, Discussion on Security of Identity Management Systems, Business Processes. [10]

5. Access Control for Web Services: Approaches to Enforce Access Control for Web Services, WS-AC: An Adaptive Access Control Model for Stateless, Web Services, The WS-AC Model, WS-AC Identity Attribute Negotiation, WS-AC Parameter Negotiation. [10]

Reference Book:

1. Elisa Bertino, Lorenzo D. Martino, Federica Paci, Anna C. Squicciarini, Security for Web Services and Service Oriented Architectures, Springer Science (2009).

Total Lectures: 52

CS 574 Mobile and Wireless Security 4-0-0-4

1. **Wireless Technologies:** Introduction to Wireless technologies- Wireless data networks-Personal Area Networks -Transmission Media – WLAN standards - Securing WLANS - Countermeasures - WEP (Wired Equivalence Protocol). [10]

2. **Multiple Access Techniques and Wireless Networking**: Introduction- FDMA, TDMA, Spread Spectrum Multiple Access: Space Division Multiple Access- Packet Radio, Introduction To Wireless Networks- Differences Between Wireless And Fixed Telephone Networks, Development Of Wireless Networks, Traffic Routing In Wireless Networks Integrated Services Digital Network (ISDN), Protocols For Network Access. [12]

3. **Wireless Threats**: Kinds of security breaches – Eavesdropping, Communication Jamming, RF interference, Covert wireless channels, DOS attack, Spoofing, Theft of services, Traffic Analysis, Cryptographic threats, Wireless security Standards. [10]

4. **Security in Data Networks**: Wireless Device Security Issues - CDPD security (Cellular Digital Packet Data), GPRS security (General Packet Radio Service), GSM (Global System for Mobile Communication) security, IP security. [10]

5. **Wireless Transport Layer Security**: Secure Socket Layer - Wireless Transport Layer Security - WAP Security Architecture - WAP Gateway. [10]

Reference Books:

1. Nichols and Lekka, “Wireless Security-Models, Threats and Solutions”, Tata McGraw – Hill, New Delhi, 2006.
2. Merritt Maxim and David Pollino,”Wireless Security”, Osborne/McGraw Hill, New Delhi, 2005.
3. William Stallings, “Cryptography and Network Security - Principles and practices, Prentice Hall, New Delhi, 2006.

Total Lectures: 52

CS 576 Information Security Policies 4-0-0-4

1. Cyber Security and its problem-Intervention Strategies: Redundancy, Diversity and Autarchy. Private ordering solutions, Regulation and Jurisdiction for global Cyber security, Copy Right-source of risks, Pirates, Internet Infringement, Fair Use, postings, criminal liability, First Amendments, Data Losing. [13]

2. Copy Right-Source of risks: Pirates, Internet Infringement, air Use, postings, Criminal Liability, First Amendments, Losing Data, Trademarks, Defamation, Privacy-Common Law Privacy, Constitutional law, Federal Statutes, Anonymity, Technology expanding privacy rights. [13]

3. Duty of care &criminal liability: procedural issues, Electronic Contracts & Digital Signatures, Misappropriation of information, Civil Rights, Tax, Evidence. Information security policies and procedures : Corporate policies-Tier 1,Tier 2 and Tier 3 policies, Process management planning and preparation developing policies-asset classification policy developing standards. [13]

4. Information security: fundamentals-Employee responsibilities- information classification-Information handling- Tools of information security- Information processing-secure program Administration. Organizational and Human Security: Adoption of Information Security Management Standards, Human Factors in Security- Role of information security professionals [13]

Reference Books:

1. Jonathan Rosenoer, Cyber Law: The law of the Internet, Springer, 1997
2. Mark F Grady, Fransesco Parisi Thomas R. Peltier, The Law and Economics of Cyber Security, Cambridge University Press, 2005.
3. Kenneth J. Knapp, "Cyber Security and Global Information Assurance: Threat Analysis and Response Solutions", IGI Global, 2009.
4. Thomas R Peltier, Justin Peltier and John blackley,"Information Security Fundamentals", 2nd Edition.

Total Lectures: 52

CS 578 Operating System and Mobile Application Security 4-0-0-4

1. Introduction to android: An open platform for mobile development, android applications, and android SDK features, developing for android, developing for mobile devices, android development tools. Introducing the application manifest, using the manifest editor, the android application lifecycle, externalizing resources, fundamental android UI design, introducing views and layouts, creating new views and menus. [10]

2. Intents, broadcast receiver, adapters and the Internet: Introducing Internet and adapters, using internet resources, introducing dialogs, Data storage, retrieval and sharing techniques for saving data, saving simple application data and loading files, databases in android. [10]

3. Maps, Geocoding and Location based services: setting up the emulator with test providers, Selecting the location provider, finding your location, using proximity alerts, using the geocoder, creating map based activities and mapping earthquakes example Advance Android development paranoid android, using AIDL to support IPC for services, using internet services, building rich user interfaces. [10]

4. Mobile Web Architecture, Standards and Tools: Mobile Internet Access, Mobile Web browser Evolution, Mobile Web Standards and development time, WAP and WAP Standards, XHTML, WML and WML Script, Mobile Web Development Approaches, Content Adaption and Adaption Strategies, How to recognize end user device, Device Detection in PHP, Tools Available for mobile web development, Conversion Engines, Emulators, Mobile Web Checkers, Dynamic content**.** [11]

5. Mobile Application Development Management & Security Mobilized Enterprise Web Architectures, User To Mobile Client Security Issues, Mobile Client Security Issues, Client Server Communications Security Issues, Existing Web Architectures and Back End Systems Security Issues, Project Management, Requirements, Design, Code Development and Integration, Integration and System Testing, Deployment and Release Management, Re Evaluation and Reiteration, Operations and Maintenance. [11]

Reference Books

1. Reto Meier, Professional Android Application Development, John Wiley and Sons, 2010.
2. Rick Rogers, John Lombardo, Zigurd Mednieks, G. Blake Meike, Android Application Development Programming with the Google SDK, O'Reilly, 2009.
3. Valentino Lee; Heather Schneider; Robbie Schell , Mobile Applications Architecture, Design, and Development, Prentice Hall April 16, 2004.

Total Lectures: 52

CS 580 Biometric Security 4-0-0-4

1. Overview: Introduction, benefits of biometrics over traditional authentication systems, benefits of biometrics in identification systems, selecting a biometric for a system, Key biometric terms and processes, biometric matching methods, Accuracy in biometric systems. [11]

2. Physiological Biometric Technologies: Leading technologies: Finger-scan, Facial-scan, Iris-scan, Voice-scan, components, working principles, competing technologies, strengths and weaknesses. Other physiological biometrics: Hand-scan, Retina-scan, components, working principles, competing technologies, strengths and weaknesses, automated fingerprint identification systems. [11]

3. Behavioral Biometric Technologies: Handprint Biometrics, DNA Biometrics, signature and handwriting technology, Technical description, classification, keyboard / keystroke dynamics, Voice, data acquisition, feature extraction, characteristics, strengths, weaknesses, deployment. [10]

4. Multi Biometrics: Multi biometrics and multi factor biometrics - two-factor authentication with passwords - tickets and tokens – executive decision - implementation plan. [10]

5. Biometric Applications: Categorizing biometric applications – application areas: criminal and citizen identification, surveillance, PC/network access, e-commerce and retail/ATM, costs to deploy, other issues in deployment. [10]

Reference Book:

1. Samir Nanavathi, Michel Thieme, and Raj Nanavathi, "Biometrics -Identity verification in a network", Wiley Eastern, 2002.
2. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley Eastern Publications, 2005.
3. John Berger," Biometrics for Network Security", Prentice Hall, 2004.

Total Lectures: 40

MA 531 Advanced Computational Mathematics 3-0-0-3

1. Calculus of Finite Differences and Interpolation: Finite differences and difference operators, Construction of difference tables, Interpolation and extrapolation with equal intervals (Newton- Gregory forward, backward, Stirling and Bessel's formula), Interpolation and extrapolation with unequal intervals (Newton's divided difference and Lagrange's formula). [08]

2. Numerical Differentiation and Integration: Numerical differentiation with equal and unequal intervals, numerical integration (newton-Cotes quadrature formula, Trapezoidal, Simpson's 1/3, Simpson's 3/8, Weddle's and Romberg rules), Double and triple integration using Trapezoidal and Simpson's rules. [07]

3. Numerical Solution of Simultaneous Equations: Gauss elimination method (Partial Pivoting), Jacobie's iteration method, Gauss Jordan method, Gauss Siedel iteration method. [4]

4. Numerical Solution of Algebraic and Transcendental Equations: Bisection method, Regular falsi method (method of false position), Newton Raphson method and its applications, Graeffe's root squaring method with error analysis.

[4]

5. Numerical Solution of Ordinary and Partial Differential Equations: Numerical solution of ordinary differential equations of first order and first degree using Picard's, Taylor series, Euler, Euler's modified, Runge-Kutta method of fourth order and Milne's Predictor -Corrector method.
Classification of partial differential equations (elliptic, parabolic, and hyperbolic). Finite difference approximations to partial derivatives. Jacobi and Gauss Siedel method, Crank - Nicolson method, Solution of Laplace and Poisons equations. [10]

6. Linear Algebra: Review of group, ring and field , Vector Spaces, Subspaces, Linearly dependent and independent, Basis, Dimensions, Isomorphism, Linear transformations and their matrix representations , Rank, Inverse of Matrices, Cauchy- Schwarz inequality, Eigenvalue, Eigenvectors. [07]

Text Books:

1. M.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, 2012.
2. B.S. Grewal, Numerical Methods, BPB publication, 2012.
3. Introduction to Linear Algebra with applications by Jim Defranza and Daniel Gagliardi, TMH, Year 2013.

Reference Books:

1. Numerical Mathematics Analysis by James B. Scarborough.
2. Introduction Methods of Numerical Analysis by S.S. Shastry.
3. Applied Numerical methods with MATLAB by Steven C Chapra, TMH.
4. Introduction of Numerical Analysis by Forberg.
5. V. Rajaraman Computer oriented numerical methods 3rd edition PHI – 2012
6. Linear Algebra and Its applications by David C. Lay, Addison- Wisley(An imprint of Pearson education).

MA 533 Advanced Computational Mathematics Laboratory 0-0-2-1

Implement the following in C/C++/MATLAB:

(1) Newton-Gregory's formulae for forward and backward interpolation.
(2) Stirling formula.
(3) Bessel's formula.
(4) Newton's divided difference formula.
(5)Lagrange's formula.
(6) Numerical differentiation.
(7) Numerical integration: Newton –Cotes quadrature formula..
(8) Trapezoidal rule.
(9) Simpson rules.
(10) Romberg rules.
(11) Solution of differential equations by Euler's method modified Euler's method.
(12) Runge-Kutta method.
(13) Milne's Predictor-Corrector method.
(14) Bisection method
(15) Regula Falsi method
(16) Newton – Raphson method.
(17) Graeffe's root squaring method.
(18) Gauss elimination method (with partial pivoting).
(19) Eigen values and eigen vectors.
(20) Solution of partial differential equations.

RM 17.101 **Research Methodology** **2-0-0-2**

1. **Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches,Research Process,Validity and Reliability in Research. [2]

2.**ProblemFormulation:**Identification, Selection and Formulation of a Research Problem, Criteria ofagood Research Problem, Reviewof Literature, Research Gaps. [4]

3.**Research Design:**Research Framework, Meaning &Significance of Research Designs, Features of a good Research Design, Types of Research Design. [4]

4.**Dataforresearch:**TypesofData,Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis.[4]

5. **Data Analysis and Simulation Tool:** Introduction to SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [8]

6. **ReportWriting:**Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [4]

TextBooks:

1. R.Pannershelvam, "ResearchMethodology" PrenticeHall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"ResearchMethodology: MethodsandTechniques",New Age International (p) Limited,Publishers New Delhi, 4ndedition,2018.

References –

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013.
4. Dr.A.K.Phophalia, “Modern Research Methodology: New Trends and Techniques” Paradise Publishers Jaipur, 1st edition, 2012.
5. Pankaj Madan, “Research Methodology”, Global Vision Publishing House, New Delhi, 2nd edition, 2016.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech VLSI

Total Lecture: 40

EC 502 FPGA ARCHITECTURE & APPLICATIONS 3-1-0-4
(Elective I)

1	**PROGRAMMABLE LOGIC:** ROM, PLA, PAL, PLD, PGA – Features, Programming and Applications using Complex Programmable Logic Devices.	6
2	**FPGA:** Field Programmable Gate Arrays – Logic Blocks, Routing Architecture, Design Flow, Technology Mapping for FPGAs.	4
3	**FINITE STATE MACHINES (FSM):** Top Down Design – State Transition Table, State Assignments for FPGAs. Problem of Initial State Assignment for One Hot Encoding. Derivations of State Machine Charges.	8
4	**REALIZATION OF STATE MACHINE:** Charts with a PAL. Alternative Realization for State Machine Chart using Microprogramming. Linked State Machines. One – Hot State Machine, Perimeters for State Machines – Basic Concepts, Properties.	8
5	**FSM ARCHITECTURES AND SYSTEMS LEVEL DESIGN:** Architectures Centered Around Non-Registered PLDs. State Machine Designs Centered Around Shift Registers. One – Hot Design Method. Use of ASMs in One – Hot Design. K Application of One – Hot Method. System Level Design – Controller, Data Path and Functional Partition.	10
6	**DIGITAL FRONT END DIGITAL DESIGN TOOLS FOR FPGAS & ASICS:** Using EDA Tool ("FPGA Advantage") – Design Flow Using FPGAs of Parallel Adder Cell, Sequential Circuits, Multiplexers.	4

Text Books:

1 P.K.Chan & S. Mourad, Digital Design Using Field Programmable Gate Array, Prentice Hall, 1994.

2 S.Trimberger, Edr., Field Programmable Gate Array Technology, Kluwer Academic Publicatgions,1994.

3 J. Old Field, R.Dorf, Field Programmable Gate Arrays, John Wiley & Sons, Newyork, 1995.

Reference Books:

1 S.Brown, R.Francis, J.Rose, Z.Vransic, Field Programmable Gate Array, Kluwer Pubin, 1992.

Total Lecture: 40

EC 504 **ASIC DESIGN** **3-1-0-4**

(Elective II)

1	**ASIC DESIGN STYLES:** Introduction – categories-Gate arrays-Standard cells-Cell based ASICs-Mixed mode and analogue ASICs – PLDs.	4
2	**ASICs – PROGRAMMABLE LOGIC DEVICES:** Overview – PAL –based PLDs: Structures; PAL Characteristics – FPGAs: Introduction, selected families – design outline.	6
3	**ASICs –DESIGN ISSUES:** Design methodologies and design tools – design for testability – economies.	6
4	**ASICs CHARACTERISTICS AND PERFORMANCE**: design styles, gate arrays, standard cell -based ASICs, Mixed mode and analogue ASICs.	6
5	**ASICs-DESIGN TECHNIQUES:** Overview- Design flow and methodology- Hardware Description languages-simulation and checking-commercial design tools.	6
6	**LOGIC SYNTHESIS, SIMULATION AND TESTING:** Verilog and logic synthesis –VHDL and logic synthesis - types of simulation -boundary scan test - fault simulation- automatic test pattern generation.	6
7	**ASIC CONSTRUCTION:** Floor planning, placement and routing system partition.	2
8	**FPGA PARTITIONING**: Partitioning Methods-Floor Planning- Placement-Physical Design Flow-Global Routing-Detailed Routing –Special Routing-Circuit Extraction-DRC.	4

Text Books:

1 L.J.Herbst, "Integrated circuit engineering", OXFORD SCIENCE Publications, 1996.

2 M.J.S.Smith, "Application - Specific integrated circuits", Addison-Wesley Longman Inc 1997.

3 **Himanshu Bhatnagar, "Advanced ASIC Chip Synthesis: Using Synopsys Design Compiler, Physical Compiler, and PrimeTime", Kluwer Academic Publishers.**

Reference Books:

1 Michael John Sebastian Smith, "Application specific integrated circuits", Addison-Wesley.

Total Lectures 40

EC 541 Semiconductor Device Models for Circuit Simulation 3-1-0-4

1. Principle of circuit simulation and its objectives. [4]

2. Introductions to SPICE- DC, small signal, large signal, high frequency, noise models of diodes and measurement of diode model parameters. [6]

3. DC, small signal, high frequency and noise models of bipolar junction transistors, extraction of bipolar junction transistor model parameters. [6]

4. DC, small signal, high frequency and noise model of MOSFETs. [5]

5. Devices scaling, short and narrow channel MOSFETs. [5]

6. MOSFET channel mobility model, level-1 and level-2 large signal MOSFET Models. [4]

7. Extraction of MOSFET model parameters. [5]

8. JFET and MESFETs, extraction of JFET and MESFET model parameters. [5]

Text Books:

1. Dasgupta N., and Dasgupta A., Semiconductor Devices - Modeling and Technology, Prentice-Hall of India, 2004.
2. Ben G. Streetman, Sanjay Banerjee, "Solid State Electronic Devices", Prentice Hall.
3. Adir Bar-Lev, "Semiconductors and electronic devices", Prentice-Hall International.

Total Lectures 40

EC 542 Analog VLSI Design 3-1-0-4

1. Basic consideration in analog VLSI design. [4]

2. MOS current sources, current mirrors, out buffers and voltage reference circuits. [6]

3. CMOS amplifier. [7]

4. Noise in CMOS amplifier. [3]

5. CMOS comparators. [6]

6. Mixed signal circuits. [6]

7. MOS circuit components. [4]

8. Switched capacitor filters realization by MOS technology. [4]

Text Books:

1. Razavi B., Design of Analog CMOS Integrated Circuits, McGraw-Hill, New York, 2001.
2. D. Johns and K. *Martin*, "*Analog Integrated Circuit Design*", *John* Wiley & Sons.
3. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design", Oxford university press.

Total Lectures 40

EC 543 VLSI Fabrication Technology 3-1-0-4

1. Crystal growth and Epitaxy [3]
2. Diffusion and Ion-implantation [4]
3. Oxidation Processes [3]
4. Film Deposition Techniques [4]
5. Etching and Cleaning [4]
6. Lithographic Processes [5]
7. Metal Deposition and Interconnect Formation [2]
8. Process Integration : Bipolar and MOS (NMOS & CMOS) [7]
9. Packaging [3]
10. Testing [3]
11. Reliability and Yield [2]

Text Books:

1. Gandhi S. K., VLSI Fabrication Principles – Silicon and Gallium Arsenide, John Wiley & Sons, 2nd Ed., 2003.
2. A.I.C.T.E, Design and Fabrication Technology, A.I.C.T.E, Bangalore, 2001.
3. *S. M. Sze*, "*VLSI Technology"*, Second Edition, McGraw-Hill.

Total Lectures 40

EC 544 VLSI Systems and Subsystems 3-1-0-4

1. System specification using HDL. [6]
2. General VLSI Components. [7]
3. Arithmetic circuits in CMOS VLSI. [5]
4. Memories and Programmable logic. [7]
5. System level physical design. [7]
6. VLSI clocking and system design. [6]
7. Reliability and testing of VLSI circuits [2]

Text Books:

1. Hill F. J., and Peterson G. R., Computer Aided Logical Design with Emphasis on VLSI, John Wiley & Sons, 4th Ed., 1993.
2. Wolf W., Modern VLSI Design- System-On-Chip Design, Pearson Education Asia, 3rd Ed., 2002.
3. John P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons.

Total Lectures 40

EC 545 Elements of Digital VLSI Design 3-1-0-4

1.	CMOS Technology & Device Scaling	[6]
2.	Stick Diagram, Layout and Full Custom Mask Design	[4]
3.	MOS inverters : Static and Dynamic Characteristics	[4]
4.	Inverter Delay and Power Dissipation	[5]
5.	Interconnect delay	[2]
6.	Combinational MOS Logic Circuits	[4]
7.	Sequential MOS Logic Circuits	[4]
8.	Dynamic Logic Circuits	[3]
9.	Low power VLSI Circuits	[4]
10.	Introduction to BiCMOS Circuits	[2]
11.	Introduction to FPGA and ASICS	[2]

Text Books:

1. Weste N. H., Principles of CMOS VLSI Design, Pearson Education Asia, 2nd Ed., 2001.
2. Kang S., CMOS Digital Integrated Circuits Analysis and Design, Tata McGraw-Hill, 3rd Ed., 2003.
3. Baker J. R., CMOS - Circuit Design, Layout and Simulation, Prentice-Hall of India, 2000.

Total Lectures 40

EC 546 **Mixed-Signal Systems (Elective III)** **3-1-0-4**

1.	Introduction to mixed-signal systems.	[2]
2.	Continuous time and sampled data signal processing.	[5]
3.	Static and dynamic logic, OTA-C circuits.	[6]
4.	Switched current techniques.	[3]
5.	Switched capacitor techniques.	[3]
6.	Converters and Delta-sigma modulators.	[4]
7.	Filter design strategies.	[6]
8.	Image processing.	[7]
9.	Silicon compilers.	[3]

Text Books:

1. Christoph G., Languages for System Specification - Selected Contributions on UML, SystemC, System Verilog, Mixed-Signal Systems, and Property Specifications from FDL'03, Springer Publisher, 1996.
2. Nishath K. V., Simulation Techniques and Solutions for Mixed-signal Coupling in Integrated Circuits, Springer Publisher, 1994.
3. Baker R. J., CMOS Mixed-Signal Circuit Design, Prentice-Hall of India, 2001.

Total Lecture: 40

EC 548 **VLSI Physical Design and Design Automation (Elective II)** **3-1-0-4**

1.	Basic VLSI design methodologies.	[3]
2.	Algorithmic graph theory and computational complexity.	[4]
3.	Tractable and intractable problems.	[3]
4.	Combinatorial optimization.	[4]
5.	Layout compaction.	[3]
6.	Placement and partitioning.	[4]
7.	Floor planning.	[3]
8.	Routing.	[3]
9.	Simulation.	[4]
10.	Logic synthesis and verification.	[4]
11.	High-level synthesis.	[5]

Text Books:

1. Sarrafzadeh M., and Wong C. K., An Introduction to VLSI Physical Design, McGraw-Hill, New York, 1996.
2. Geiger R. L., Allen P. E., and Strader N. R., VLSI Design Techniques for Analog and Digital Circuits, McGraw-Hill, New York, 1990.
3. Naveed Sherwani, "Algorithms for VLSI Physical Design Automation", Springer International Edition.

Total Lectures 40

EC 550 Embedded System Design 3-1-0-4

1. **Introduction to Embedded System & Design Concepts:** Introduction & examples of embedded system, Concept of embedded system design , design challenges, processor technology & IC technology, Embedded processor & general purpose processor, trades-offs, development phase of embedded system & use of software tools for development of embedded system . [4]

2. **Embedded Processor Architecture/Microcontrollers:** Role of processor selection in embedded system, overviews of 8-bits/16-bits/32-bits microcontrollers, 8051 microcontroller: Architecture, basic assembly language programming concepts, instruction sets, addressing modes, logical operations, arithmetic operations, branching instructions, Boolean instructions, subroutines, timing subroutine, serial data communication & interrupt process, assembly language programming examples [8]

3. **Interfacing, programming & real-time applications:** Memory & I/O interfacing, Timer & counter operation & Programming, Serial communication,& interrupt handling, LCD & keyboard interfacing, DS 12887 RTC interfacing, interfacing ADC/DAC, real world interfacing & applications. [12]

4. **Embedded software Architecture & Development:** Challenges & issues in an embedded software development, real-time programming language & embedded OS, Embedded software architecture: Round-Robin, Round-Robin with interrupt, RTOS architecture, tasks & tasks states, priority based scheduling, Semaphore & shared data, timer function, memory management, encapsulating semaphore & queue, hard real-time scheduling consideration, saving memory space & power. Embedded software development process & tools, implementation aspects of embedded systems, validation & debugging of embedded system. [10]

5. **Networks for Embedded system:** 12C two wire busses, the can bus, SHARC link ports, Ethernet, Myrinet, IEEE 1451.1 & IEEE 1451.2 plugs & play standards, embedded TCP/IP. [6]

Text Books:

1. Dreamtech Software Team, Programming for Embedded Systems, Wiley Publishing, Inc., 2003.
2. Mazidi and Mazidi, "The 8051 Microcontroller And Embedded Systems Using Assembly And C", Pearson Education India.
3. David E. Simon, "An Embedded Software Primer", Addison-Wesley Professional.

Total Lectures 40

EC 553 **DESIGN OF DIGITAL SYSTEMS** **3-1-0-4**
(Elective I)

Introductory concepts: Number System and floating-point numbers, Combinational logic circuits, Flip-Flops and related devices, Digital Arithmetic operations and circuits, counters and registers. [5]

Integrated Circuit Logic family: Evolution of TTL, IIL (merged structure), CML logic, 10K and 100K series of ECL, Stacked ECL, EFL. [7]

Evolution of nMOS logic: Passive load, saturated load, linear load, dynamic behaviour, Gates realization. [5]

CMOS logic families: static and dynamic behaviour, IC interfacing, TTL driving CMOS and vice-versa, different types of circuit realization. [5]

MSI Logic Circuits: Derived logic building blocks such Decoders/ drivers, Encoders, Multiplexers, De-multiplexers, Magnitude Comparators, applications. [5]

MESFET, MESFET Inverter, DCFL, supper buffer FET logic, BFL [8]

Memory Devices: General memory operations, Programmable logic devices, Semi-conductor memories, SRAM, DRAM, FAMOS, FLOTOX. [5]

Text Books:

1. R. J. Tocci : "Digital System: Principles & Applications" – PHI
2. Manufacturers IC – Data Sheet.
3. Leo Chartrand, "Advanced Digital Systems: Experiments and Concepts with CPLDs", Cengage Learning.

Reference Books:

1. John F. Wakerly, "Digital Design: Principles and Practices", Prentice Hall.

Total Lectures 40

EC 556 **Low Power VLSI Technology (Elective III)** **3-1-0-4**

1.	Introduction to low power VLSI technology.	[2]
2.	Voltage scaling and power-delay tradeoff.	[5]
3.	Threshold voltage scaling.	[4]
4.	Multi-threshold CMOS.	[4]
5.	Variable threshold CMOS.	[3]
6.	Estimation and optimization of switching activity.	[5]
7.	Reduction of switched capacitance.	[2]
8.	Adiabatic logic circuits.	[4]
9.	Low-power memories.	[4]
10.	DC-DC converters.	[3]
11.	Low-power architecture.	[4]

Text Books:

1. Weste N. H., Principles of CMOS VLSI Design, Pearsons Education Asia, 2nd Ed., 2001.
2. Geiger R. L., VLSI Design Techniques for Analog and Digital Circuits, McGraw-Hill, New York, 1990.
3. Yeo K., Rofail S. S., and Goh W., CMOS/BiCMOS ULSI Low Voltage, Low Power, Pearsons Education Asia, 2003.

Total Lectures 40

MA 509 Advanced Mathematics 3-1-0-4

1. Computer based numerical methods:
   Methods for numerical solution of algebraic and transcendental equations: Direct methods e.g. Bisection method, Regula-Falsi method; Iterative method e.g. Newton-Raphson method.
   Methods for the solution of simultaneous linear equations: Direct methods e.g. Gauss elimination method; Iterative method e.g. Gauss-Seidel method, Jacobi method
   Finite difference table for equal and unequal intervals in the independent variable values. Newton's forward and backward interpolation formula; Newton's interpolation formula for divided differences. Numerical differentiation. Numerical Integration methods: Simpson's rules, Trapezoidal rule and Romberg's method.
   Numerical solution of ordinary differential equations: Euler method, Modified Euler method and Runge-Kutta methods.
   Numerical solution of elliptic and parabolic differential equations using finite difference approach.
   [20]

2. Statistics and Probability:
   Concept of random variable, total and conditional probability, Bayes' theorem,probability distributions and probability density functions, moments and moment generating functions. Some theoretical probability distributions such as binomial, Poisson, normal, uniform, exponential, rectangular, χ^2, t, F.Sampling theory, sampling distributions and sampling techniques.Estimation theory, Point and Interval estimation of mean and variance of data. Testing of hypotheses. Simple and Composite hypothesis. Correlation and Regression. Multiple and Partial correlation and regression. Concepts of stochastic processes with special reference to Monte Carlo methods. [20]

Text Books

1. Shastri S.S., Introductory Method of Numerical Analysis, Prentice-Hall of India, 3rd Ed., 2002.
2. Trivedi K.S., Probability and Statistics with Reliability Queuing and Computer Science Application, Prentice-Hall of India, 2002.

Reference Book

1. Dass H.K., Advanced Engineering Mathematics, S. Chand and Company Ltd., 1999.

Mody University of Science & Technology, Lakshmangarh (Sikar)

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Department of CSE

Course structure for

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CA 507 **Information Systems** **3-0-0-3**

Total Lectures: 40

1. **Information:**Concepts, Information: a quality product, Classification of information, Methods of data and Information collection, Value of information, General model of a human as a information processor, Summary of information concepts and their implications, organization and information, MIS and Information concepts. [8]

2. **Information Systems, Organizations, management and Strategy:** Organisations and Information Systems, how information system impact organizations and business firms, Type of Information System, Managerial Challenges of Information Technology. Components of information System, Information System Activities. [8]

3. **Information Systems for Functional Areas:** Information for financial, Marketing, Inventory control, Production function, Personnel function, Cases related to information, requirement for above functional areas. [8]
4. **Computer Concepts & Peripherals:** Need of computer Literacy, Use and Definition of Computer, Generation of Computer, Classification of Computer, Peripherals: Input, output and storage technologies. [7]

5. **Computer System & System Software:** Brief history of Computer Hardware, Type of Computer System, Microcomputer System, Mainframe Computer System, System Software: Definition, operating system, programming language, web languages and services, Programming software. [9]

Text Book:

1. Steven Alter "Information Systems the foundation of E-Business", 4th Edition Person education, 2010.
2. Brien James A. O'and MarakasGeorge M., "Management Information System" 9th Edition, Tata McGraw Hill Education Private Limited, 2010.

Reference Book:

1. RajaramanV. "Analysis and Design of Information System", Prentice-Hall of India, 3rd Edition, 1996.
2. BasandraSuresh K. "Management Information System", Wheeler Publication, 2003.

CA 508 **Theory of Computation** **3-1-0-4**

Total Lectures:40

1. **Finite Automata and Regular Expression:** Finite State Systems, Basic definitions, Regular Languages and Regular Expressions, Finite Automata, Kleen theorem, Arden's theorem, Mealy and Moore Machine and their Conversion, Pumping Lemma for Regular Sets, Decision Algorithms, Myhill-Nerode theorem and Minimization of finite automata. [12]

2. **Context-Free Grammars:** Context-Free Grammars, Union, Concatenation of CFGs, Derivation Trees, Simplification of Context-Free Grammars, Chomsky Normal Form, Greibach Normal Form, Ambiguous Grammar, Inherently Ambiguous Context-Free Languages. [9]

3. **Context-Free Languages and Pushdown Automata:** Pushdown Automata and Context Free Languages, Pumping Lemma for CFL, Closure Properties of CFL and Decision Algorithms for CFL. [6]

4. **Turing Machine:** Turing Machine Model, Techniques for Turing Machine Construction, Turing Machines as Language Acceptor, Combining Turing Machines, Properties of Recursive And Recursively Enumerable Languages and Universal Turing Machine. [8]

5. **Chomsky Hierarchy of Languages:** Regular Grammars, Unrestricted Grammars and Turing Machines, Context-Sensitive Grammars and Linear Bounded Automata. [5]

Text Books:

1. Martin John C. "Introduction to languages and the theory of computation", 4th edition, McGraw-Hill, 2003
2 Peter linz , "An introduction to Formal Languages and Automata" , Narosa Publishing House, sixth edition, 2010.

Reference Books:

1 Hopcroft John E., Motwani Rajeev and Jeffery Ullman *D.* , "Introduction to Automata Theory, Languages, and Computation", 3rd edition, Narosa Publishing House, 2006.

2. Sipser Michael, "Introduction to Theory of Computation", 1st edition, Cengage Learning, 2012.

CA 509 **C Programming** **3-0-0-3**

Total Lectures:40

1. **Introduction:**Brief History, Library& Linking, Compilation & Execution, Data Types, Operator and Expression Identifier, Keyword and Token, Constant, Data Declaration and Definition, Operators and Expression, Precedence & Associability of Operators. [7]

2. **Control and Loop Statement:** Introduction, Selection Statements, If, The Conditional Expression, switch, Iteration Statements: for loop, while loop, do-while loop, Jump, Goto label, break and continue, exit() function. [7]

3. **Array, Function and String:** Definition, declaration and Types of Array, Operation and application of array, Brief introduction on string header files and applications of strings. Function, argument passing, scope of variable, call by reference and call by value, recursion, passing array to function. [5]

4. **Structure and Union:** Definition, Declaration and Initialization, Accessing Structure members, Arrays of Structure, Passing Structure to function, Structure to Pointer, Union. [6]

5. **Pointers:** Definition, declaration, Pointer to Pointer, NULL Pointer, De-referencing Pointer, Pointer Arithmetic , array to pointer (1-D array ,2-D array), pointer array, function to pointer. [6]

6. **File handling:** Introduction, Defining and Opening a File in read and writes mode, Closing a file and ending of file, Enumerated data types, Error Handling During I/O Operation, Random Access to Files, Command Line Arguments. [5]

7. **Storage Classes & Preprocessor:** Introduction,Storage Classes. Preprocessor Directive, Macro. [4]

Text Books:

1. Scheldt Herbert, “C The Complete Reference” Tata McGraw hill 6th edition,2010.

2. Kernighan & Ritchie, “C Programming Language” Prentice Hall Second Edition, 1988.

Reference Books:

1 Kanetkar Y.P., “Let us C Solutions” 10th edition, BPB publication, 2010.

2. Balaguruswamy E., “Programming in ANSI C “5th Edition Tata McGraw-Hill Education, 2004.

CA 510 **C++ Programming** **3-0-0-3**

Total Lectures:40

1. **Introduction**: Overview of oops, Differences between OOP and Procedure Oriented programming, Structure of a C/C++ program, Differences between C/C++, Data Types in C++, Identifier and Keywords, Constants,C++ Operators, Type Conversion,Variable declaration, statements, Expressions, Features of iostream.h,Input andOutput, Conditional Expression,Loop statements, Jump statements. [7]

2. **Data Abstraction and Polymorphism:**Class Definition, Controlling access to other functions, Memory Allocation, Different Types of Constructors, Destructor,Dynamic Creation and Destruction of Objects.Overloading functions and operators, Overloading New and Delete operators. [7]

3. **Inheritance:**Definition, DerivedClasses, Syntax of Derived Classes, Base Class, Types of Inheritance, Overloading Inherited Member Functions ,Virtual Base Class. [5]

4. V**irtual functions and polymorphism:** Static and Dynamic bindings,virtual functions, dynamic binding through virtual functions,virtual function call mechanism, implications of polymorphic use of classes , virtual destructors , calling virtual functions in a base class constructor. [6]

5. **I/O and Templates:** Standard I/O Using C functions, stream I/O in C++, formatted I/O, File I/O, generic Classes in C++, Necessity of Templates , generic classes using Macros, class templates, Function Templates, Advantages of Templates. [8]

6. **Exception and File Handling:** Benefits of exception handling, troubles with standard C functions , exception handling mechanism in C++, hierarchy of file stream classes, opening and closing files, file modes, testing for errors,file pointers and their manipulations, ASCII & Binary files, sequential and random access files. [7]

Text Books:

1. Schildt Herbert, C++: The Complete Reference ,4th edition, Tata Mcgraw Hills, 2003.

2. Balagurusamy E., Object Oriented Programming With C++,4thedition, Tata Mcgraw Hills, 2013

Reference Books:

CA 511 **Digital Electronics** **3-1-0-4**

Total Lectures: 40

1 **Number Systems and Codes:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic. [2]

2 **Introduction to Boolean Algebra:** Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [2]

3 **Logic Gates:** Diode and transistor as a switch, basic logic gates, derived logic gates, block diagrams and truth tables, logic diagrams from Boolean expression and vice versa, converting logic diagram to universal logic, positive logic, negative logic and mixed logic. [5]

4 **Simplification of Boolean Functions:** K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method. [5]

5 **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]

6 **Sequential Circuits:** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters. [10]

7 **Logic Families:** Logic gate characteristics (propagation delay, speed, noise margin, fan-in, fan-out, power dissipation), standard logic families (RTL, DCTL, TTL, ECL, MOS) [5]

8 **Programmable Logic:** Introduction to programmable logic array (PLA), programmable array logic (PAL). [1]

Text Books:

1. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Delhi, 4th Edition, 2009.
2. Floyd, T. L. and Jain, R.P., "Digital Fundamental", Pearson Education, Delhi, 8th Edition, 2009.
3. Tocci, R. J., Widmer, N. and Moss, G., "Digital System: Principles and Applications", Pearson Education, Delhi, 10th Edition, 2007.

Reference Books:

1. Puri, V. K., "Digital Electronics: Circuits and Systems", Tata McGraw-Hill, Patel Nagar, New Delhi, 4th Edition, 2001.
2. Karim, M.A. and Chen. X., "Digital Design: Basic Concepts and Principles", CRC Press Taylor & Francis Group, Printed in India by Saurabh Printers, 2nd Indian reprint, 2010.
3. Jain, R. P., "Modern Digital Electronics", Tata McGraw-Hill, Patel Nagar, New Delhi, 4th edition,1999.

CA 512 Systems Analysis and Design **3-0-0-3**

Total Lectures= 40

1. **System Concepts:** Definition, characteristics and elements, Types of system, problems in system development, principles of system building, system engineering [5]

2. **Information Systems**: Information, components and types of information system, computer based information systems. [4]

3. **System Models**: System Development Life Cycle (SDLC), Prototype, Prototype tools and strategy. [5]

4. **Systems Analysis** : Role of systems Analyst, system planning , information gathering tools for determining information requirements, cost/benefit analysis. [6]

5. **Feasibility Study** : System performance constraints, specific system objectives, steps in feasibility analysis, feasibility report. [3]

6. **Structured Analysis** : Definition, Tools of Structured Analysis: data flow diagram, decision tree and decision table. [5]

7. **System Design**: Process and stages in design, input/output and form design, control design, design of database interactions. [6]

8. **System implementation**: System testing and quality assurance, implementation and system maintenance, hardware and software selection, system security and recovery. [6]

Text Books:

1. Awad, Elis M. , " Systems Analysis and Design", Galgotia Publications Pvt. Lid, New Delhi, 1997.
2. Senn, James A., "Analysis & Design of Information ", McGraw Hill Education (india) Pvt. Ltd., New Delhi, 2005.

Reference Books:

1. Goyal, Arunesh , " Systems Analysis and Design", PHI Learning Pvt. Ltd., New Delhi, 2011.
2. Hoffer, J. A., George, J. F. and Valacich, J. S., " Modern Systems Analysis & Design", Pearson Education(Singapore) Pvt. Ltd., Delhi,2005.

CA 514 **Operating system** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Overview, Evolution,Types, operating system functions and characteristics. [3]

2. **Process Management:** The process concept, operating system services for process management, scheduling algorithms and multiple processor scheduling. [5]

3. **Memory Management:** Storage allocation methods, paging, segmentation, virtual memory concept, demand paging, page replacement algorithms and trashing. [5]

4. **Input /Output and File Systems:** Hardware organization, device scheduling policies, Functions of file systems, file access and allocationmethods, directory systems, structured organizations, directory and file protection mechanisms and implementation issues. device dependent and device independent software. [7]

5. **Deadlocks:** Characterization, prevention and avoidance, deadlock detection and recovery and practical consideration. [5]

6. **Process Synchronization:** Critical section problem, semaphores, classical process co-ordination problems and their solutions, inter process communication and message-passing mechanisms. client-server modeling, RPC, threads. [6]

7. **Protection & Security:** Goals of Protection, Principles of Protection. Domain of protection Access Matrix, Implementation of Access Matrix. Access control, Revocation of Access Rights. Capability- Based systems, Language - Based Protection, Security problem, program threats, system and network threats cryptography as a security tool, user authentication, implementing security defenses, fire walling to protect systems [9]

Text Books:

1. Silberschatz A., and Galvin P.B., Operating System Concepts, John Wiley &Sons, 6th Edition, 2005.
2. Tanenbaum A.S., Modern Operating Systems, Pearson Education Asia, 4th Edition, 200

Reference Books:

1 Stallings W., Operating Systems, Pearson Education Asia, 5thEdition, 2008.
2 Tanenbaum A.S. and Woodhull A. S., Operating Systems- Design and Implementation, Pearson Education Asia, 2nd Edition, 2009.

CA 515 Mathematical Foundation of Computers **3-1-0-4**

Total Lectures:40

1. **Matrix Theory :** Introduction to the matrix theory, types of matrices, inverse of matrices, rank of matrices, solving system of linear equations, Eigen values and Eigen vectors, Sparse matrix, diagonalization and triangulization of matrices. [16]

2. **Three -dimensional geometry and Vector calculus:** Basic concepts of three-dimensional geometry (viz. direction cosines and direction ratios), equation of a plane and of a straight line. Basic concepts of vectors, gradient, divergence and curl of a vector. [8]

3. **Calculus:** Introduction of differential and integral calculus, derivatives of various types of functions, basic idea of differential equations, solutions of ordinary differential equations with constant coefficients. [10]

4. **Complex Algebra:** Introduction to the complex algebra, complex numbers, geometrical representation of complex numbers: Argand diagram, De-Moirvre's theorem. [6]

Text Books:

1. Ramana B. V. , " Higher Engineering Mathematics", Tata McGraw – Hill Publishing Company Ltd., P 1390, 2nd edition, 2001

2. Babu Ram, "Engineering Mathematics", Pearson, New Delhi, 2010.

3. Narayan Shanti , "Analytical Solid Geometry", S Chand & Company, New Delhi,1988.

Reference Books:

1. Grewal B. S. and Grewal J. S. , "Higher Engineering Mathematics" , Khanna Publishers, New Delhi, P. 1390, 40th edition,2004

2. Kreyszig Errwin, "Engineering Mathematics", John Wiley& Sons, New York, , p. 1639, 9th Edition,1998.

CA 516 **Data Structures** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Data Structure definition, Requirement of different Data Structures, Abstract Data Type, Analysis of Algorithm. [3]
2. **Linear Data Structure:** One and Two-dimensional Arrays, Array Representation, Selection Sort, Bubble Sort, Quick Sort, Heap Sort and Merge Sort,Sequential Search, Binary Search. **L**inked List and itsrepresentations, Operations on Linked List, Types of Linked List, Stack and its representation, Operations on Stack, Queue and its representation, Operations on Queue, Applications of these data structures. [15]
3. **Tree :** Binary Tree and its travesals (Breadth-First, Depth-First), Expression Trees (Infix, Prefix, Postfix Traversals), Binary Search Trees, Heaps,AVL Tree. [12]
4. **Graph:** Matrix Representation, List representation and applications, Minimum Spanning Tree finding algorithms, Shortest Path finding algorithms. [5]
5. **Hashing Techniques:** Hash Function, Address Calculation Techniques, Common Hashing Functions, Collision Resolution, Linear Probing, Double Hashing, Bucket Hashing, Deletion and Rehashing. [5]

Text Books:

1. Horowitz and Sahani, “Fundamental of data structures”,Galgotia Publication,1998.
2. Lipschutz, “Data Structures Schaum’s Outline Series”, Tata Mcgraw Hills,2006.

Reference Books:

1 TenenbaumAaron M., YedidyahLangsam and Moshe J. Augenstein “Data Structures Using C and C++” , PHI,2009.
2. Kruse R. etal, “Data Structures and Program Design in C”, Pearson Education,2007.

CA 517 **Business Accounting** **3-0-0-3**

Total Lectures: 40

1. **Fundamentals of Accounting:** Meaning, Scope and objective of accounting, Accounting principles, Accounting concepts and conventions, Double entry system. [5]

2. **Financial Accounting:** Rules for Journalisation, Posting in ledger, Trial balance, Preparation of financial statement: Trading account, Profit and loss account, Balance sheet;Analysis of financial statement. [10]

3. **Management Accounting:** Concept andobjectives of Management Accounting, Ratio Analysis: Objectives, Advantages and limitations,Types of ratios; Funds flow analysis and Cash flow analysis, Capital budgeting. [10]

4. **Cost Accounting:** Concept and principles, Classification and elements of cost, Techniques of Cost Accounting: Marginal costing, Standard costing, Budgetary Control -Types of budgets, Preparation of budgets; Working capital. [12]

5. **Computerized Accounting**: Uses of Microsoft Excel in accounting, analysis of balance sheet with excel Tally software-application. [3]

Text Books:

1. Bhattacharya A. K, Financial accounting, Prentice Hall of India, 3rd edition, 2006.

2. Khan M.Y. and Jain P.K., Management Accounting, Tata McGraw-Hill Education,2006

3.SaxenaV.K. &VashistC.D., Advanced Cost and Management Accounting , Sultan Chand and Sons,2002.

Reference Books:

1. Jain S.P &NarangK. L, Financial Accounting, Kalyani Publications, 2013.

2.Kulkarni.Mahesh, Management Accounting, Career Publications, 2008.

3.PatankarSanjay, Management Accounting, NiraliPrakashan, 2010.

4. MaheshwariS. N., Management Accounting and Financial Control, S. Chand & Company, 1996.

5 Gupta S.P., Management Accounting, SahityaBhawan, 2nd Edition, 2000.

CA 518 Discrete Mathematics and Probability Theory **3-1-0-4**

Total Lectures = 40

1. **Set Theory:** Sets, Venn-diagrams, algebra of sets, finger sets, binary relations and equivalence relations [6]

2. **Probability Theory:**Fundamentals:Addition and multiplication of probability, Bayes theorem, Binomial, Poisson and normal distribution. [9]

4. **Graph Theory**: Introduction, graph, undirected graph, simple, multiple graph and pseudo graph, walk, path, cycle and connectivity, sub-graph, types of graph, isomorphic graph and representation of graph in computer memory. [10]

5. **Mathematical Logic:**Prepositional calculus, basic logical operations, statements generated by set conditional statements, converse inverse and contraposition statements. [8]

6. **Boolean Algebra:** Basic theorems on Boolean algebra, duality principle, Boolean functions and Boolean expressions. [7]

Text Books:

1. Rosen Kenneth H, "Discrete Mathematics & its applications with Combinatorics and Graph Theory", TMH,2012.

2. Palaniammal S., "Probability & Random Processes", PHI Learning Pvt. Ltd,2000.

3. DeoNarsingh, "Graph Theory with Applications to Engineering and Computer Science", PHI, 1979.

Reference Books:

1. Hines William W., Montgomery D. C. and Goldman David M., "Probability and Statistics in Engineering", Wiley, 2003.

2. Chart rand G. and Zhang P., "Introduction to Graph Theory", TMH, 2006.

3. Kolman B., Busby R. C. and Rass S., "Discrete Mathematical Structures", Prentice – Hall of India Pvt. Ltd, 2013.

CA 525 **Digital Electronics Laboratory** **0-0-4-2**

1 To study the use of General Purpose Digital Trainer and familiarization with the digital IC Data-Books.

2 To study AND, OR. NOT, NAND, NOR, EX-OR gates and their specified experiments.

3 To set up a 4-bit Binary Counter (74LS93) to demonstrate its sequence of Counting.

4 To study the characteristics curve of TTL and CMOS logic gates.

5 To design and test 4-bit Adder and Subtractor circuits.

6 To compare the magnitude of two 4-bit Binary Numbers A and B.

7 Design a combinational circuit with 4 inputs and 4-outputs that converts a 4-bit Gray Code to an equivalent 4-bit Binary number.

8 Design and implement a BCD to Seven Segment Decoder / Driver.

9 To design and implement a 2 to 1 multiplexer.

10 To design and implement a 1:2 & 1:4 de multiplexer.

11 To investigate the operation of various flip flops SR, JK, T and D using gates and FF ICs.

12 To study the following application of shift register using IC 74LS164 and 74LS194 (Shift Right Logic, Shift Left Logic, Parallel Load).

13 Design and test arithmetic and logic circuit using combinational circuit (logic circuit, multiplexer and 4-bit binary adder/ full adder. (Already covered in experiment no.6, 10 &11)

14 Design and test a 4-bit Up Down binary counter. (Already covered in experiment no.3)

NOTE: All experiments are to be performed on either physical apparatuses or on digital electronics simulator like Virtual Bread Board etc.

CA 527 C Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types & Operators
- Control Statements
- Arrays
- Strings

Programs

- Apply logic to print different patterns(at least 5)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- Implementing matrix operations
- Searching and Sorting
- String Manipulations
- Program to understand the decision making constructs and find the roots of a quadratic equation
- Program to understand the implementation of library function

2. Functions

Testing

- Function & Function Calling
- Storage Classes

Programs

- Function Declaration and Definition
- Function call by value and call by reference
- Illustration of storage classes

3. Pointers, Structure and Union

Testing

- Pointer
- Structure
- Union

Programs

- Declaring and initializing pointers
- Accessing a variable through its pointer
- To Implement and use user defined type structures
- Creating a new data type Date with the help of structure
- To understand the use of pointers in arrays
- To learn dynamic memory allocation and deallocation
- To implement list and pointer to list

4. File Handling

Testing

- FILE

Programs

- program to Create a File & Store Information
- program to illustrate Reading of Data from a File and to delete or replace a specific Line from a Text File
- program to Create Employee Record and Update it

CA 528 **C++ Programming Lab** **0-0-4-2**

1. Introduction to C++

Testing:
• Data Types & Operators
• Control Statements
• Arrays

Programs:

- Apply logic to print different patterns (atleast 3)
- Find average, minimum and maximum of an array elements.
- To print Fibonacci series.
- Multiplication of two matrices
- Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

2. Classes and Object

Testing:
• Class with function printing hello World
• Class with default constructor
• Class with parameterized constructor
• Destructor
• Static and constant data

Programs:

- To demonstrate classes and different types of constructors.
- Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

3. Inheritance and Polymorphism

Testing:
• Inheritance
• Function Overloading
• Operator overloading
• Overriding
• Comparisons between private, public and protected
• Virtual function and [pure]virtual class
• This pointer
• Exception handling
• Abstract class

CA 529 **Data Structures Laboratory** **0-0-4-2**

Arrays Testing:

- Array declaration and initialization
- Addition & multiplication
- Deletion of elements.

Programs:

1. To implement the array concepts for matrix applications.
2. To implement the 1-D, 2-D and 3-D array concepts for data storage and retrieval.
3. Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

Linked List Testing:

- Insertion
- Deletion
- Traversing
- Searching

Programs:

1. To implement various operations over the linked list.
2. To implement variations of linked list e.g. Circular linked list.
3. Application programs based on above elements in different areas of computing like Science, Business, Mathematics and other manual processes.

Stack Testing:

- Array implementation
- Linked list implementation
- Push and Pop

Programs:

1. To implement various operations over the stack.
2. To demonstrate applications of stack e.g. infix to prefix conversion.

Queue Testing:

- Array implementation
- Linked list implementation
- Insertion
- Deletion

CA 603 **Design and Analysis of Algorithms** **3-1-0-4**

Total Lectures:40

1. **Analysis of Algorithms:** Asymptotic notation, proof by induction, solving recurrences, the Master Theorem, analysis of algorithms for time and space complexity, worst case, average case and amortized case analysis. [10]
2. **Algorithm Methodologies:** Recursion, divide and conquer algorithms, greedy algorithms, dynamic programming, backtracking and branch-and-bound with examples, applications and analysis. [12]
3. **Graph Algorithms:** Basic graph search methods (BFS, DFS), spanning trees, Prim, Kruskal algorithms, path finding and shortest path algorithms, topological sorting, bipartite graphs. [10]
4. **Infeasibility:** P and NP classes, NP hard problems, parallel algorithms-principles, models and analysis and applications**.** [8]

Text Books:

1. Cormen T. H., Leiserson C. E., Rivest R. L., and Stein C., "Introduction to Algorithms", Prentice-Hall of India, 2nd ed,2002.
2. Horowitz E., "Computer Algorithms", Galgotia Publications,2008.

Reference Book:

1. Aho A.V., Design and Analysis of Computer Algorithms, Pearson Education Asia, 2000.
2. Brassard G., "Fundamentals of Algorithmics", Prentice-Hall of India,2003.

CA 605 Computer Communication Networks 3-1-0-4

Total Lectures: 40

1. **Introduction:** Layered architecture, OSI, TCP/IP. [5]
2. **Physical Layer:** Transmission media, physical layer protocol, switching techniques. [6]
3. **Data Link Layer:** Design issues- framing, error control and flow chart, stop and wait protocol, sliding window protocol, and performance analysis. [7]
4. **Medium Access Sub Layer:** P-ALOHA, S-ALOHA, CSMA, reservation scheme, CSMA/CD, Ethernet, Token Ring, Token Bus, DQDB, FDDI. [6]
5. **Network Layer:** Rotating algorithms, congestion control, internetworking, IP Layer, X.25, ISDN, etc. [6]
6. **Transport Layer:** Quality of service, connection management, flow control and buffering, multiplexing, crash recovery, ICP. [5]
7. **Application Layer:** Network security, electronic mail, SNMP, DNS, etc. [5]

Text Books:

1. Tanenbaum A. S., "Computer Networks", Prentice-Hall of India, 4th ed.,2003.
2. Stallings W., "Data and Computer Communications", Prentice-Hall of India, 6th ed.,2003

References Books:

1. Forouzan B. A., "Data Communications and Networking", Tata McGraw-Hill, 3rd ed.,2006,
2. Hayes J. F., "Modeling and Analysis of Computer Communication Networks", Khanna Publishers.,2003

CA 606 **Cryptography and Network Security** **3-1-0-4**

Total Lectures:40

1. **Introduction**: Attacks, Services and Mechanisms, Security Attacks, Security Services, Integrity check, digital Signature, authentication. [3]

2. **Secret Key Cryptography:** Block Encryption, DES rounds, S-Boxes IDEA: Overview, comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB, CBC, OFB, CFB, Multiple encryptions DES. [6]

3. **Hash Functions And Message Digests:** Length of hash, uses, algorithms (MD2, MD4, MD5, SHS) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages, digest computation.) SHS: Overview, padding, stages. [7]

4. **Public Key Cryptography:** Algorithms, examples, Modular arithmetic (addition, multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption. Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures. [9]

5. **Authentication:** Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs offline guessing, storing. Cryptographic Authentication: passwords as keys, protocols, KDC's Certification Revocation, Interdomain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution, smart cards, biometrics. [8]

6**. Network Security:** Electronic mail security, IP security, Network management security. SSL, SET Intruders and Viruses, Firewalls, Intrusion Detection. [7]

Text Books:

1. Kaufman, c., Perlman, R., and Speciner, M., "Network Security, Private Communication in a public world", 2nd ed., Prentice Hall PTR,2002.

2. Stallings, W., "Cryptography and Network Security: Principles and Practice", 3rd ed., Prentice Hall PTR,1994.

Reference Books:

1. Stallings, W. "Network security Essentials: Applications and standards", Prentice Hall,2006.

2. Behrouz A Forouzan. "Cryptography and Network Security"; McGraw Hill.,2007.

CA 607 **Database Management Systems** **3-0-0-3**

Total Lectures:40

1. **Introduction:** Databases and database users, database system concepts and architecture, data modeling using the Entity-Relationship (ER) model, Enhanced Entity Relationship model. [7]

2. **Relational Data Model:** Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model. [7]

3. **Structured Query Language (SQL):** SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views. [4]

4. **Database Design:** Functional dependencies and normalization of relational databases, First Normal Form (1NF), 2NF, 3NF, Boyce-Codd normal form (BCNF), multivalued dependency, 4NF. [8]

5. **Transaction Processing:** Introduction, properties, recoverability, serializability. Concurrency control techniques: Two phase locking protocol, Database recovery techniques: Recovery concepts, recovery techniques based on deferred and immediate update. [7]

6. **Object and Object-Relational Databases:** Concepts for object databases, object database standards and design, object relational systems. [7]

Text books:

1. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Management Systems, 5th Edition, Pearson Education,2008.
2. Raghu Ramakrishnan, Database Management Systems, 3rd Edition, TMH,2002.

Referenc books:

1. G.W. Hansen, and J.V. Hansen, Database Management and Design, 2nd Edition, PHI,1999.
2. Korth and Schilberschatz, Database System Concepts, 4th Edition, TMH,2006.
3. C.J. Date, Database Systems, 2nd Edition, TMH,2003.

CA 608 **Management Information Systems** **3-0-0-3**

Total Lectures:40

1. **Organization:** Hierarchy in the organization structure, information flows, concentration of authority, characteristics of managers, problem solving by managers. [5]
2. **Information Needs and Sources of Managers:** Activities of the organization, managerial activities, planning, types of management decisions and information needs, types of information needed, sources of information. [5]
3. **Basics of Management Information Systems**: Overview of information system, MIS concepts, definition, role and impact of MIS, process of management, organization structure and behaviors, decision making, information concepts, levels of information systems, system concepts, types of system, system development model. [10]
4. **Development of Management Information Systems:** Information requirements determination tools, development and implementation of MIS, choice of information technology. [6]
5. **Application of Management Information Systems:** Applications in manufacturing sector-personnel management, financial management, production management, material management, marketing management, applications in service sector, Decision support system. [8]
6. **Special Topics:** Technology of information system, business process reengineering, electronic business technology. [6]

Text Books:

1. Jawadekar W. S., Management Information Systems, McGraw-Hill, New York, 2nd ed,2002.
2. Basandra, S. K., Management Information Systems, Wheeler Publishing, New Delhi,1997.

Reference Books:

1. O' Brien, J. A., Management Information Systems, Galgotia Publications,2003.
2. Post, G. V., and Anderson D. L., Management Information Systems, Tata McGraw – Hill,2006.
3. Davis G. B., and Olson M. H., Management Information Systems, Tata McGraw-Hill,1985.

CA 609 **Java Programming** **3-0-0-3**

Total Lectures: 40

1. **The Genesis of Java:** The importance of Java to Internet, Java's magic-the byte code, the Java buzzwords, the continuing revolution, Java and HTML, using blocks of code, lexical issues, the Java class libraries. [4]

2. **Data Types, Variable, and Arrays:** Java as a strongly typed language, the simple types, integers, floating-point types, characters, Booleans, a closer look at literals, variables, type conversion and casting, automatic type promotion in expressions, arrays, a few works about string, a note to C/C++ programmers about pointers, operators-arithmetic operators, the bitwise operators, relational operators, Boolean logical operators, the assignment operator, the ? operator, operator precedence, using parentheses, control statements-Java selection statements, iteration statements, jump statements. [8]

3. **Classes:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, the this keyword, garbage collection, the finalize () method, a stack class, overloading methods, using objects as parameters, a closer look at argument passing, returning objects, recursion, introducing access control, understanding static, introducing final, arrays revisited, introducing nested and inner classes, exploring the string class, using command-line arguments. [9]

4. **Inheritance:** Inheritance basics, using super, creating a multilevel hierarchy, when constructors are called, method overriding, dynamic method dispatch, using abstract classes, using final with inheritance, the object class, Multithreading. [6]

5. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, creating your own exception subclasses, using exceptions. [7]

7. **I/O, Applets, and String Handling:** I/O basics, reading console input, writing console output, the Print Writer class, reading and writing files, applet fundamentals, the transient and volatile modifiers, string constructors, string length, special string operations, character extraction, operations on string. [6]

Text Books :

1. Schildt Herbert "Java: The Complete Reference" McGraw Hill Education; 9 edition,2014.

Reference Books:

1. Budo Timothy "Understanding Object-Oriented Programming with JAVA" . Pearson,1999.
2. Balagurusamy E " Programming with JAVA, A Primer" Tata Mcgraw Hill,2006.

CA 610 **Mobile Computing** **3-0-0-3**

Total Lectures:40

1**. Introduction,**issues in mobile computing, overview of wireless telephony: cellular concept, GSM: air-interface, channel structure, location management: HLR-VLR, hierarchical, handoffs, channel allocation in cellular systems, CDMA, GPRS. [8]

2. **Wireless Networking,**Wireless LAN Overview: MAC issues, IEEE 802.11, Blue Tooth, Wireless multiple access protocols, TCP over wireless, Wireless applications, data broadcasting, Mobile IP, WAP: Architecture, protocol stack, application environment, applications. [8]

3. **Data Management Issues**, data replication for mobile computers, adaptive clustering for mobile wireless networks, File system, Disconnected operations. [8]

4. **Mobile Agents computing**, security and fault tolerance, transaction processing in mobile computing environment. [8]

5**. Ad Hoc Networks**, localization, MAC issues, Routing protocols, global state routing (GSR), Destination sequenced distance vector routing (DSDV), Dynamic source routing (DSR), Ad Hoc on demand distance vector routing (AODV), Temporary ordered routing algorithm (TORA), QoS in Ad Hoc Networks, applications. [8]

Text Books:

1. Schiller J., “Mobile Communications”, Addison Wesley,2003.

2. Mehrotra A. , “GSM System Engineering”,1997.

3. Heijden M. V. D., M. Taylor, “Understanding WAP”, Artech House,2000.

Reference Books:

1. Perkins Charles, “Mobile IP”, Addison Wesley,1994.

2. Perkins Charles, “Ad hoc Networks”, Addison Wesley,2001.

CA 621 Database Management Systems Laboratory 0-0-4-2

1. **Creating Tables in SQL**

   Testing
   - Create command
   - Update commands
   - Insertion of records
   - Deletion of records
   - Primary Key
   - Foreign Key

   Programs
   - A Database Schema should be created with at least five relations.

2. **Populating records in relations**

   Testing
   - Entity integrity constraint
   - Referential Integrity constraint
   - Domain constraint

   Program
   - Populate the records with the above mentioned constraints for the 5 relations in the schema designed in 1.

3. **Views**

   Testing
   - Creation
   - Deletion
   - Modification

   Program
   - Create 5 meaningful views for the designed database.

4. **PL/SQL**

   Testing
   - Structures
   - Control Statements
   - Variables
   - cursors

CA 623 Computer Communication Networks Laboratory 0-0-4-2

Assignments are based on the course contents of CA 605 Computer Communication Networks.

CA 625 Java Programming Laboratory 0-0-4-2

1. Introduction

Testing

- Data Types and Operators
- Control Statements
- Arrays

Programs

- Apply logic to print different patterns(at least 3)
- Programs like to print Fibonacci series, check whether a number is prime or not
- Max and min of a given list of numbers, their sum and average
- Result of a student using switch-case
- 3 application programs based on above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.

2. Classes, Object and Inheritance

Testing

- Objects and reference variables
- Constructors and parameterized constructors
- this, static, command line arguments
- Inheritance, overloading and overriding
- super, abstract classes and Dynamic method dispatch

Programs

- Write a program to illustrate super .
- Show method overloading to calculate the area of different shapes.
- Manipulate the above program to illustrate run time polymorphism.
- application programs based on above elements in different areas of computing like-Science, Business, Mathematics and other manual processes.

3. Package, Interfaces and Exception Handling

Testing

- importing packages
- interfaces and multiple inheritance
- exception-handling fundamentals
- built-in exceptions and creating one's own exception subclasses

Programs

- Write and execute a program which is inside a package "MyPacK".
- Write a program which imports a package.

CA 626 Software Engineering Lab 0-0-4-2

1. Design a software process model for a project based on SRS.

   Testing
   - Waterfall model
   - Prototyping model
   - Iterative model
   - Spiral model etc.

   Design SRS for 5 different projects and use CASE tool to select the model.

2. Software project estimation.

   Testing
   - Effort estimation
   - Development time estimation
   - Schedule estimation
   - Cost estimation

   Design 5 different projects and use CASE tool to estimate the effort, schedule, and cost required to develop a software product.

3. Develop data flow diagrams.

   Testing
   - Context diagrams
   - Level 1/2/3 diagrams
   - Balancing DFDs
   - Synchronous/asynchronous operations

   Draw DFDs for 5 different projects using CASE tool.

4. Develop software code as per coding standards.

   Testing
   - Reading Data
   - Data processing
   - Data storage
   - Data display

   Write code for a complete project that has these features.

5. Black box and white box testing.

CA 628 Mobile Application Development Laboratory 0-0-4-2

1. What is Android? o Setting up development environment o Dalvik Virtual Machine & .apk file extension o Fundamentals: a. Basic Building blocks - Activities,Services,Broadcast Receivers & Content providers b. UI Components - Views & notifications c. Components for communication -Intents & Intent Filters o Android API levels (versions & version names)
2. Emulator-Android Virtual Device o Launching emulator o Editing emulator settings o Emulator shortcuts o Logcat usage o Introduction to DDMS o Second App:- (switching between activities) Develop an app for demonstrating the communication between Intents
3. Basic UI design o Form widgets o Text Fields o Layouts o [dip, dp, sip, sp] versus px, Menu o Option menu o Context menu o Sub menu o menu from xml o menu via code
4. : Intents (in detail) o Explicit Intents o Implicit intents o Examples
5. Styles & Themes o styles.xml o drawable resources for shapes, gradients (selectors) o style attribute in layout file o Applying themes via code and manifest file
6. SQLite Programming o SQLiteOpenHelper o SQLiteDatabse o Cursor o Reading and updating Contacts o Reading bookmarks o
7. Notifications o Broadcast Receivers o Services and notifications o Toast o Alarms

CA 629 Computer Organization and Architecture 3-0-0-3

Total Lectures: 40

1. **Principles of Computer Organisation:** Software hardware interaction layers in computer architecture, central processing unit, machine language instructions, addressing modes, instruction types, instruction set selection, instruction cycle and execution cycle. [10]

2. **Processor and ALU Design:** Number system, computer arithmetic and ALU design, control unit, data path and control path design, microprogramming versus hardware control, RISC Vs CISC, pipelining in CPU design, superscalar processors. [10]

3. **Memory Organisation:** Memory subsystem, storage technologies, memory array organization, memory hierarchy interleaving, cache and virtual memories and architectural aids to implement these. [10]

4. **Input-Output Organisation:** Input-output devices and characteristics, input-output programming, bus interface, data transfer techniques, I/O interrupts, and channels. [10]

Text Books:

1. Mano M. M., "Computer System Architecture", Prentice-Hall of India, 3rd ed.1992.
2. Hayes J. P., "Computer Architecture and Organization", McGraw- Hill, New York, 3rd ed.,1988.

Reference Books:

1. Hwang K., "Advanced Computer Architecture: Parallelism, Scalability and Programmability", McGraw-Hill, New York.,1993.
2. Carter N., "Computer Architecture", Tata McGraw-Hill,2002.

CA 630 **Advanced DBMS** **3-1-0-4**

Total Lectures:40

1. **Parallel and Distributed Databases:** Database System Architectures: Centralized and Client-Server Architectures – Server System Architectures – Parallel Systems- Distributed Systems – Parallel Databases: I/O Parallelism – Inter and Intra Query Parallelism – Inter and Intra operation Parallelism – Distributed Database Concepts - Distributed Data Storage – Distributed Transactions – Commit Protocols – Concurrency Control – Distributed Query Processing – Three Tier Client Server ArchitectureCase Studies. [10]

2. **Object and Object Relational Databases:** Concepts for Object Databases: Object Identity – Object structure – Type Constructors – Encapsulation of Operations – Methods – Persistence – Type and Class Hierarchies – Inheritance – Complex Objects – Object Database Standards, Languages and Design: ODMG Model – ODL – OQL – Object Relational and Extended – Relational Systems : Object Relational featuresinSQL/Oracle – Case Studies. [8]

3. XML Databases: XML Databases: XML Data Model – DTD - XML Schema - XML Querying – Web Databases – JDBC – Information Retrieval – Data Warehousing – Data Mining. [7]

4. Mobile Databases: Mobile Databases: Location and Handoff Management - Effect of Mobility on Data Management - Location Dependent Data Distribution - Mobile Transaction Models - Concurrency Control - Transaction Commit Protocols- Mobile Database Recovery Schemes. [7]

5. Multimedia Databases: Multidimensional Data Structures – Image Databases – Text/Document Databases- Video Databases – Audio Databases – Multimedia Database Design. [8]

Text Books:

1. R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, Fifth Edition, Pearson Education/Addison Wesley,2010.

2. Thomas Cannolly and Carolyn Begg, “ Database Systems, A Practical Approach to Design, Implementation and Management”, Third Edition, Pearson Education,2009.

Reference Books:

1. Henry F Korth, Abraham Silberschatz, S. Sudharshan, “Database System Concepts”, Fifth Edition, McGraw Hill,2005.

2. C.J.Date, A.Kannan and S.Swamynathan,”An Introduction to Database Systems”, Eighth Edition, Pearson Education,2006.

CA 631 **Real Time Systems** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Issues in Real Time Computing, Structure of a Real Time System. Task Classes, Performance Measures for Real Time Systems, Estimating Program Run times. Task Assignment and Scheduling -Classical Uniprocessor scheduling algorithms, UniProcessor scheduling of IRIS Tasks, Task Assignment,Mode Changes, and Fault Tolerant Scheduling. [8]

2. **Programming Language and Tools:** Desired Language characteristics, Data Typing, Control structures,Facilitating Hierarchical Decomposition, Packages, Run-time (Exception) Error handling, Overloading andGenerics, Multitasking, Low Level programming, Task scheduling, Timing Specifications, Programming Environments, Run-time Support. [8]

3. **Real time Databases**: Basic Definition, Real time Vs General Purpose Databases, Main Memory Databases,Transaction priorities, Transaction Aborts, Concurrency Control Issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time systems. [8]

4. **Real-Time Communication**: Communications Media, Network Topologies Protocols, Fault TolerantRouting. Fault Tolerance Techniques - Fault Types, Fault Detection. Fault Error containment Redundancy,Data Diversity, Reversal Checks, Integrated Failure handling. [8]

5. **Reliability Evaluation Techniques**: Obtaining Parameter Values, Reliability Models for HardwareRedundancy, Software Error models. Clock Synchronization - Clock, A Nonfault-Tolerant SynchronizationAlgorithm, Impact of Faults, Fault Tolerant Synchronization in Hardware, Fault Tolerant Synchronization in Software. [8]

Text Books:

1. C.M. Krishna, Kang G. Shin, “Real-Time Systems”, McGraw-Hill International Editions,1997.

1. Stuart Bennett, “Real Time Computer Control-An Introduction”,Second edition Perntice Hall PTR,1994.

Reference Books:

1. Peter D. Lawrence, “Real time Micro Computer System Design – An Introduction”, McGraw Hill,1988.
2. S.T. Allworth and R.N. Zobel, “Introduction to real time software design”, Macmillan, II Edition,1987.

CA 632 **Software Project Management** **3-1-0-4**

Total Lectures:40

1.**Introduction To Software Project Management :**Project Definition – Contract Management – Activities Covered By Software Project Management – Overview Of Project Planning – Stepwise Project Planning. [6]

2. **Project Evaluation :** Strategic Assessment – Technical Assessment – Cost Benefit Analysis – Cash Flow Forecasting – Cost Benefit Evaluation Techniques – Risk Evaluation. [6]

3. **Activity Planning:** Objectives – Project Schedule – Sequencing and Scheduling Activities – Network Planning Models – Forward Pass – Backward Pass – Activity Float – Shortening Project Duration – Activity on Arrow Networks – Risk Management – Nature Of Risk – Types Of Risk – Managing Risk – Hazard Identification – Hazard Analysis – Risk Planning And Control. [9]

4. **Monitoring And Control:** Creating Framework – Collecting The Data – Visualizing Progress – Cost Monitoring – Earned Value – Priortizing Monitoring – Getting Project Back To Target – Change Control – Managing Contracts – Introduction – Types Of Contract – Stages In Contract Placement – Typical Terms Of A Contract – Contract Management – Acceptance. [9]

5. **Managing People And Organizing Teams:** Introduction – Understanding Behavior – Organizational Behaviour: A Background – Selecting The Right Person For The Job – Instruction In The Best Methods – Motivation – The Oldman – Hackman Job Characteristics Model – Working In Groups – Becoming A Team –Decision Making – Leadership – Organizational Structures – Stress –Health And Safety – Case Studies. [10]

Text Books:

1. Bob Hughes, Mikecotterell, “Software Project Management”, Third Edition, Tata McGraw Hill,2011.

2. Ramesh, Gopalaswamy, "Managing Global Projects", Tata McGraw Hill,2001.

Reference Books:

1. Jalote, “Software Project Management in Practice”, Pearson Education,2002.

2. Royce, “Software Project Management”, Pearson Education,2005.

CA 633 **M -Commerce** **3-1-0-4**

Total Lectures:40

1. **Electronic Commerce:** Introduction, e-commerce marketplace, Focus on portals, Location of trading in the marketplace, Commercial arrangement for transactions , auctions business models for e-commerce, Revenue models, E-commerce versus E-business. [6]

2. **Mobile Commerce:** Overview, Infrastructure, Types of Mobile Commerce Services, Technologies of Wireless Business, Benefits and Limitations, Support, Mobile Marketing and Advertisement, Non Internet Applications in M–Commerce. [6]

3. **Mobile Commerce Technology:** Framework of Mobile Commerce,NTT Docomo‘s I– Mode, Wireless Devices for Mobile Commerce, Classification of Framework for Mobile Location Based Services, Wireless Personal and Local Area Networks, The Impact of Technology in Mobile Communications Networks. [7]

4. **Mobile Commerce Theory and Applications:** The Ecology of Mobile Commerce, Wireless Application Protocol, Mobile Business Services, Mobile Portal, Factors affecting the Adoption of Mobile Gaming Services, Mobile Data Technologies and Small Business Adoption and Diffusion. [5]

5. **Business– to– Business Mobile E-Commerce:** Enterprise Enablement, Email and Messaging, Field Force Automation, maintenance and management, Remote IT Support Customer Retention, B2C Services, Warehouse automation security. [6]

Text Books:

1. Chaffey Dave, “E-Business and E-Commerce Management”, Pearson Education, Third Edition, 2009,.

2. Mennecke Brian E., Strader Troy J., “Mobile Commerce: Technology, Theory andApplications”, Idea Group Inc., IRM press,2003.

Reference Books:

1. Louis P. J., “M-Commerce Crash Course”, McGraw- Hill,2001.

2. May Paul, “Mobile Commerce: Opportunities, Applications, and Technologies of Wireless Business” Cambridge University Press,2001.

3. Papazoglou Michael P., Ribbers Peter M.A., “e-business organizational and Technical foundation”,Wiley India,2009.

4. Dr.Pandey , Shukla Saurabh “E-commerce and Mobile commerce Technologies” , Sultanchand ,2011.

CA 634 **Software Engineering** **3-0-0-3**

Total Lectures:40

1. **Introduction To Software Engineering:** Software crisis, Software engineering Approach and Challenges, Software development process models with comparison: Waterfall, Rapid prototyping, Timeboxing and Spiral Models, and Automation through software environments. [8]
2. **Planning The Software Project:** Cost Estimation, Planning Schedule, Staffing, Project Monitoring, Quality Assurance and Risk Management. [8]
3. **Structured Analysis:** Initial Investigation, Feasibility study, Traditional and modern methods of requirement determination, SRS, Structuring the requirements: Process modeling, logic modeling, conceptual data modeling, Metrics. Validation VS verification [8]
4. **Design Fundamentals:** Function and Object Oriented Design concepts, Verification and Metrics. Coding and Maintenance: Coding Process, Metrics, Testing fundamentals, Types of Testing, Metrics, Types of Maintenance. [8]
5. **Software Re-Engineering:** Source Code Translation, Program Restructuring, Data Re-Engineering, Reverse Engineering. [8]

Text Books:

1. Sommerville Ian, “Software Engineering”, Addison Wesley, 6th ed,1995.
2. Hoffer, George, Valacich, “Modern System Analysis and Design” Pearson Education, 3rd ed,2012.

Reference Books:

1. Pressman S. Roger, “Software Engineering”, Tata McGraw-Hill,2009.
2. JalotePankaj, “An integrated Approach to Software”, Engineering, Narosa Publishing House,2014.

CA 642 **Digital Image Processing** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Background, Digital Image Representation, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System. Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry. [8]
2. **Image Transforms:** Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two-Dimensional Fourier Transform, Other Separable Image Transforms. [8]
3. **Image Enhancement :** Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background, Smoothing Filters, Sharpening Filters, Lowpass Filtering, Highpass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. [8]
4. **Image Restoring:** Degradations Model - Definitions, Degradation Model for Continuous Functions, Diagonalization of Circulant and Block-Circulant Matrices, Circulant Matrices, Block Circulant Matrices, Effects of Diagonalization on the Degradation Model, Algebraic Approach to Restoration, Unconstrained Restoration, Constrained Restoration, Inverse Filtering – Formulation, Removal of Blur Caused by Uniform Linear Motion, Restoration in the Spatial Domain, Geometric Transformation. [8]

5. **Image Compression:** Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria. Image Compression Models,The Channel Encoder and Decoder. Elements of Information Theory Measuring Information, The Information Channel, Fundamental Coding Theorems, Using Information Theory. Error-Free Compression. Lossy Compression. [8]

Text Book:

1. Rafael. C. Gonzalez & Richard E.Woods., “Digital Image Processing”, 2/e Pearson Education, New Delhi.2009.

Reference Books:

1. W.K.Pratt., “Digital Image Processing” ,3/e Edn., John Wiley and sons, Inc,2001.

2. M. Sonkaet.al “Image Processing, Analysis and Machine Vision”, 2/e, Thomson, Learning, India Edition,1998.

CA 644 **Artificial Intelligence** **3-1-0-4**

Total Lectures:40

1. **Introduction:** Overview of artificial intelligence (AI) and AI techniques. [3]
2. **Problem Solving:** Searching, state space formulation, depth first & breadth first searches and intelligent searching. [7]
3. **Production Systems:** Design, implementation & limit factors and case studies. [7]
4. **Game Playing:** Minimax and Alpha-beta pruning. [6]
5. **Knowledge and Reasoning:** Propositional & first order topic, semantic networks, inference and logical reasoning systems. [6]
6. **Knowledge Representation:** CD, frames & scripts, learning and neural networks. [6]
7. **Advanced Topics:** Expert system, natural language processing, PROLOG. [5]

Text Books:

1. Rich E., and Knight K., Artificial Intelligence, Tata McGraw-Hill, 2nd ed,2008.
2. Bratko I., PROLOG Programming for Artificial Intelligence, 3rd ed,2001.

Reference Books:

1. Russell S., and Norvig P., Artificial Intelligence – A Modern Approach, Prentice-Hall of India, 2nd ed,2009.
2. Patterson D. W., Introduction to Artificial Intelligence and Expert Systems, Prentice-Hall of India,1990.

CA 646 **Parallel Processing** **3-1-0-4**

Total Lectures:40

1. **Parallel Processing:** Introduction, data and control parallelism, (concurrency, scalability, speedup, Amolahl's Law), PRAM model of parallel computation, parallel algorithm design. [8]
2. **Multiprocessors and Multicomputers:** Processor organization, shared memory and message passing systems, message passing interface programming with respect to PARAM 10000. [9]
3. **Array Processing:** SIMD array processing, communications, SIMD interconnection networks, algorithms for array processing. [8]
4. **Applications:** Parallel algorithms for matrix multiplication, fast Fourier transform, linear systems, sorting, numerical integration, and optimization. [7]
5. **Parallel Programming Languages:** C, C++ and high performance FORTRAN. [8]

Text Books:

1. Hwang K., "Advanced Computer Architecture", Tata McGraw-Hill,2003.
2. Quinn M. J., "Parallel Computing", Tata McGraw-Hill, 2nd ed,2002.

Reference Books:

1. Hwang K. and Briggs F. A., "Computer Architecture and Parallel Processing", McGraw-Hill, New York.,1984.
2. Sinha P. K., "Distributed Operating System", Prentice-Hall of India,1997.

CA 648 **Service Oriented Architecture** **3-1-0-4**

Total Lectures:40

1. **Roots of SOA**: Characteristics of SOA - Comparing SOA to client-server and distributed internet architectures – Anatomy of SOA- How components in an SOA interrelate - Principles of service orientation. [5]

2. **Web Services**: Service descriptions – Messaging with SOAP –Message exchange Patterns – Coordination –Atomic Transactions – Business activities – Orchestration – Choreography - Service layer abstraction –Application Service Layer – Business Service Layer – Orchestration Service Layer [9]

3**. Service Oriented Analysis**: Business-centric SOA – Deriving business services- service modeling - Service Oriented Design – WSDL basics – SOAP basics – SOA composition guidelines – Entity-centric business service design – Application service design – Task- centric business service design [9]

4. **SOA Platform Basics**: SOA support in J2EE – Java API for XML-based web services (JAX-WS) - Java architecture for XML binding (JAXB) – Java API for XML Registries (JAXR) - Java API for XML based RPC (JAX-RPC)- Web Services Interoperability Technologies (WSIT) - SOA support in .NET – Common Language Runtime - ASP.NETweb forms – ASP.NET web services – Web Services Enhancements (WSE) [10]

5.WS-BPEL Basics: WS-Coordination overview - WS-Choreography, WS-Policy, WS-Security. [7]

Text Books:

1. Thomas Erl, "Service-Oriented Architecture: Concepts, Technology, and Design", Pearson Education,2005.

Reference Books:

1. Thomas Erl, "SOA Principles of Service Design" The Prentice Hall,2007.
2. Newcomer, Lomow, "Understanding SOA with Web Services", Pearson Education,2005.
3. Sandeep Chatterjee, James Webber, "Developing Enterprise Web Services, An Architect's Guide", Prentice Hall Professional, 2004.

CA 709 **Distributed Systems** **3-1-0-4**

Total Lectures:40

1. **Characterization of Distributed Systems:** Definition, distributed systems- Internet, intranet, mobile, ubiquitous computing, resource sharing and World Wide Web challenges- heterogeneity, openness, security scalability failure handling concurrency and transparency. [4]
2. **System Models:** Architecture models- software layers, system architecture, variations on client-server model, interfaces and objects, design requirement for distributed architectures, fundamental models-interaction models, failure model and security model. [5]

3. **Distributed Object and Remote Invocation:** Introduction to remote method invocation (RMI) and interface in distributed systems, communication between distributed objects- objects model, distributed objects, distributed objects model and design issues for RMI, implementation of RMI and distributed garbage collection, remote procedures call and sun RPC case study, events and notifications-participants, JINI distributed event specification, Java RMI case study, building client and server programs, design and implementation of Java RMI. [10]

4. **Time and Global State:** Clocks, events and process states, synchronizing physical clocks- synchronization in a synchronous system, Cristian method for synchronizing clocks, Berkley algorithm and network time protocol, global state and consistent cuts. [5]

5. **Distributed Shared Memory:** Introduction, message passing versus DSM, implementation approaches to DSM, design and implementation issues-structure and synchronization model. [5]
6. **Processes and Processors in Distributed Systems:**Threads, system models, processor allocation, scheduling, fault tolerance. [5]

7. **Distributed File System:** Design, implementation, trends in distributed file system. [6]

Text Books:

1. Coulouris G., "Distributed System Concepts and Design", Pearson Education Asia, 3rd edition, 2003
2. Tannenbaum A. S., "Distributed Operating Systems", Pearson Education Asia,2001.

Reference Books:

1. Sinha P. K., "Distributed Operating Systems", Prentice-Hall of India, 2001.
2. Valduriez O., "Principles of Distributed Database Systems", Pearson Education Asia, 2nd edition, 2002.

CA 711 **Data Mining and Warehousing** **3-0-0-3**

Total Lectures:40

1. **Overview:** Concept of data mining and warehousing, data warehouse roles and structures, cost of warehousing data, roots of data mining, approaches to data exploration and data mining, foundations of data mining, web warehousing, web-warehousing for business applications and consumers, introduction to knowledge management, data warehouses and knowledge bases. [6]

2. **Data Warehouse:** Theory of data warehousing, barriers to successful data warehousing, bad data warehousing approaches, stores, warehouse and marts, data warehouse architecture, data about data - metadata, metadata extraction, implementing the data warehouse, data warehouse technologies. [4]

3. **Data Mining and Data Visualization:** Data mining, OLAP, techniques used to mine the data, market basket analysis, current limitations and challenges to DM, data visualization. [5]

4. **Designing and Building the Data Warehouse:** Theenterprise model approach of data mining design, data warehouse project plan, analysis and design tools, data warehouse architecture, specification and development**.** [5]

5. **Web-Based Query and Reporting:** Delivering information over the web, query and reporting tools and business value, architectural approaches to delivering query capabilities over the web. [3]

6. **Web Based Statistical Analysis and Data Mining:** Analytical tools, business value from analytical tools, humble spreadsheet, statistical products overview – statistical analysis applications, correlation analysis, regression analysis, data discovery tools. [6]

7. **Future of Data Mining and Data Warehousing:** Future of data warehousing, trends in data warehousing, future of data mining, using data mining to protect privacy, trends affecting the future of data mining, future of data visualization. [3]

Text Books:

1. Marakas G. M., “Modern Data Warehousing, Mining and Visualisation”, Pearson Education Asia, 2003.
2. Mattison R., “Web Warehousing and Knowledge Management”, Tata McGraw-Hill,2002.
3. Anahory S., and Murray D., “Data Warehousing in the Real World”, Pearson Education Asia,2002.

CA 715 **Computer Graphics** **3-1-0-4**

Total Lecture:40

1. **Overview:** Display devices – Video, refresh CRT, raster scan, random scan, color CRT, monitors raster scan systems, video controller, raster scan display processor, input devices – trackball and space ball, joy-sticks, digitizers, scanners, touch panels, light pen. [4]
2. **Scan Conversion:** Primitive drawing – DDA and Bresenham algorithm for line, circle, ellipse, general curves, filling – scan line polygon fill algorithm, inside-outside tests, flood-fill, boundary-fill, attributes – area fill attributes, line and text attributes. [8]
3. **Two-Dimensional and Three-Dimensional Transformations:** Basic transformations, matrix representation and homogeneous co-ordinates, composite transformation, reflection, shear transformation. [8]
4. **Three-Dimensional Object Representations:** Polygon surfaces, polygon tables, plane equations, polygon meshes, curved lines and surfaces, quadric surfaces, spheres, curves, spline representations and spline specifications, Bezier and B-spline curves. [8]
5. **Clipping and Viewing:** Line clipping – Cohen Suther Land, Liang-Barsky, polygon clipping – Suther Land – Hodgman, Weiter-Atherton, projection and its transformation – parallel and perspective, vanishing points. [8]
6. **Visibility:** Classification and detection algorithm, back face detection, depth – buffer, scan line, depth sorting and BSP tree, ray casting method and curved surfaces. [4]

Text Books:

1. Hearn D. and Baker P. M., "Computer Graphics", Prentice-Hall of India, 2nd edition, 2004.
2. Newman W., and Sproul R. F., "Principles of Interactive Computer Graphics", McGraw-Hill, New York, 2nd ed, 1992.

Reference Books:

1. Foley J. D., and Van D. A., "Fundamentals of Interactive Graphics", Addison-Wesley, 2nd ed, 1983.
2. Roger D. F., "Procedural Elements for Computer Graphics", McGraw-Hill, New York, 2nd edition, 1985
3. Harrington S., "Computer Graphic", McGraw-Hill, New York, 2nd editon, 1995
4. Xiang Z., and Plastock R., "Theory and Problems of Computer Graphics", McGraw-Hill, New York, 2nd edition, 2000.

CA 725 COMPUTER GRAPHICS LABORATORY 0-0-4-2

1. **Introduction to computer graphics & graphics systems**

   Testing
   - Demonstration of graphics display devices, IO devices.
   - Initialization of graphic in 'C'.
   - Use of graphics primitives – line, circle, rectangle, arc, etc.

   Programs
   - Graphics programs are to be written for the above graphics primitives with color and moving effect (E.g. bus, hut, fish, kite etc).

2. **Scan conversion**

   Testing
   - Line drawing algorithms (DDA, Bresenham, mid-point).
   - Circle generation algorithm (Bresenham, mid-point)
   - Ellipse generation algorithm
   - Filling algorithm (boundary fill, flood fill, scan line polygon fill)

   Program
   - Graphics programs are to be written for each of the above algorithms.

3. **2D & 3D transformation**

   Testing
   - Translation
   - Rotation
   - Scaling
   - Reflection
   - Shearing

   Program
   - Graphics programs are to be written for each of the above algorithms for different axis.

4. **2D viewing & clipping**

   Testing
   - Line clipping algorithm (Cohen Sutherland, Liang Barsky)
   - Polygon clipping (Sutherland Hodgeman, Weiler and Atherton)

   Program
   - Graphics programs are to be written for each of the above algorithms.

CS 218 Computer Organization and Architecture 3-1-0-4

Total Lectures:40

1. **Basic Structure of Computers:** Functional units, basic operational concepts, bus structures, software performance, memory locations and addresses, memory operations, instruction and instruction sequencing, addressing modes, assembly language, basic I/O operations. [8]

2. **Arithmetic Unit:** Addition and subtraction of unsigned and signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication and fast multiplication, integer division, floating-point numbers and operations. [8]

3. **Processing Unit:** Fundamental concepts, execution of a complete instruction, multiple bus organization, hardwired control, microprogrammed control, parallel processing, pipelining, basic concepts of hazards, data and instruction hazards, data path and control hazard consideration. [10]

4. **Memory System:** Basic concepts, semiconductor RAMs, ROMs: speed, size and cost, cache memories, performance consideration, virtual memory, memory management requirements, secondary storage. [8]

5. **I/O Organization:** Accessing I/O devices, interrupts, direct memory access, buses, interface circuits, standard I/O interfaces (PCI, SCSI, USB). [6]

Text Books:

1. Hamacher Carl, Vranesic Zvonko and Zaky Safwat, "Computer Organization", , McGraw-Hill, 5th Edition, 2002.
2. Stallings William, "Computer Organization and Architecture-Designing for Performance", Pearson Education, 8th Edition, 2011.

Reference Books:

1. Mano Morris, "Computer System Architecture", Pearson Education, 3rd Edition, 2007.
2. Hayes John P., "Computer Architecture and Organization", McGraw Hill, 3rd Edition, 1998.
3. Patterson David A. and Hennessy John L., "Computer Organization and Design: The hardware / software interface", Morgan Kaufmann, 2nd Edition, 2002.

CT 509 **Basic Communication Skills** **3-0-0-3**

Total Lectures:40

1. **Spoken English:** Basic sentence types, Tenses (Present, Past, Future), Modals (can, could, shall, should, will, would, may, might, must, ought to, need), Determiners, Question Tags, Phrasal verbs. [8]

2. **Reading and Writing:** Reading Comprehension**:** Efficient reading and note taking, Proof Reading, Précis Writing, Report Writing, Theme (paragraph) Writing, Resume Writing, composing an email. [5]

3. **Advance Communication:** Definition and purpose, Art of Communication, Quizzes, exercise and incidents for practice. [6]

4. **Group Discussion:** Definition, importance, process, points to be borne in mind while participating, Do's and Don'ts in GD, Practice. [6]

5. **Interview skills:** Definition, process, types and preparation (physical, mental), Preparation for FAQ, Dos and Don'ts, Practice. [6]

6. **Communication issues:** Choice of words, sentence formation, essentials of effective communication, barriers to communication. [3]

7. **Different Notions and Concepts:** Request, order, condition, purpose, suggestion, wishes, obligation, possibility, concession. [3]

8 **Phonetics:** Phonology and morphology, body language, pronunciation. [3]

Text Books:

1. Hornby A.S.: "A Guide to Patterns and Usage", Oxford University Press, Delhi,1975.
2. Leech Geoffery: "English Grammar for today", Longman, Delhi,2009.
3. Tonguk R.K, Kumar S.K; "An English Miscellany", Oxford University Press, New Delhi,1999.

Mody University of Science & Technology
Lakshmangarh (Sikar)

College of Engineering & Technology

Department of Nuclear Science & Technology (NST)

Detailed Syllabus for

M. Tech. (Nuclear Science & Technology)

NU- 501 Quantum Mechanics and Electrodynamics 3-1-0-4

Quantum Mechanics

1. Origin of quantum theory and related experiments, wave-particle duality, wave function and its Born interpretation, uncertainty principle, Schrodinger equation, wave functions, wave packets, probability amplitudes, solutions to Schrodinger equation in one dimensions; Barrier penetration, Potential wells, Simple harmonic oscillator, Schrodinger equation in three dimensions.

[7]

2. Formalism of quantum mechanics; Liner vector space, Function spaces, Hilbert space formalism, inner product and probability, completeness of Eigen functions, delta functions, Bra & Ket notation, matrix representation of an operator, change of basis, unitary transformations.

[6]

3. General treatment of angular momentum, spin, identical particles; SHM problem by operator method; Pauli exclusion principle; Scattering theory; some calculations, Perturbation theory, WKB approximation.

[7]

Electrodynamics

4. Coulomb law and electrostatics, Laplace and Poisson equations, Maxwell's equations, partial polarization, Lorentz force, Poynting theorem. Scalar and vector potentials, Gauge transformations and gauge invariance.

[5]

5. Special theory of relativity, four vectors, Field tensor, Relativistic formulation of electrodynamics, Maxwell equations in covariant form

[4]

6. Relativistic charged particle in an electromagnetic field, Motion in uniform electric and magnetic fields and combinations of E and B fields, Non uniform static magnetic field

[4]

7. Green's function for wave equation (relativistic), Radiation from localized moving charges, Multi pole expansion, dipole and quadrupole radiation, Radiation from accelerated charge

[4]

8. Power radiated by point charge, Larmor's formula, Angular distribution of power, Bremsstrahlung and synchrotron radiation, Dispersion theory, Radiative reaction, Radiative damping

[5]

Text Books:

1. Griffiths D. J., Introduction to Quantum Mechanics, 2nd edition, Pearson, 2009.
2. Griffiths D. J., Introduction to Electrodynamics, 3rd edition, Prentice Hall India, 1999.
3. Ghatak A. K. & Lokanathan S., Quantum Mechanics: Theory and Applications, 5th edition, Macmillan India, 2004.

Reference Books:

1. Schiff L. I., Quantum Mechanics, 3rd edition, Tata McGraw-Hill, 2010.
2. Zettili N., Quantum Mechanics: Concepts & Applications, 2nd edition, Wiley, 2009.
3. Jackson J. D. Classical Electrodynamics, 3rd edition, Wiley, 1998.
4. Lifshitz E. M. & Landau L. D., Quantum Electrodynamics (Course of Theoretical Physics), 2nd edition, Pergamon Press, 1981.

NU- 503 **Nuclear Physics** **3-1-0-4**

1. Basic concepts of general properties of nuclei: Charge, Masses and relative abundances, mass defect, size and shape, binding energy, angular momentum, magnetic dipole moments and electric quadrupole moments, Parity, Nuclear radius, Radioactivity, units of radiation, Aplha, Beta and Gamma decay.

[8]

2. Nuclear forces: The Deutron, Nucleon- Nucleon scattering, p-p and n-n interactions, properties of nuclear force, phase shift analysis, Measurement of nuclear parameters, Mossbaur effect

[8]

3. Nuclear models: Liquid drop model, Fermi gas model, Shell model, Collective model, Compound nucleus and Statistical model

[8]

4. Nuclear reactions: Types of reactions and conservation laws, Reaction dynamics, Scattering and reaction cross sections, the Q of Nuclear reaction, Nuclear fission, Nuclear fusion

[8]

5. Elementary particle physics, Hadrons and leptons, their masses, spin parity decay structure, quarks and gluons, Charge conjugation, The CPT theorem and applications of symmetry arguments to particle reactions, symmetries, weak interactions

[**8**]

Text Books:

1. Krane K. S., Introductory Nuclear Physics, John Wiley, 1987.
2. Roy R. R. & Nigam B. P., Nuclear Physics; Theory and Experiments, 1st edition, New Age International, 1967.
3. Burcham W. E. & Jobes M., Nuclear and particle Physics, 2nd edition, John Wiley, 1995.

Reference Books:

1. Wong & Samuel S. M., Introductory Nuclear Physics, 2nd edition, John Wiley, 1999.
2. Cohen B. L., Concepts of Nuclear Physics, Tata McGraw-Hill edition, 2008.

NU 505 **Reactor Physics** **3-1-0-4**

Nuclear Fission; Delayed Neutrons; Reactor Types, Neutron Slowing-down and Thermalization, Critical Reactor; Multigroup Transport and Diffusion Equations for a Critical Reactor [12]

Reactor Calculations and Homogenization, Multigroup Constants, Group Constants in Resonance Region [8]

Perturbation & Variational Methods; Nodal and Finite-Element Transport Theory Methods; Integral Transport Theory [8]

Non-critical Reactors; Point Reactor Kinetics Equations; Solution of Kinetics Equations; Determination of Kinetics Parameters; Feedback; Xenon Oscillations; Fuel Depletion; Spatial Effects. [12]

Text Books:

1. P. F. Zweifel, *Reactor Physics*, McGraw-Hill, New York (1973).
2. Rudi J.J. Stamm'ler and M. J. Abbate, *Methods of Steady-State Reactor Physics in Nuclear Design*, Academic Pr (1983)
3. K. Sriram and Y. R. Waghmare, Introduction to Nuclear Science and Technology, South Asia Book (1990)
4. S.Garg, F. Ahmed and L.S.Kothari, *Physics of Nuclear Reactors*, Tata McGraw Hill, New Delhi (1986).

NU 520 Nuclear Power Plant Operation and Control 3-1-0-4

1. Applications of Reactor Physics for operation, Function of Delayed Neutron Monitoring System and method of identifying failed fuel, Neutron Flux Monitoring, Steady State operation of reactor [6]

2. Subcritical multiplication and reactor startup- Reactor operation without feedback- Analytic solution of reactor kinetics, Dynamic period , Reactor operation with feedback effects- Achievement of feedback effects, Shutdown margin [6]

3. Energy release and deposition, Heat generation parameters, Neutron flux distributions and power profiles in reactor cores, Power peaking factors, Heat generation in the structure, Reactor shutdown [6]

4. Temperature coefficients of reactivity, reactivity feedback, Loss-of-cooling accidents, Reactivity insertion accidents, Containment pressurization process, Response of a PWR pressurizer to load changes, Nuclear Power Plant control [6]

5. Review of fundamentals: Laplace transforms, frequency response and stability analysis, process identification, Advanced control techniques: Feed forward control, ratio control, cascade control, Computer process control: z-transforms, digital signal conditioning, system identification, stability analysis, classical control algorithms (PID etc.), Introduction to Model predictive and adaptive control schemes [8]

6. Sensors for pressure, flow, leak, level, temperature and composition, valve dynamics, neutronic instrumentation, reactor protection instrumentation, process instrumentation [8]

BOOKs

1. Lamarsh, John. Introduction to Nuclear Engineering. 3rd ed. Englewood Cliffs, NJ: Prentice Hall, 2001
2. Reactor Control Engineering by J M Harrer, Van Nostrand, (1963)
3. Control of Nuclear Reactors and Power Plants, by M. A. Schulz , McGraw-Hill Co., New York (1961)

Suggested Readings:

1. D R Coughanowr, Process Systems Analysis and Control, McGrawHill, 1991**.**
2. G Stephanopoulos, *Chemical Process Control*, Prentice Hall, 1985.
3. S Glasstone and A Sesonske, *Nuclear Reactor Engineering*, Vonostrand, 1981

NU- 522 Radiation Physics Instruments and Shielding 3-1-0-4

1. Atomic and Nuclear Structure, Natural and Artificial Radiation, Units and Measurement, Laws of Decay, Properties of Different Types of Radiation, Production of Radionuclides, Interactions of Charged Particles and Photons, Biological Effects of Ionizing Radiation, Radiation Protection Standards and Their Implementation [**10**]

2. Radiation detectors: Gas-filled ionization detectors-Ionization chambers, proportional counters and GM counters, Pulse height spectra and energy resolution, Semi-conductor detectors – Working of a p-n junction detector, partially and totally depleted detectors, surface barrier detectors, Lithium drifted Silicon detectors (Si(Li)), high-purity Germanium(HPGe) gamma detectors, Particle identification and time of flight technique, Scintillation detectors- scintillation mechanism in inorganic crystal scintillators and organic scintillators, Pulse height spectrum using a monoenergetic gamma ray source, Production and detection of neutrons-typical neutron sources, He proportional counters, fission counters. [**10**]

3. Radiation Instrumentation, Portable Survey Instruments, Use of radiation Survey Instruments, Scintillation Counters Radiation Shielding, Shielding Materials for Different Types of Radiation, Requirement for Shielding, Acceptable Radiation Levels for Various Areas, Merits and Demerits of Shielding Material, Criterion for Selecting Shielding Material [**10**]

4. Protection against Radiation Exposure, External radiation protection, Internal radiation protection, Calculation of Radiation Dose, Field, Man-rem and Duration of Work, Biological and Genetic Effects. [**10**]

Books:

1. Knoll G. F., *Radiation Detection and Measurement*, 3rd Edition, John Wiley and Sons (2000)
2. Martin A. A. & Samuel A. H., Introduction to Radiation Protection, 5th edition, Oxford university Press, (2006)
3. Cember H., Introduction to Health Physics, 3rd edition, McGraw-Hill, (1996)

Suggested Readings:

1. Turner J. E., Atoms, Radiation, and Radiation Protection, 3rd edition, Wiley, 1995.
2. Kapoor S. S. and Ramamurthy V. S., *Nuclear Radiation Detectors*, Wiley Eastern Limited, New Delhi (1986).

NU 523 Simulations in Nuclear Engineering 1-0-6-4

Physical simulation- advantage and limitations, Transport phenomena – concept of physical domain and computational domain- assumptions and limitations in numerical solutions [3]

Introduction to Finite difference Techniques, Finite Element Techniques, Finite Volume Techniques [3]

Basics about Monte Carlo Simulation, Algorithms for Monte carlo simulations [4]

Computational methods to analyze nuclear reactor systems described by various differentials, integral and integro-differential equations, Typical problem studies related with radionuclide decay chain, spatial dependence of radiation diffusion, transient heat diffusion [30]

Text Books:

1. Law, A. M. and Kelton, W. D., Simulation, Modeling & Analysis", 3rd Edition, Tata Mc Graw Hill , New Delhi-2003
2. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom, "The Finite Element Method for Engineers".
3. Banks, J, Carson J. S. H. and Nelson, B. L. " Discrete Event System simulations", 2nd edition , PHI, New Jersey, 1999
4. Elmer E Lewis and warren F Miller Jr., Computational methods of Neutron Transport, Wiley – Inter science, 1993

Reference Books:

1. Hector Guerrero Excel Data Analysis: Modeling and Simulation.
2. James; Biersack, J.P.; Ziegler, M.D. Ziegler, "SRIM - The Stopping and Range of Ions in Matter"
3. COMSOL Multiphysics manuals

NU 524 **Physics and Technology of Nuclear Fusion** **3-1-0-4**

1. Plasma- the fourth state of matter, Debye shielding, Collective behavior, Plasma frequency, Plasma Sheath, Plasma in nature and Laboratory, Industrial applications of plasma **[6]**
2. Basic plasma processes, Ionization and Recombination, Coulomb collision, Radiations from plasmas, Plasma Transport processes **[5]**
3. Motion of charged particles in electric and magnetic fields, Adiabatic invariance, Introduction to kinetic theory, Boltzmann equation, Vlasov plasma model, Fluid model from kinetic model, MHD equation, Plasma equilibrium and stability analysis **[6]**
4. Waves and instabilities in plasma **[5]**
5. Plasma generation using DC, RF and microwave power, Plasma diagnostics- Langmuir probe and Spectroscopy **[5]**
6. Energy crisis and role of fusion, Lawson criterion, Ignition criterion and burn physics, Plasma confinement approaches, Open and closed magnetic systems, alternate confinement concepts **[7]**
7. Fusion technology: Plasma heating, First wall sputtering and cooling, Diverter, Blanket physics, Fusion materials **[6]**

Books:

1. Introduction to Plasma Physics, F. F. Chen, 2nd edition, Plenum Press, (1984)
2. Physics of High Temperature Plasma, G. Schmidt , 2nd edition Burlington, MA: Academic Press (1979)
3. Fusion Research, Thomas J Dolan, Pergamon Press, 1982

Suggested Readings:

4. Industrial Plasma Engineering, Vol.1, Principles, J. R. Roth, Institute of Physics, 2001
5. Fusion Plasma Physics, Weston M Stacy, Wiley-VCH, 2001
6. Plasma physics and Fusion Energy, J. P. Freidberg, Cambridge University Press, 2007

NU 525 **Nuclear Power Engineering – I** **3-1-0-4**

Principles of the conversion of nuclear energy to useful power, Over view of various types of nuclear power plants that have been designed, built and operated, Economics of nuclear vs. other types of power plants. Economics of nuclear power plants, accounting for capital costs, fuel costs and O&M (operations and maintenance) costs, as well as environmental aspects - sustainability, proliferation, safety [6]

Neutron induced reactions-Reaction mechanism-microscopic cross sections-variation of cross section with neutron energy-resonances-1/v law, Nuclear fission-fission products-prompt & delayed neutrons-energy balance per fission-mechanism of fission-fissile and fertile materials[6]

Introduction of Nuclear reactor plant design, Reactor Assembly, Coolant Channels, Moderator and Auxiliary Systems, Primary heat Transport and Auxiliaries, Special Safety Systems and Reactor Shield cooling systems, Detailed features of pressurized water reactor components, including steam generators, Pressurisers and chemical-shim control systems. [12]
Problems related to features of gas-cooled reactor cycles and components, and compare/contrast those features with those of conventional LWRs. Difference in neutron spectrum and fuel type between a fast reactor and a LWR affect fast reactor physics and performance. [8]
Advanced future types of nuclear power plants that are in the design or developing stages. Reactor designs of power plants, their energy conversion principles, cycles and load-following characteristicsCompare and contrast the relative merits of different types of power plants. [8]

Text Books:

1. S. Glasstone & A. Sessoske, Vol I & II, CBS Publishers & Distributors, New Delhi (2009)

2. M. M. El-Wakil, *Nuclear Energy Conversion,* American Nuclear Society; Revised edition (1982)

3. John R. Lamarsh and Anthony J. Baratta, *Introduction to Nuclear Engineering*, 3rd Edition, Prentice Hall (2001).

NU-526 Nuclear Power Engineering-II

Chain reaction-classical four factor formula-eta vs. energy curve-conversion & breeding ratios-thermal and fast reactors.- Neutron lifetime-Conversion & breeding though eta vs. energy curve, Macroscopic cross-section, mean free path, neutron flux ,neutron current, beam attenuation-dependence of flux on space, energy, direction and time- simplified model, Neutron balance equation-rigorous Boltzmann and simplified diffusion equation through Fick's law. Multiplying and non-multiplying media

[10]

Boiling Water Reactors : **[10]**
Reactor Internals and Their Functions, Emergency Safeguard Systems, Reactor Safety, Containment System, Spent Fuel Management

Pressurized Water Reactor: **[10]**
Reactor Internals and Their Functions, Emergency Safeguard System, Reactor Safety, Containment System, Spent Fuel Management

Application of Reactor Physics for Operation **[5]**
Design Basis of Reactor Regulation and Protection System **[5]**

NU 528 **Reactor Thermal Hydraulics** **3-1-0-4**

1. Introduction – Different Reactor Types, Introduction – Types of Fuels and Steam Generators [**3**]
2. Conservation Equations, Heat Transfer – Basics, Basic Modes of Heat Transfer, Conduction Heat Transfer Equations [**4**]
3. Thermal Conductivity, Capacity and Diffusivity 1-D Steady-State Heat Conduction without Heat Generation – Plane Wall, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Hollow Cylinder, Sphere, Series-Composite Slab, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Series-Parallel Composite Slab, Composite Cylinder, Heat Flow Through Composite Structures Critical Thickness of Insulation Variable Thermal Conductivity, Conduction Heat Transfer with Internal Heat Generation Conduction Heat Transfer in Multidimensional Systems [**11**]
4. Transient Heat Transfer, Convective Heat Transfer, Heat Transfer Coefficient with Phase Change Thermosyphon cooling, Dimensional Analysis, Radiation Heat Transfer, Pressure Drop Analysis, Pressure Drop Analysis [**10**]
5. Fuel, Clad and Coolant Temperatures, Sub channel Analysis of Rod Bundle Fuels, Sub channel Analysis of Rod Bundle Fuels, Hotspot and Hot channel Factors, Coolant Channel Orificing, Introduction to Two-phase Flow and Basic Relations, Two-phase Flow and Boiling, Reactor Thermal Hydraulics Critical Heat Flux [**12**]

Books:

1. El-Wakil, M. M., Nuclear Heat Transport, McGraw Hill Book Co., New York (1985)
2. Glasstone S. & Sessonske A., Nuclear Reactor Engineering, Vol I and Vol II CBS Publishers & Distributors, New Delhi (2009)
3. Lahey R. T. and Moody F. J., The Thermal-Hydraulics of Boiling Water Nuclear Reactor, 2nd Edition, (1993)

Suggested Readings:

1. Todreas N. E. and Kazimi M., Nuclear Systems Volume I: Thermal Hydraulics Fundamentals, Taylor & Francis Pubs. 2nd Edition, (1989)

List of Nuclear Laboratory Experiments

1. To verify inverse square law using an α- source (^{241}Am) and p-i-n detector
2. Attenuation of α-particles in air and determination of thickness of mylar foil using α-source
3. Characteristic and dead time of a GM Counter, counting statistics using a GM counter
4. To determine the linear and mass attenuation coefficient of lead/ aluminium/ copper using ^{60}Co source (micro- curie) with GM setup
5. Determination of half life of ^{116}In using a GM counter
6. Determination of end point energy of β – particles by absorption method using a GM counter
7. Determination of gamma energy by using a scintillation detector
8. Determination of energy resolution of a Si- surface barrier detector with an ^{241}Am alpha source
9. Determination of the photo peak efficiency of a NaI (Tl) scintillation detector as a function of gamma ray energy.
10. Study of γ-γ directional correlation using a ^{60}Co source and a pair of scintillation Detectors
11. Study of angular distribution of Compton scattered gamma rays using scintillation spectrometer and deduction of total scattering cross section.
12. Determination of rest mass of electron by measuring the energy of Compton scattered gamma rays using a scintillation spectrometer.
13. Measurement of resolving time of a fast-slow coincidence set-up and determination of true-to- chance ratio.
14. Measurement of energy of β-particles using a β–ray spectrometer

NU 532 **Plasma Laboratory** **0-0-2**

List of Plasma Experiments

1. Glow discharge characteristic- Paschen curve
2. Density and electron temperature measurement using Langmuir probes in the glow discharge.
3. To study the conditions of striations in Plasma
4. Plasma confinement studies using magnetic field
5. Dielectric barrier discharge- plasma generation at atmospheric pressure
6. Ion acoustic wave propagation in plasma

Third Semester

NU- 603 Fast Breeder Reactors and Nuclear Engineering Materials 2-1-0-3

1. Fast breeder Reactor : Breeding requirements and fast reactors, Fast reactor system features, Oxide fuels in fast reactors, Carbide/Nitride fuels in fast reactors, Metal fuel development (emphasis on U-Pu-Zr) **[4]**

2. Fast reactor physics, Four-group flux and adjoint flux distributions, Reactivity and stability, System response to accident initiators **[3]**

3. Fast reactor thermal hydraulics: sodium heat transfer, Natural circulation in fast reactors, SGTR mitigation. **[3]**

4. Nuclear Materials and Processing: Nuclear fuels: Metallic, ceramic (Oxides, MOX and Carbide fuels)- fabrication, properties and applications, Reactor Core Materials: Zircalloys, Zr-Nb alloy--- fabrication, properties and applications in reactors, Heavy water: production process, purification and applications **[10]**

5. Fuel Chemistry, Solid Fission Products, Swelling and Fission Gas Bubbles, Fission Gas Release, Corrosion in Nuclear Reactors, Plant Life Extension **[5]**

6. Nuclear waste; types - liquid waste - solid waste - aerial effulent -disposal of fuel or wastes; waste categories – low - level waste - intermediate level waste - high level waste. Basics about Nuclear Waste treatment, PUREX, Waste forms for long-term storage **[5]**

Books:

1. Waltar A. E. and Reynolds A.B., Fast Breeder Reactors, Pergamon Press, New York (1981).
2. Bendict M., Pigford T. and Levi H., Nuclear Chemical Engineering,
3. Wilson P. D., Nuclear Fuel Cycle: From ore to wastes, Oxford Press, 1996

Suggested Readings:

1. Callister D., Fundamentals of Material Science & Engineering, Wiley
2. Raghvan V., Physical Metallurgy: Principles & Practices,
3. Gupta C. K., Materials in Nuclear Applications

NU-605 Nuclear Plant Safety & Regulatory Frame work 2-1-0-3

1. Nuclear power plant safety requirements, Basic concepts in safety and reliability, Loss of coolant accident, Conceptual design of safety systems, Risk and reliability analysis of systems, Operational safety procedures, Manrem budgeting and control, Surface contamination and control

[15]

2. Role of Atomic Energy Regulatory Board (AERB) and Department of Atomic Energy (DAE), Legislation, rules and regulations for safe electricity generation, Legislation for regulation and its effective implementation for nuclear power plants, Role of Central and State Electricity Regulatory Commissions, Applicable AERB Safety Codes, Guides and Technical Specifications, Surveillance requirements and systems, Comparison with the regulatory framework of conventional industry

[15]

Books:

1. Lewis E. E., Nuclear Power Reactor Safety, E. E. Lewis, Wiley-Inter science publication, 1977
2. M. Rosen, Regulatory Codes and Guides issued by the International Atomic Energy Agency (IAEA), (1985)

Suggested Readings:

1. Mishra K. B., Reliability Analysis and Prediction, Elsevier Publications, (1992)
2. Haldar A. and Mahadevan S., Probability, Reliability and Statistical Methods, John Wiley & Sons (2000)
3. Codes and Guides issued by the Atomic Energy Regulatory Board) (AERB), (1982), Niyamak Bhavan, Anushaktinagar, India

SESSION

2019-2020

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Course structure for

PhD

CS 702 **Advances in Computer Science and Engineering** **Total Lectures: 52**
4-0-0-4

Prerequisite(s): Knowledge of core subjects of computer science and engineering.

Objective(s): To strengthen the knowledge of core subjects of computer science and engineering.
To provide research orientation to the students and latest developments in core areas.

1. **Digital Computer Organization and Architecture:** Boolean algebra, Combinational and sequential circuits. Minimization, Number representations and computer arithmetic (fixed and floating point), Machine instructions and addressing modes, ALU, data-path and control unit, Instruction pipelining, memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode). [10]
2. **Data Structures and Algorithms:** Arrays, stacks, queues, linked lists, trees, binary search, trees, binary heaps, graphs, recursion, searching, sorting, hashing, asymptotic worst case time and space complexity, algorithm design techniques: greedy, dynamic programming and divide-and-conquer, graph search, minimum spanning trees, shortest paths, programming in C. [10]
3. **Theory of computer science and compiler design:** Regular expressions and finite automata, context-free grammars and push-down automata, regular and context-free languages, pumping lemma, Turing machines and undecidability, compiler design: lexical analysis, parsing, syntax-directed translation, runtime environments, intermediate code generation. [10]
4. **Operating System:** Processes, threads, inter-process communication, concurrency and synchronization, deadlock, CPU scheduling, memory management and virtual memory, file systems. [6]
5. **Databases:** ER-model, relational model: relational algebra, tuple calculus, SQL, Integrity constraints, normal forms, file organization, indexing (e.g., B and B+ trees), transactions and concurrency control. [6]
6. **Computer Networks:** Concept of layering. LAN technologies (Ethernet), flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state), TCP/UDP and sockets, congestion control, Application layer protocols (DNS, SMTP, POP, FTP, HTTP), basics of Wi-Fi, network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls. [10]

Outcome(s): This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles of computing to the analysis of computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to maintain life-long learning and continue to be motivated to learn new subjects.

Reference Books:

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd edition, 2008.
2. Thomas H. Cormen, "Introduction to Algorithms", PHI, 3rd edition, 2012.
3. John E. Hopcroft, Rajeev Motwani, J D Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson, 3rd edition.
4. A V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques and Tools", Pearson, 2nd edition, 2014.
5. Galvin, Silberschatz, Gagne, "Operating System Concepts", Wiley India, 9th edition, 2015.
6. Navathe, "Fundamentals of Database Systems", Addison Wesley, 5th edition, 2007.
7. Tanenbaum, "Computer Networks", PHI, 4th edition, 2002

EC702 Advances in Electronics & Communication Engineering **Total Lectures:52**

3-1-0-4

Objective: The course focuses on the basic theory and techniques used in the area of digital signal processing, VLSI design, Microwave Engineering, Antenna & Wave Propagation and Digital Data communication. It also offers a profound understanding of the design, analysis and applications of some complex circuits and devices with the help of computer aided simulation and synthesis tool for hardware design.

Prerequisite:
Basic understanding of core engineering courses given in the syllabus, is required.

VLSI Design Technology

MOS modeling and performance parameters, Design aspects: Review of MOS transistor models , Concept of Scaling and deep submicron VLSI design, Low Power VLSI design, Issues related to high speed VLSI Design (CMOS technology), New trends in Digital VLSI design, Example of Mixed VLSI Design, Advanced Testing and Verification Approaches, Wafer cleaning processes and wet chemical etching techniques. Introduction to hardware description languages (VHDL), logic, circuit and layout verification. MEMS **[10]**

Microwave & Radar Engineering

Maxwell's Equation, Wave Equation and Boundary conditions, Transmission lines, Microwave Passive Components, Measurements of Wavelength, Frequency, Impedance, SWR etc., Q of Cavity, Microwave Linear Beam Tubes, Reflex Klystron. Traveling Wave Tube, Transferred Electron Devices, Principle of operation of Radar, Radar equation, CW and Frequency Modulated Radar, MTI and Pulse Doppler Radar **[12]**

Antenna & Wave Propagation

Introduction of Antenna & its parameters. Reciprocity theorem, Review of microwave antennas- Parabolic Reflector, Cassegrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication. Frequency- independent antennas, Scattering and diffraction. Internal-equation methods, current distribution: Self and mutual impedances. **[10]**

Digital Data Communications

Local Area networks:- token ring, Ethernet, Traditional, Fast and GIGA bit Ethernet, FDDI, DIGITAL MULTIPLEXING :- TDM , T1 carrier , CCITT , CODECS, COMBO CHIPS , North American Hierarchy , Line Encoding , T-carrier , Frame Synchronization Inter Leaving Statistical TDM FDM , Hierarchy ,Wave Division Multiplexing . **[10]**

Signal Processing

Multi-rate Digital Signal Processing: Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion. Linear Prediction And Optimum Linear Filters: Forward and backward linear prediction; Properties of the linear prediction – error filters; Applications of linear prediction., Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters. Power Spectral Estimation: Principle and traditional methods of spectral estimation; Modern methods of parametric estimation; Applications of spectral analysis,. **[10]**

Course Outcomes:

This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles to the analysis of electrical and computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to electrical and computer engineering problems.
4. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
5. Ability to be competitive in the engineering job market.

Text books

1. R.E Collin, "Antennas & Radio Wave Propagation", Mc-Graw Hill
2. D M Pozar,"Microwave Engineering", JohnWilley & Sons
3. Proakis, Rader, Ling, and Nikias, Advanced digital signal processing, Macmillan, 1992
4. John P. Uyemura : Introduction to VLSI Circuits and Systems, John Wiley & Sons,Inc, 2002
5. Electronic communication systems, fundamentals through advanced - W. TOMASI, Pearson 4th Edition.
6. Introduction to Radar, M. I. Skolnik, McGraw Hill.

Reference books

1. Annapurna das & Sisir K das, Microwave Engineering Tata Mcgraw Hill.
2. Data communication and networking - B.A. Forouzen
3. Kin. Lu. Wong, "Compact and Broadband Microstrip Antenna", John Wiley & Sons
4. S. Stergiopoulos (editor), "Advanced Signal Processing Handbook: Theory and Implementation for Radar, Sonar, and Medical Imaging Real-Time Systems", CRC Press LLC, 2001.
5. Neil Weste and David Harris, "CMOS VLSI Design ", 4thEd., Addison Wesley, 2011.

EE 702 **Advances in Electrical Engineering** **Total Lectures: 52**

4-0-0-4

Objective: To provide an exposure on the basic principles and techniques used in the area of ultra-capacitor, control systems and its sliding modes control, Smart Grid, Renewable Energy Integration. It also offers a profound understanding of the design, analysis and applications of Smart Grid, Renewable Energy integration with the help of computer aided simulation and synthesis tools / ETAP Software.

Pre-requisite: Basic understanding of core engineering courses given in the syllabus is required.

1. **Ultra- Capacitor:** Introduction, History, Basic principles of Ultracapacitors, Principles and energy storage mechanism, EC vs. Aluminum (Al) electrolytic capacitors, Capacitors vs. batteries, Benefits and limitations of Ultracapacitors, Ultracapacitor vs. Flywheels, Applications, Cell voltage, Comparison with battery or other energy storage devices, Cost of EC capacitors, Electrochemical Double Layer Capacitor: basic construction, Components of Ultracapacitor, EC capacitor sizes, Future of energy storage industry, Uninterruptible power supply and backup power. [8]
2. **Applications & Future Scenario of Ultra- Capacitor:** Modern day applications of Ultra capacitor, Future application growth, New material developments, Cost reduction, Ultra capacitor may overtake batteries, Market trends, ultra capacitors in the grid, Vehicular applications, Ultra capacitors in wind turbines, Water Desalination/Purification, New Ultra capacitor work at constant voltage, Electrochemical flow Ultra capacitor, Micro Ultra capacitor, Ultra capacitor for resistance welding. [8]
3. **Advanced control systems :** Introduction, Intuitive theory of sliding mode control, Sliding Surface, sliding mode, concept of equivalent control, sliding mode equations, sliding mode observer/differentiator, second order sliding mode. [7]
4. **Classical sliding modes:** Introduction, state feedback sliding mode control: Regular form, Eigen valve placement, quadratic minimization. State feedback control laws design: Single input system, multi-input system, unmatched uncertainty, output tracking with integral action. Output based hyper plane design, control law development. Integral sliding mode control: Problem formulations, control design objective, ISM control design. [8]
5. **Smart Grid:** Introduction, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, The Environmental Impacts of Smart Grid, Technologies Required for Smart Grid. [8]
6. **Renewable Energy Integration:** Introduction, Solar Energy, Wind Energy, Distributed Energy Resources Integration Challenges, Forecasting and Scheduling, Impacts of Renewable Energy into the Grid. [8]
7. **Smart Meter:** Details Description of Smart Meter, Benefits of Smart Meter, Technical Configurations of Smart Meter, Components of Smart Meter Network in Distribution System, Characteristics, Communication Protocols. [5]

Course Outcomes: This course helps our students to apply the knowledge of advanced principles, state of -the-art design techniques, software tools, and research methods for solving challenges of Smart Grid, Renewable Energy Integration and ultra capacitor.

Text Books:

1. R. P. Deshpande, "Ultra -capacitors: Future of Energy Storage", Mc-Graw Hill Education.
2. C-Edwards & S.K. Spurgeon, "Sliding mode control: Theory & Application", Taylor & Francis, 1998.

3. Shawkat Ali A. B. M., Smart Grids Opportunities, Developments and Trends, Springer-Verlag, London , 2013

Reference Books:

1. B. E. Conway, "Electrochemical Super capacitors: Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum Publishers (1999)
2. Utkin V.I., "Sliding modes in control & optimization", Springer-verlay, 1992.
3. Momoh James., Smart Grid Fundamentals of Design and Analysis, John Wiley &Sons, Inc., Hoboken, New Jersey, 2012

ET 901 **Research Methodology** **4-0-0-4**

1. **Introduction:** meaning of research, objectives, motivation for research, types of research, research approaches, research process, validity and reliability in research. [02]

2. **Problem formulation:** identification, selection & formulation of a research problem, objectives of formulation, criteria of a good research problem, review of literature. [03]

3. **Research design:** research framework, meaning & significance of research designs, features of a good research design, types of research design. [04]

4. Data for research: types of data, sources of data, methods of collecting data, data presentation techniques. Methods of data analysis. [10]
*Use of SPSS and MATLAB tools for data analysis.

5. **Mathematical background for research:** approaches to probability, probability distributions; binomial, Poisson, uniform, exponential and normal distributions. Review of basic statistical measures; measures of central tendency, measures of variation. Sampling methods, correlation analysis, simple regression, multiple regression, time series analysis, cluster analysis, clustering techniques. Queuing theory; introduction, simple Markovian queuing models. [10]

6. **Algorithmic Research:** introduction, types of algorithmic research problems, types of solution procedures, steps of development of algorithm. [04]

7. **Simulation:** introduction, need for simulation, simulation analysis of a case study. [03]

8. **Thesis writing:** format; general format of cover page, dedication, certificate, declaration, acknowledgement, abstract, list of contents, list of figures, list of tables, appendices, and references. Contents of thesis; background to research, literature review, problem statement, objectives of research, rationale for the study, motivation to the study, methods, definitions, research models, research design & analysis, results, findings, implications, contributions, significance of research, future directions, and conclusion. [04]
*Practical classes to be taken.

Reference Books.

1. Mr. R. Pannershelvam, "Research Methodology", Prentice Hall India, 2006.
2. Mr. C. R. Kothari, "Research Methodology : Methods and Techniques", Second edition, New Age International Publishers, 2006.
3. Mr. Ranjit Kumar, “Research Methodology: A step by step guide for beginners” , Second edition, Pearson, 2006

Outcome(s): *This course supports the achievement of the following outcomes*

- *Current trends in the rapidly evolving field*
- *The intellectual and philosophical framework necessary to explore wide spectrum of research in mechanical engineering.*
- *To contribute to expanding the frontiers of knowledge and to provide research training.*
- *Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, and research methods for solving engineering problems*

Text Books:

1. Timoschenko S.P. and Goodier J.N, "Theory of elasticity" McGraw-Hill Publishers
2. Dally and Riley, "Experimental stress analysis", McGraw-Hill Publishers
3. B.H. Amstead, Philip F, Ostwald and Myron L, "Manufacturing Processes" Begeman, John Wiley and sons, eighth edition.
4. Sunil Chopra & Peter Meindl, "Supply Chain Management: Strategy, Planning & Operation", Pearson Education Asia
5. Rao S. S, "Engineering Optimization- Theory and Practice", New Age International
6. Nag P. K, "Basic and Applied thermodynamics", TMH, Latest Edition
7. William M. Kays, Michael E. Crawford, "Convective Heat Transfer"**,** McGraw-Hill Publishers.

Reference Books:

1. Boresi & Sidebottom, "Advanced Mechanics of materials", Wiley International.
2. Garg and Venkitakrishnan, "Enterprise Resource Planning: Concepts and Practice", 2nd Ed, PHI
3. G.F. Benidict, "Advanced Manufacturing Processes",Marcel Deker Publisher.
4. Van Wylen G.H. & Sonntag R.E, "Fundamentals of Classical Thermodynamics", John Wiley & Sons.

NT-702 Advances in Nanoscience and Technology Total 52 lectures
3-1-0-4

Objective: The course focuses on the basic theory and techniques used in the area of nano Science & Technology. The paper covers important areas and gives profound understanding about nano world, synthesis of nano materials, various characterization techniques for nano materials and applications of nano Science & technology in the area of modern electronics, medical sciences and environmental sciences. It may guide and help the student in deciding about the research area in which he/ she may like to contribute further.

Pre-requisite:
Basic understanding of core science and engineering courses given in the syllabus

Course Outcomes:

This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles to the analysis of nano science & technological problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems
3. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to nano science & technology problems.
4. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
5. Ability to be competitive in the innovative research areas and relevant job market.

Syllabus details

1. Nano World : [12]

Introduction, History of nanomaterials, what is nano? Beginning of Nanoscience, Moore,s law, Nanoscience: The multidisciplinary science, Different types of nanomaterials, Properties of nanomaterials, Zero dimensional, one-dimensional and two dimensional nanostructures-clusters of metals and semiconductors, nanwires, Size dependent properties-size dependent absorption spectra-phonons in nanostructures, seeing nano-objects

2. Synthesis of Nanomaterials: [16]

Physical Methods: Top-down and bottom-up approach, Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ion sputtering, Laser ablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxial, Chemical vapour deposition method and other variants, Electro deposition.

Chemical Methods: Chemical reduction method, Sol- gel, Micelles and microemulsions, Solvothermal synthesis, hydrothermal methods, photochemical synthesis, electrochemical synthesis, Thermolysis routes, Sonochemical routes, Liquid-liquid interface, Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, template synthesis, organic block copolymers, porous silicon, and Pulsed electrochemical deposition. Nanoporous Materials, Silicon, Zeolites, mesoporous materials, nanomembranes and carbon nanotubes, AgX photography, smart sunglasses, and transparent conducting oxides, molecular sieves, nanosponges.

Biological Methods of Synthesis: Use of bacteria, fungi, Actinomycetes for nanoparticle synthesis, Magnetotactic bacteria for natural synthesis of magnetic nanoparticles; Mechanism of formation; Viruses as components for the formation of nanostructured materials; Synthesis process and application, Role of plants in nanoparticle synthesis

3. Characterization Techniques : [12]

X-ray diffraction, Scanning Probe Microscopy, SEM, TEM, Optical microscope and their description, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurements, Magnetic and electrical measurements. Lithographic Techniques: AFM based nanolithography and nanomanipulation, E beam lithography and SEM based nanolithography and nanomanipulation, Ion beam lithography, oxidation and metallization. Mask and its application. Deep UV lithography, X-ray based lithography

4. Applications of Nanomaterials: [12]

Electronic Applications:

Applications of nano for IC chips, STM based lithography-Molecular electronics- LEDs- Memories – CNT and Graphene based Electronic devices - transistor based sensors and its general applications- Applications of Nanomaterials in Space

Applications of Nanomagnetic materials

Nanomagnetism- Bionanomagnetism- type of magnet materials –tag and drag drug delivery – hyperthermia- hypothermia-MRI

Environmental Applications:

Bioremediation- removal of bacteria and microbes- sensors for DNA- Proteins, and Biological applications – self assembly systems- tissue culture- nanopharma

Text Books:

1. Nanoworld: An introduction to Nanoscience and technology – C N R Rao
2. A Textbook of Nanoscience and Technology: T. Pradeep
3. Nano: The Essentials-T. Pradeep
4. Introduction to Nanotechnology, Wiley, Charles P. Poole Jr. & Frank J. Owens
5. Lehninger Principles of Biochemistry, Sixth Edition, Nelson and Cox, W.H. Freeman and Company

References:

1. Physical Chemistry: Gilbert W. Castellan
2. Physical Chemistry of Surfaces: Authur W. Adamson, Alice P. Gast
3. The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C. N. R. Rao, Achim Müller, A. K. Cheetham, Wiley
4. NANO: The Next Generation-Mohan Sundar Rajan, National Book Trust, India

CS 19.203 **Data Structures** **Total Lectures: 40**

Credit:3-0-0-3

Pre-requisite(s): CS 19.101 (Programming Language)

Objective(s):

- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1. **Introduction:** Basic terminology, elementary data organization, algorithm, efficiency of an algorithm, time and space complexity, asymptotic notations, time-space trade- off, abstract data types. [4]
2. **Array & Linked list:** Definition, single and multidimensional arrays, representation of arrays: row major order, and column major order, application of arrays, sparse matrices and their representations. Singly linked lists, doubly linked list, circular linked list, insertion, deletion, traversal, polynomial representation and addition, generalized linked list. [10]
3. **Searching & Sorting:** Sequential search, binary search, comparison and analysis, hash function, collision resolution strategies, insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort. [10]
4. **Stack & Queue:** Primitive stack operations: push and pop array and linked list implementation of stack, application of stack: prefix and postfix expressions, evaluation of postfix expression, recursion, and tower of Hanoi problem. Queue operations, circular queues, array and linked list implementation of queues, dequeue and priority queue [8]
5. **Tree:** Binary trees, binary tree representation, tree traversal algorithms: inorder, preorder and postorder, threaded binary trees, Huffman algorithm, binary search trees AVL trees. [8]

Outcome(s): On the successful completion of the course, the student will be able to:

- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:

1.Lipschutz, "Data Structures" Schaum's Outline Series, TMH, Revised Edition Feb. 2014

2. Horowitz and Sahani, Fundamentals of Data Structures, University Press, 2nd Edition, 2008.

Reference Books:

1.Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI, 2nd Edition, 2012.

2. D. Samanta, Classic Data Structures, PHI, 2nd Edition, 2009

3. Jean Paul Trembley and Paul G. Sorenson, An Introduction to Data Structures with applications, McGraw Hill, 2nd Edition, 2003.

CS-19.205 **Objected Oriented Programming** **Total Lectures: 40**

3-0-0-3

Objective: The objective of this course is to:

1. cover issues related to the definition, creation and usage of classes, objects and methods.
2. Discuss the principles of inheritance and polymorphism.
3. Provide the foundation of good programming skills by discussing key issues of the design of object-oriented software, including programming design and documentation.
4. Cover the basics of API and to explore the java abstract programming interface.

Pre-requisite: Programming Language

1. **Overview:** Introduction to OOP, OOP concepts, interactive Development Environments: Eclipse/Net Beans, basics of OOP, importance of Java Primitive data types, type casting, arrays, ArrayList, operators and control structures, identifiers, constants and literals. [9]

2. **Classes and Inheritance:** Class fundamentals, objects, constructors, this keyword, garbage collection, the finalize() method, overloading methods, understanding static & final, exploring the string class. Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, the object class, using abstract classes, interface. [10]

3. **Package, and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, user defined exception, assertions [10]

4. **Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managing threads, thread class built-in functions. [4]

5. **I/O and String Handling:** I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer. [7]

Outcome: Upon completion of this course, students are able to:

1. Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
2. Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
3. Develop programs using the in-built Java API and the Java standard class library.
4. Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifies, automatic documentation through comments, error exception handling).
5. Use of development environment like Eclipse for collaborative programming

Text Books:

1. Herbert Schildt, Java the Complete Reference, Herbert Schildt, 8th Edition, 2011.
2. Bert Bates and Kathy Sierra, Head First Java, O'Reilly,2005

Reference Books:

1. Allen B. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
2. Paul Deitel, Harvey Deitel, Java How To Program (Early Objects), 10th Edition, 2014.
3. E. Balaguruswamy, Programing with Java A Primer, Tata Mc. Graw Hill, 2007

EC 19.201	Electronic Devices and Circuits	Total Lectures: 40 3-0-0-3

Objective To acquire fundamental knowledge of operation, design and application of various Electronic devices and circuits.

Pre-requisite Basic Electronics and Physics of electron.

1. **Junction Diode:** Junction breakdown**,** Current components in a p-n diode, Quantitative analysis of p-n diode characteristics and equivalent circuit, diode resistance, interconnections of diodes, transition and diffusion capacitance. [6]

2. **Transistors**: Operation of transistor, transistor current components, transistor circuit configurations, transistor biasing schemes and operating point stabilization, hybrid-pi model of BJT, low and high frequency models of JFET, MOS Devices - NMOS, PMOS and CMOS [11]

3. **Small Signal Amplifiers at Low Frequency:** Coupling schemes for multistage amplifiers, frequency response of coupled amplifier, RC coupled transistor amplifier, transformer coupled transistor amplifier, cascode circuits, Differential amplifier, Darlington amplifier. [7]

4. **Power Amplifiers:** Power amplifier circuits, class-A, class-B, class-AB, class-C, push pull amplifiers- class-A, class-B, Class- AB, complementary symmetry push-pull and quasi-complementary symmetry, push-pull amplifiers. [8]

5. **Oscillators:** Classification criterion for oscillation, tuned collector, Hartley, Colpitts, RC phase shift, Wien bridge and crystal oscillators, astable, monostable and bistable multivibrators, Schmitt trigger [8]

Outcome: After completion of this course, students would be able to understand the working phenomena and applications of various electronic devices and circuits. Knowledge gained from this course would also be utilized to design different electronic circuits and devices.

Text Books:

1. Robert L. Boylestad & Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, 11th Edition, 2013.
2. Thomas L. Floyd, Electronic Devices, Pearson Education, 10th Edition , 2018.

Reference Books:

1. Bell, David A., Operational Amplifiers & Linear ICS, Prentice Hall of India, 3rd Edition, 2018.
2. J. Millman & C. C. Halkias, Electronic Devices and Circuits, McGraw Hill

EC 19.202 **Digital Electronics** **Total Lectures: 40**

Objective: The aim of this course is to present the principles and techniques of combinational and sequential digital logic design and optimization at a gate level. The use of transistors for building gates is also introduced. **3-0-0-3**

Pre-requisite: Basics of Electronics Engineering

1. **Number Systems and Boolean Algebra:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic, Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [5]
2. **Logic Gates and Simplification of Boolean Functions:** Basic Logic gates, Universal gates, K-map representation, incompletely specified functions, simplification realization with gates, Quine-Mc Cluskey method. [5]
3. **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]
4. **Sequential Circuits and Programmable Logic :** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters, PAL, PLA. [10]
5. **Introduction to Verilog HDL:** Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools. Gate Level Modeling: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State Gates, Array of Instances of Primitives, Design of Flip-flops with Gate Primitives, Delays, Strengths and Construction Resolution, Net Types, Design of Basic Circuits. [10]

Outcomes: Upon successful completion of this course, students should be able to:

1. Gain fundamental knowledge of the basic logic gates such as AND, OR, NAND NOR, EX-OR and their implementation in Logic Circuits.
2. Design multipliers, Combinational Circuits and registers.

Text Books:

1. M. M. Mano and M. D. Ciletti, Digital Design, Pearson Education, 4th Edition, 2009.
2. T. L. Floyd and R.P. Jain, Digital Fundamental, Pearson Education, 8th Edition, 2009.

References

1. V. K. Puri, Digital Electronics: Circuits and Systems, Tata McGraw-Hill, 4th Edition, 2001.
2. R. P. Jain, Modern Digital Electronics, Tata McGraw-Hill, 4th Ed, 2003.

EC 19.203 **Semiconductor Physics** **Total Lectures: 40**

3-0-0-3

Objective: The aim of the course is to develop physics and engineering strategies of semiconductor materials and to discuss their functionalities in modern electronic and optoelectronic devices

Pre-requisites : Basic Modern physics , Optics

1	**Introduction -** Solids, Crystals and Electronic grade materials, Formation of energy bands in solids, Concept of hole, Density of states and Fermi level, Intrinsic and extrinsic semiconductors, Direct and indirect semiconductors Recombination and Generation of carriers,	[8]
2	**Fermi distribution and energy** - Density of states - Valance and conduction band density of states - intrinsic carrier concentration - intrinsic Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors - Bandgap Engineering.	[8]
3	**Carrier transport –** Drift and Diffusion: Equations of state – Continuity and Poisson equation, Carrier transport by Drift: Low field, High field and very high field (Impact ionization) - Einstein relation, phonon scattering. Macroscopic transport: Carrier transport by Diffusion	[8]
4	**Generation and recombination** - Electron - hole pair: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons: Origin, electronic levels and properties Radiative and nonradiative recombination (Shockley - Read - Hall and Auger) processes. Carrier transport - continuity equations. Optical constants: Kramers - Kronig relations.	[8]
5	**Optical processes in semiconductor**, choice of materials for LED, LED power and efficiency, LED structures - Planar LED, Dome LED, Surface Emitting LED, Edge Emitting LED, Optical detection principle, quantum efficiency, Photoconductor, p-n photodiode, p-i-n photodioe, APD, Heterojunction diode, optocouplers.	[8]

Outcome: This course will provide the students with a basic understanding of the physics and principles of semiconductor material.

Text Books:

1. Kevin F Brennan, The Physics of Semiconductors, Cambridge Univ. Press, 2012.
2. Peter Y Yu and Manuel Cardona, Fundamentals of Semiconductors, Springer, 4th Edition, 2010.

Reference Books

1. D. A. Neamen, Semiconductor Physics and Devices, 3rd Ed., Tata McGraw-Hill, 2003.
2. S.M. Sze, Physics of Semiconductor Devices, John Willey, 3rd Ed., 2007.

EC 19.204 **Integrated Circuits and Applications** **Total Lectures: 40**

3-0-0-3

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: Electronics Devices and Circuits

1. **Differential Amplifier:** Operational amplifier, bipolar and FET differential amplifiers, constant current source, current mirror, level translator, block diagram of operational amplifier, frequency response and stability, operational amplifier parameters, offset compensation techniques. [5]

2. **Application of Op-amp:** Inverting and non-inverting amplifiers, voltage follower, integrator and differentiator circuits, instrumentation amplifier, current to voltage converter and voltage to current converter, voltage to frequency conversion, analog simulation of differential equations using operational amplifiers. [5]

3. **Oscillators and Active Filters:** Phase shift, Wein bridge, quadrature, square wave, triangular wave, saw tooth wave and voltage controlled oscillator, Low pass, high pass, band pass and band reject filters, designing of second order filters using Butterworth approximations, higher order filters and state variable filters. [15]

4. **ICs and Applications:** Clipping and clamping circuits, comparator, LM-311 comparator, schmitt trigger, log and antilog amplifiers, half and full wave rectification, IC-8038, IC LF-398, IC-555. [5]

5. **Voltage Regulator and PLL:** Voltage regulator IC-723, switching regulators, regulator IC series 78xx, 79xx, building blocks of PLL, IC-565 and its applications, four-quadrant multiplier and its applications. [10]

Outcomes: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI, New Delhi, 3rd Edition.
2. B. P. Singh and Rekha Singh, Electronic Devices and Integrated Circuit", Pearson Education, 2003.

Reference Books:

1. R. F. Coughlin and F. F. Driscoll, Operational Amplifiers & Integrated Circuits, Pearson Education, 5th Edition, 2001.
2. S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits, Pearson Education, 3rd Edition, 2003.

EC 19.206	Principles of Electromagnetics	Total Lectures: 40

Objective: To develop the understanding of basics concepts of electromagnetic field theory and its applications. **3-0-0-3**

Pre-requisite: Basic understanding of laws of Physics and Mathematics

1. **Introduction:** Transformation of a point and a vector in different coordinate systems, Differential length, area, volume Physical meaning of gradient, divergence and curl, Laplacian of a scalar, Divergence theorem, Stoke's theorem, review of electrostatic and magneto static fields. [5]
2. **Time Varying Fields and Maxwell's Equations:** Faraday's law of electromagnetic induction, Maxwell's equations in integral and differential form, potential functions, electromagnetic boundary conditions. [5]
3. **Electromagnetic Waves:** Introduction, Helmholtz wave equation, Wave equations and their solutions for free space, lossy dielectric, Lossless dielectrics and good conductor medium, Poynting vector and the flow of power. Reflection of plane wave at dielectric media and conducting surfaces for normal incidence. [15]
4. **Transmission lines:** Types of transmission lines, transmission line parameters, two conductor transmission line equations, input impedance, standing wave ratio and power of transmission lines, smith chart, transmission line impedance matching techniques. [5]
5. **Guiding Structures:** General wave behaviors along uniform guiding structure, rectangular and circular wave guides, wave propagation in rectangular and cylindrical cavity resonators. [10]

Outcomes: After completion of the course, students would be able to apply Knowledge of electromagnetic principles in engineering and solve curriculum problems.

Text Books:
1. Matthew N. O. Sadiku, Principles of Electromagnetics, Oxford University Press, 4th Edition, 2015.
2. William H. Hayt: Engineering Electromagnetic, TMH, 8th Edition, 2013.

Reference Books:
1. David J. Griffiths, Introduction to Electrodynamics (Third Edition); Pearson Education, 4th Edition, 2013.
2. M. L. Sisodia and G. S. Raghuvanshi, Microwave Circuits and Passive Devices, New Age Publication, 1987.

EC 19.411 **Telecommunication Switching Systems** **Total Lectures: 40**

3-0-0-3

Objectives:

1. To acquire knowledge on simple telephone communication and basics of switching system.
2. To get acquainted with electromechanical switching systems.
3. To gain knowledge on digital switching systems, stored program control system, traffic engineering, telephone networks and ISDN.
4. To apply the knowledge of Telecommunication Switching in designing switching systems.

Pre-requisite: Analog communication

1. **Introduction to Switching Systems:** Introduction, simple telephone communication, basics of switching system
2. **Electromechanical Switching Systems: Introduction to Strowger switching system,** Crossbar switching systems, single stage and multistage switching systems, common control, pulse dialling, tone dialling.
3. **Digital Switching Systems:** Stored Program Control, centralised SPC, distributed SPC, software architecture, application software, space division, and time division switching, time multiplexed space division, time multiplexed time division switching and combination switching.
4. **Traffic Engineering:** Erlang's equation, blocking probability and B-D equation.
5. **Telephone Networks:** Subscriber loop, digital subscriber loop, high speed digital transmission over subscriber line, wire-in, wire-less media, coaxial cables, optical fibre cables, microwave propagation, satellite transmission, numbering plan, charging plan, Inchannel signalling, common channel signalling.
6. **ISDN and ATM Standards:** ISDN architecture, channels, interfaces, protocol, B-ISDN architecture, frame relay, ATM protocols

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of telecommunication Switching Systems.
2. Able to describe different mechanical and electronic switching systems, telephone networks.

Able to design various switching systems.

Text Books:

1. Thiagarajan Viswanathan, Telecommunication Switching Systems and Networks, PHI, 2nd Edition, 2015.
2. J. E. Flood, Telecommunication Switching, Traffic and Networks, Pearson Education, 1st Edition, 1999.

References:

1. John C. Bellamy, Digital Telephony, Wiley Publications, 3rd Edition, 2000.

EC 19.412 **Wireless Networks** **Total Lectures: 40**

3-0-0-3

Objectives: To acquire fundamental knowledge of various types of wireless networks and apply them to wireless communication applications.

Pre-requisite: Analog Communication, Digital Communication

1. **Introduction:** Introduction to wireless networks, Wireless communication systems – Paging system, cordless telephone system, cellular telephone system [4]

2. **Basics of cellular communication systems:** Frequency reuse, channel assignment, call handoff, interference and system capacity, Mobile radio propagation – path loss and fading, 2G, 2.5 G and 3G wireless networks [10]

3. **Multiple Access Techniques:** Frequency Hopped Multiple Access, Code Division Multiple Access, Hybrid Spread Spectrum Multiple Access, Packet Radio, Carrier Sense Multiple Access, Reservation Protocol [10]

4. **Equalization, Diversity and Channel Coding:** Fundamentals of equalization, Linear equalization, Nonlinear equalization, Diversity techniques – space diversity, time diversity, frequency diversity, polarization diversity, RAKE receiver, Block code and convolution code. [8]

5. **Wireless Networking:** Wireless local area network, RF and IR WLAN, advantages and applications, IEEE 802.11, IEEE 802.16, HYPERLAN, Bluetooth, WiMax, Ultra-Wide Band communication. [8]

Outcomes: After completion of the course, students would be able
1. To apply wireless communication concepts and ideas to engineering applications and
2. To develop high performance wireless communication network.

Text Books:
1. T. S. Rappaport, Wireless Communication, Principles and Practice, Pearson Education, 2nd Edition, , 2009
2. Upena Dalal, Wireless Communication, Oxford University Press, 1st Ed., 2009.

References:
1. Jochen Schiller, Mobile Communications, , Pearson Education, 2nd Edition, 2012
2. Vijay Garg, Wireless Communications and Networking, First Edition, Elsevier, 1st Edition, 2007.

EC 19.413 **Fiber Optics Communication** **Total Lectures: 40**

3-0-0-3

Objectives:
1. To acquire knowledge on basics of Optical Fibers.
2. To get acquainted with different types of optical fiber.
3. To gain knowledge on transmission characteristics of optical fiber, fabrication, cabling, jointing techniques.
4. To apply the knowledge of optical fiber communication in designing fiber optic systems for communication.

Pre-requisite: Analog Communication

1. **Basic Concepts of Optical Communication:** Introduction to wave propagation in planar optical waveguides, ray theory, introduction to electromagnetic mode theory, phase and group velocity. [9]

2. **Fiber Configurations and Mode Theory:** Wave propagation in cylindrical fibers, modes and mode coupling, step and graded index fibers, single-mode fibers. [5]

3. **Signal Degradation in Optical Fibers:** Introduction to transmission characteristics of fibers, attenuation, material absorption and scattering loss, bend loss, dispersion, intra modal and intermodal dispersion in step and graded index fibers, overall dispersion in single and multi-mode fibers. [9]

4. **Fiber Fabrication and Fiber Joints:** Preparation of different types of fibers, optical fiber cables and stability of characteristics, Fiber alignment, fiber splices, connectors, couplers. [10]

5. **Optical Fiber Communication Systems:** Fiber amplifiers system, description of an optical fiber communication system, system design, power budget, hybrid fiber coaxial system and WDM technology. [7]

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of Optical Fiber Systems. Able to describe different mechanical and electronic switching systems, telephone networks.
2. Able to describe different types of fibers, losses, dispersion, jointing techniques, fabrication, cabling etc.
3. Able to design various fiber optic communication systems.

Text Books:
1. John M. Senior, Optical Fiber communications, Pearson Education, 3rd Edition, 2009.
2. Gerd keiser, Optical Fiber communication, Tata McGraw Hill, 5th Edition, 2013.

EC 19.414	Business Support System – Intelligent Network (BSS-IN)	Total Lecture: 40 3-0-0-3

Objectives:
1. To acquire knowledge on advanced intelligent networks
2. To get acquainted with different protocols like TCP/IP/SCTP.

Pre-requisites: Linux Basic, Database Basic, TCP/IP Basic.

1	**Introduction to Telecom Market:** Customer and Vendors, How Adds and promotion benefits, Statistics (Postpaid/Prepaid).	**[2]**
2	**GSM Basic and Evolution:** Architecture, Call Flows (Cover RAN/CORE/IN), OSI/SS7 Basic, Evolution (2G to 5G)	**[4]**
3	**Intelligent Network Overview:** Common Charging Architecture - High Level Common Architecture, Charging Mechanisms, Charging Functions- Offline Charging Funtions; Offline Charging Funtions; Architecture Mapping ,Charging Principles; Charging data generation and quota supervision; Charging information utilization, OCS - Required Functionality, OCS - Reference Model/Architecture, OCS Rating Function, OCS Functionality Message Flows, OCS CDRs, Policy Control And Charging; Reference Architecture; Policy Control Requirements; Reference Points; Functional Entities; PCC Rules; QoS Rules; PCC Procedure and Flows, Refill And voucher management, Subscriber/Customer management - Customer Care	**[11]**
4	**Unit 4*: Billing Mediation and Provisioning Basic** CDR, UDR, TAP files, RAP files, NRTRDE, Billing System architecture (Mediation, usage and tariff database, formatting and rating processes, invoice generation),Types of usage (duration, volume, QoS, day and time, number of events, type of service),Types of rating (batch rating, pre-event rating, post-event rating, backwards rating, prepaid balance management, spending control/unbilled limit), Standard rating functions (staircase, offset, linear), Parameters of billing (usage & recurring &onetime charges, discounts & fees & taxes),Types of billing (regular, on-demand, immediate, simulation, information), Different product features (supports MVNO, real-time discounts, cross discounts, shared balances, multiple balances), Different marketing tools (business partners, bundles and counters, F&F, free units, discounts), Typical Telecom Environment: Multivendor environment, Std Protocols & proprietary Interfaces, Integration challenges, File Mediation fundamentals: ASN.1, Need, Typical Use Cases, Architecture, Event Mediation fundamentals: Diameter, 3GPP, Need, Typical Use Cases, Architecture Provisioning fundamentals: MML, CAI, CAI-3G etc, Need, Typical Use Cases, Architecture	**[12]**
5	**Protocols/Tools and 3PP Services integration with BSS :** TCP/IP/SCTP; Stack Description ; Connection Flow; Messages Flow; Use Cases ,SIGTRAN/SS7; Stack Description; Connection Flow; Messages Flow; Use Cases, DIAMETER; Stack Description; Connection Flow ;Messages Flow; Use Cases, CAMEL ; Stack Description; Connection Flow ;Messages Flow ;Use Cases, Integration With CRBT/MoMo, IVR Services, Practical Example/Use Cases.	**[11]**

Outcomes: After completion of the course, students would be able to
1. apply knowledge on advanced intelligent networks and ideas to engineering applications
2. describe intelligent networks, Protocols/Tools

EC 19.415 **Cellular and Satellite Communication** **Total Lectures: 40**

3-0-0-3

Objective:
1. The student gains the knowledge of the fundamental principles of cellular and satellite communication techniques and basic information about the cellular communication with their practical implementation.
2. This course helps in understanding the design of transmitter and receiver models for the cellular industry as well as defense application.

Pre-requisite: Analog Communication, Digital Communication

1.	**Cellular Communication:** Introduction to cellular communication systems and review of mobile radio propagation	[6]
2.	**Digital Cellular System:** Cellular concept, digital cellular mobile system, GSM architecture, GSM technologies, micro-cellular systems, third generation mobile communication systems and personal communication system.	[8]
3.	**Access Techniques:** Multiple access in cellular system, spread spectrum multiple access, code division multiple access, CDMA standard and IS-95.	[8]
4.	**Communication Satellite and Satellite Link Access:** Orbital mechanism and look angle determination of a satellite, spacecraft subsystem, launching of satellite, communication subsystem and transponder, Satellite link design, multi-beam and regenerative satellite, analog and digital multiple accessing in satellite.	[12]
5.	**Communication Satellite System:** Earth station, VSAT terminals, INTELSAT, INMARSAT, INSAT system and their applications, global mobile satellite system.	[6]

Outcomes:
1. The student will be able to get concepts of cellular communication systems and various satellites.
2. The student will analyze and have to design the different circuits for transmission and reception of signals for cellular communication.

Text Books:
1. Timothy Pratt and Charles W. Bostian, Satellite Communication, Wiley, 1st Edition, 2003.
2. T. S. Rappaport, Wireless Communication, Principles and Practice, 2nd Edition, Pearson Education, 2009.

Reference Books:
1. Ray E. Sheriff, Y. Fun Hu, Mobile Satellite Communication Networks, John Willey & Sons, Edition 3, 2003.
2. Madhavendra Richharia, Satellite Communications Systems: Design Principles, McGraw-Hill, Edition 2, 1999.

EC 19.421 **System Design Using HDL** **Total Lectures: 40**

3-0-0-3

Objective:
1. To acquire fundamental knowledge of designing of digital systems using VHDL.
2. Students will acquire practical working knowledge of creating digital circuits using commercial Computer-Aided-Design (CAD) tools.

Pre-requisite: Knowledge of digital logic and digital circuits are highly desired.

1. **Programmable Logic Design:** ASIC, ROM, PLA, PAL, CPLD and FPGA. [3]
2. **VHDL Based Design and fundamentals:** An overview of VHDL, Role of VHDL in system design, Introduction to CAD tools for system design, Introduction to Xilinx IDE software. Entity and architecture declaration, Introduction to behavioural, dataflow and structural models, package, package declarations and package body. [9]
3. **Basic Elements of VHDL:** Data objects – constant, variable and signal, Data types – scalar and composite, Predefined Operators – logical, relational, shift, adding and multiplying, Overloading – literal and operator. [4]
4. **VHDL Statements:** Process, variable assignment, signal assignment, sequential statements, conditional statements, loop**,** if, case, next statements, assertion and report statements, signal drivers and signal assignment statements, conditional signal assignments, select and generic, Subprograms: Application of functions and procedures, Overloading and signal assignments, Component declaration, Component instantiation. [10]
5. **Combinational and Sequential Circuit Design:** VHDL models of combinational circuits such as Adder, Multiplexer, De-multiplexer, Encoder, Decoder, Code converters, Comparators, Parity generators, Multipliers and implementation of Boolean functions, VHDL Models of sequential such as edge triggered D flip flop, T flip flop and J K flip flop, serial in serial out register, serial in parallel out register, parallel in parallel out register, counter, memory, ALU. [14]

Outcomes: After completion of the course, students would be able to:
1. Identify, formulate, and solve engineering problems
2. To use the technique, skills, and modern engineering tools necessary for engineering practice.

Text Books:
1. J. Bhaskar, VHDL Primer, Pearson Education Asia, 3rd Ed
2. Douglas L. Perry, VHDL Programming by Examples, Tata McGraw Hill, 4th Ed.

References:
1. John F. Wakerly, Digital Design: Principles and Practices, 2016.
2. Peter J. Ashenden, Beginner's guide to VHDL, 2012.

EC 19.422	Nano Electronic Devices	Total Lectures: 40
		3-0-0-3

Objective: In this course modeling aspects of Nano electronic devices are discussed from perspective of circuit applications.

Prerequisite: Electronic Devices and Circuits

3.	**Shrink-down approaches:** Introduction, CMOS Scaling, short channel effects	[2]
4.	**Nano Scale Devices:** The nanoscale MOSFET, Fin FETs, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.), Resonant Tunneling Transistors.	[10]
5.	**Atoms-up approaches:** Molecular electronics involving single molecules as electronic devices, transport in molecular structures, molecular systems as alternatives to conventional electronics (advantages and limitations), Materials for nanoelectronics, nanostructures.	[8]
6.	**Nano-Fabrication and Characterization:** Photolithography, Electron beam Lithography, Advanced Nano-Lithography, Thin-Film Technology, MBE, CVD, PECVD, Atomic Force Microscope, Electron Microscopy (TEM, SEM), Photon Spectroscopy	[10]
7.	**Carbon nanotube electronics & Printed Electronics:** band structure & transport, Overview of Flexible/Printed Electronics: OLEDs, OFETs, Organic Solar Cells, spintronics devices.	[10]

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of Nano scale devices
2. Able to describe different nano fabrication technologies like lithography, photo lithography etc.

Text Books:

1. Introduction to Nanotechnology, C.P. Poole Jr., F.J. Owens, Wiley (2003), C.P. Poole Jr., F.J. Owens, Wiley (2003).
2. Nano electronics and Information Technology (Advanced Electronic Materials and Novel Devices), Waser Ranier ,Wiley-VCH,2003 .

References:

1. Fundamentals of nano electronics by George W Hanson Pearson publications, India 2008

EC 19.423 **Embedded and Real Time Operating Systems** **Total Lectures: 40**

3-0-0-3

Objective:
1. To provide broad understanding of the requirements of Real Time Operating Systems.
2. To make the student understand, applications of these Real Time features using case studies.

Prerequisite: Computer Organization

1.	**Introduction:** Introduction to UNIX/LINUX, Overview of Commands, File I/O, (open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec).	[5]
2.	**Real Time Operating Systems**: Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use	[10]
3.	**Objects, Services and I/O**: Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem	[10]
4.	**Exceptions, Interrupts and Timers**: Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.	[10]
5.	**Case Studies of RTOS**: RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, and Tiny OS.	[5]

Outcomes:
1. Be able to explain real-time concepts such as preemptive multitasking, task priorities, priority inversions, mutual exclusion, context switching, and synchronization, interrupt latency and response time, and semaphores.
2. Able describe how a real-time operating system kernel is implemented.
3. Explain how the real-time operating system implements time management.

Text Books:
1. Qing Li, Real Time Concepts for Embedded Systems, Elsevier, 2011.
2. Rajkamal, Embedded Systems- Architecture, Programming and Design, 2007, TMH.

References:
1. Sri ram V Iyer, Pankaj Gupta, Embedded real time systems programming, TMH, 2004.
2. frank Vahid, Tony D. Givargis, Embedded system design- A unified hardware/software introduction, John Willey, 2002.

EC 19.424 **Advanced Embedded Systems** **Total Lectures: 40**

3-0-0-3

Objective:
1. To teach the Fundamentals on design attributes of functional units of a Processor
2. To discuss on Hardware software partitioning in system design
3. To teach intra & Inter processor Communications
4. To discuss strategies for processor Communications

Prerequisite: Microprocessor Programming and Interfacing

1.	**Introduction to Embedded Hardware and Software:** Terminology – Gates – Timing diagram – Memory – Microprocessor buses – Direct memory access – Interrupts – Built interrupts – Interrupts basis – Shared data problems – Interrupt latency - Embedded system evolution trends – Interrupt routines in an RTOS environment.	[8]
2.	**System Modelling with Hardware/Software Partitioning:** Embedded systems, Hardware/Software Co-Design, Co-Design for System Specification and modelling- Single-processor Architectures	[6]
3.	**Memory:** Memory write ability and storage performance – Memory types – composing memory – Advance RAM interfacing communication basic –	[8]
4.	**Microprocessor interfacing**: I/O addressing – Interrupts – Direct memory access – Arbitration multilevel bus architecture – Serial protocol – Parallel protocols – Wireless protocols – Digital camera example.	[8]
5.	**Concurrent Process Models and Hardware Software Co-Design:** Modes of operation – Finite state machines – Models – HCFSL and state charts language – state machine models – Concurrent process model – Concurrent process – Communication among process –Synchronization among process – Implementation – Data Flow model. Design technology – Automation synthesis – Hardware software co-simulation – IP cores – Design Process Model.	[10]

Outcomes: After completing this module, students will be expected to be able to:
1. Implement a RTOS based embedded system and uunderstand the embedded systems design process.
2. Define a specification for an embedded system.
3. Design an embedded system based on a specification.

Text Books:
1. David. E. Simon, An Embedded Software Primer, Pearson Education, 2001.
2. Frank Vahid and Tony Gwargie, Embedded System Design, John Wiley & sons, 2002.

References:
1. Tammy Noergaard, Embedded System Architecture, A comprehensive Guide for Engineers and Programmers, Elsevier, 2006
2. Raj Kamal, Embedded Systems- Architecture, Programming and Design, Tata McGraw Hill, 2006.

EC 19.425 **ASIC Design** **Total Lectures: 40**

3-0-0-3

Objective: The educational objectives of the ASIC design course are:

1. Graduates who desire to pursue an engineering career in VLSI Design arena will be widely employed in positions they find appropriate and desirable.
2. Graduates who desire to pursue higher degrees will be successful in gaining admission and advancing in programs they find appropriate and desirable

Prerequisite: VLSI Design

1.	**Introduction to ASICs:** Types of ASICs, Design flow, CAD tools used in ASIC design.	[6]
2.	**CMOS logic cells:** Combinational logic cells, Sequential Logic cells, Data path Logic cells, I/O cells, Cell compilers.	[8]
3.	**ASIC Library Design:** Transistor as resistors, Transistor as parasitic capacitance, Logic Effort, library cell design, library architecture.	[8]
4.	**Gate Design**: Gate array cell design, standard cell design, data path cell design.	[6]
5.	**Programmable ASICs:** Antifuse, Static RAM, EPROM, EEPROM technology, Practical issues. DC output, AC output, DC input, AC input, Clock input, Power input, Xilinx I/O Block, Actel ACT routing resources, Elmore's constant.	[12]

Outcomes:

1. Ability to apply in-depth knowledge of VLSI design principles, systems, and devices to the solution of real time problems.
2. Ability to design and evaluate a component or system to meet desired needs within the field of VLSI design.
3. Ability to function as a member of a multidisciplinary team in the solution of engineering problems such as providing CAD solution for device fabrications.

Text Books:

1. Michael John Sebastin Smith, Application - Specific Integrated Circuits – Pearson Education, 6th Ed., 2009.
2. Farzad Nekoogar and Faranak Nekoogar, From ASICs to SOCs: A Practical Approach, Prentice Hall PTR, 2003.

References:

1. S. D. Brown, R. J. Francis, J. Rox, Z. G. Uranesic, Field Programmable Gate Arrays, Kluwer Academic Publishers, 1992.
2. Andrew Brown, VLSI Circuits and Systems in Silicon, McGraw Hill, 1991.

EC 19.431 **Transform Techniques** **Total Lectures: 40**

3-0-0-3

Objective:
1. To provide broad understanding of the Transforms.
2. To make the student understand, applications of Continuous and Discrete wavelet transforms

Prerequisite: Signal Processing and Applications

1.	**Transforms:** Walsh, Hadamard, Haar and Slant Transforms, DCT, DST, KLT,– definition, properties and applications	[10]
2.	**Continuous Wavelet Transform (CWT):** Short comings of STFT, Need for wavelets, Wavelet Basis Concept of Scale and its relation with frequency, Continuous time wavelet Transform Equation- Series Expansion using Wavelets- CWT- Tiling of time scale plane for CWT.	[8]
3.	**Multi Rate Analysis:** Need for Scaling function – Multi Resolution Analysis, Two-Channel Filter Banks, Perfect Reconstruction Condition, Relationship between Filter Banks and Wavelet Basis.	[8]
4.	**Discrete Wavelet Transform (DWT):** DWT, Structure of DWT Filter Banks, Daubechies Wavelet Function, Applications of DWT.	[8]
5.	**Special Topics:** Wavelet Packet Transform, Multidimensional Wavelets, Bi-orthogonal basis- BSplines, Lifting Scheme of Wavelet Generation, Multi Wavelets	[6]

Outcomes: Ability to apply in-depth knowledge of Transforms and wavelets to the solution of real time problems.

Text Books:
1. Raghuveer M. Rao and Ajit S. Bopardikar, Wavelet Transforms-Introduction theory and applications, Pearson Education, Asia, New Delhi, 2003.
2. Soman. K. P, Ramachandran. K.I, Insight into Wavelets from Theory to practice, Prentice Hall India, First Edition, 2004.

References:
1. C. Sydney Burrus, Introduction to Wavelets and Wavelet Transforms, PHI, 1st Edition, 1997.
2. Stephen G. Mallat, A Wavelet Tour of Signal Processing, Academic Press, 2nd Edition, 2006.

EC 19.432 **Digital Image Processing** **Total Lectures: 40**

3-0-0-3

Objective:
1. To provide broad understanding of the Transforms.
2. To make the student understand, applications of Continuous and Discrete wavelet transforms

Prerequisite: Signal Processing and Applications

1.	**Introduction Digital Image processing:** Origin, fundamental steps, Component of Image processing system, Fundamental of digital image: visual perception, Image sensing and acquisition, sampling and quantization, Some Basic Relationships between Pixels Mathematical tools used in image processing.	[6]
2.	**Image Transforms:** Two-dimensional orthogonal & unitary transforms, Properties of unitary transforms, two dimensional discrete Fourier transform, discrete cosine transform, sine transform, Hadamard transform, Haar transform, Slant transform, KL transform	[7]
3.	**Image Enhancement:** Image Enhancement in Spatial domain, Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Image Enhancement in the Frequency Domain, Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering.	[10]
4.	**Image Restoration:** A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering, Geometric Mean Filter, Geometric Transformations.	[10]
5.	**Color Image Processing:** Color Fundamentals, Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening.	[7]

Outcomes:
1. Be able to explain several image enhancement techniques in spatial domain and frequency domain.
2. Able describe noise models and filtering techniques.

Text Books:
1. Digital Image Processing - Rafael C. Gonzalez and Richard E. Woods, 2 Edition, Pearson Education, 2001.
2. Fundamentals of Digital Image Processing - Anil K. Jain, Pearson Education, PHI, 2001

References:
1. Chanda and D. Dutta Majumdar "Digital Image Processing and Analysis", PHI, 2003

EC 19.433 **Adaptive Signal Processing** **Total Lectures: 40**

3-0-0-3

Objective:
1. This course treats adaptive signal processing algorithms for extracting relevant information from noisy signals.
2. The emphasis is on recursive, model based estimation methods for time-varying systems.

Prerequisite: Signal Processing and Applications

1.	**Introduction:** Definition and characteristics, general properties open and closed loop adaptation.	[1]
2.	**Adaptive Linear Combiner:** General description, input signal and Weight vectors, desired response and error performance function, gradient and minimum mean square. Theory of Adaptation with Stationary Signals: Input correlation matrix, Eigenvalues and eigenvectors of the correlation matrix, and their geometrical significance. Basic ideas of gradient search methods, gradient search by Newton's method and method of steepest descent, gradient component estimation by derivative measurement, effects of gradient noise, on weight vector solution, excess MSE, time constant and misadjustment, performance comparison of Newton and S.D. methods.	[12]
3.	**Adaptive Algorithms:** Least mean square algorithm, convergence, learning curve noise in Weight vector misadjustment and performances of LMS algorithms, sequential regression algorithm, adaptive recursive LMS algorithm, random search algorithm.	[10]
4.	**Recursive Least Square Algorithm:** Preliminaries, matrix inversion lemma, exponentially weighted RLS algorithm, update recursion for the sum of weighted error squares, convergence analysis of RLS algorithm	[8]
5.	**Adaptive Filter Structures:** Lattice structures, all poles and all zeroes versions, adaptive lattice predictor. Lattice LMS algorithms, and lattice SER algorithms, adaptive filters with orthogonal signals, DFT and lattice preprocessors	[9]

Outcomes:
1. Design and apply optimal minimum mean square estimators and in particular linear estimators. To understand and compute their expected performance and verify it.
2. Design, implement and apply Wiener filters (FIR, non-causal, causal) and evaluate their performance.
3. Design, implement and apply LMS, RLS, and Kalman filters to given applications.

Text Books:
1. Widrow and Stearns, Adaptive Signal Processing, Pearson Education, 1999.
2. Simon Haykin, Adaptive Filter Theory, Pearson Education, 2008.

References:
1. Cowan & Grant, Adaptive Filters, Prentice Hall, 1985.
2. John R. Treichler, Theory and Design of Adaptive Filters, PHI, 1987.

EC 19.434 **Speech Processing** **Total Lectures: 40**

3-0-0-3

Objective:
1. This course treats speech processing algorithms for extracting relevant information from noisy signals.
2. The emphasis is on Linear Predictive Coding, Homomorphic Speech Processing

Prerequisite: Signal Processing and Applications

1.	**Fundamentals of Digital Speech Processing:** Anatomy & Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulatory Phonetics, The Acoustic Theory of Speech Production- Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals.	[8]
2.	**Time Domain Models for Speech Processing:** Introduction- Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.	[10]
3.	**Linear Predictive Coding (LPC) Analysis:** Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, Comparison between the Methods of Solution of the LPC Analysis Equations, Applications of LPC Parameters: Pitch Detection using LPC Parameters, Formant Analysis using LPC Parameters.	[10]
4.	**Homomorphic Speech Processing:** Introduction, Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, The Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, The Homomorphic Vocoder.	[7]
5.	**Speech Enhancement:** Nature of interfering sounds, Speech enhancement techniques: Single Microphone Approach: spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter, Multi microphone Approach.	[5]

Outcomes:
1. Design and apply optimal Linear Predictive Coding. To understand and compute their expected performance and verify it.
2. Design, implement and apply Speech Enhancement techniques and evaluate their performance.

Text Books:
1. L. R. Rabiner and S. W. Schafer, Digital Processing of Speech Signals, Pearson Education.
2. Douglas O'Shaughnessy, Speech Communications: Human & Machine, 2nd Edition, Wiley India, 2000.

References:
1. Thomas F. Quateri, Discrete Time Speech Signal Processing: Principles and Practice, 1st Edition, PE.
2. Ben Gold & Nelson Morgan, Speech & Audio Signal Processing, 1st Edition, Wiley.

EC 19.435 **Digital Signal Processors and Architecture** **Total Lectures: 40**

3-0-0-3

Objective: To give an exposure to the various fixed point & a floating point DSP architectures and to develop applications using these processors

Prerequisite: Signal Processing and Applications

1.	**Introduction to Digital Signal Processing:** Introduction, A Digital signal Processing System, The sampling process, Discrete time sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time invariant systems, Digital filters, Decimation and interpolation, Analysis and Design tool for DSP systems -MATLAB	[8]
2.	**Computational Accuracy in DSP Implementations:** Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A / D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.	[8]
3.	**Architectures for Programmable DSP Devices and Pipelining:** Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing. Execution Control and Pipelining: Hardware looping, Interrupts, stacks, Relative branch support, Pipelining and Performance, Pipeline depth, interlocking, branching effects, Interrupt effects, Pipeline Programming models.	[12]
4.	**Programmable Digital Signal Processors:** Commercial Digital signal -Processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory Space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and programming, On -Chip Peripherals, Interrupts of TM320C54XX Processors, Pipeline Operation of TM320C54XX Processors.	[6]
5.	**Interfacing Memory and I/O Peripherals to Programmable DSP Devices:** Memory space organization, External bus interfacing signals, Memory Interface, Parallel I/O interface, Programmed I/O Interupts and I/O, Direct memory access (DMA), A Multichannel buffered serial port (McBSP), McBSP Programming, a CODEC interface circuit, CODEC programming, A CODEC DSP interface example.	[6]

Outcomes: By the end of the course the student will be able to:

1. Recognize the fundamentals of fixed and floating point architectures of various DSPs.
2. Learn the architecture details and instruction sets of fixed and floating point DSPs
3. Infer about the control instructions, interrupts, and pipeline operations.

Text Books:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing, Thomson Publications, 2004.
2. B. Venkata Ramani and M. Bhaskar, Digital Signal Processors, Architecture, Programming and Applications, TMH, 2004.

References:

1. Sen M. Kuo & Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, 2004.
2. Lapsleyet, DSP Processor Fundamentals, Architectures & Features, S. Chand & Co., 2000.

EC-19. 308 **Antenna and Wave Propagation** **Total Lectures: 40**
3-0-0-3

Objective: To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications and RADAR.

Pre-requisite: Principles of Electromagnetics

1. **Introduction**: Basic properties of transmitting, and receiving antenna, gain, bandwidth, and polarization, Effective aperture and Friss transmission formula. [4]

2. **Physical Concept of Radiation:** Retarded potentials hertzian dipole, antenna parameters, radiation pattern, gain, directivity, effective aperture, reciprocity and radiation from dipoles of arbitrary length. [6]

3. **Theory of Array Antenna: A**rrays of point sources, Endfire and Broadside arrays, Log-periodic, Yagi-uda arrays, Analysis of Rhombic antenna. Design of Rhombic Antennas, Loop Antenna: Radiation from small loop and its radiation resistance. Helical antenna: Normal and axial mode operation. synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method. [10]

4. **Frequency Independent Antenna:** Slot, horn antenna, parabolic antenna, aperture antennas and microstrip antenna: Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas. [8]

5. **Wave Propagation:** Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, Sky wave propagation- propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, troposphere propagation, Super refraction, antenna for aeronautical mobile systems, cell-site and mobile antenna, adaptive antennas. [12]

Outcomes: After completion of the course, students will be able to

1. Select the appropriate portion of electromagnetic theory and its application to antennas.
2. Distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.
3. Assess the need for antenna arrays and mathematically analyze the types of antenna arrays.
4. Distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.
5. Outline the factors involved in the propagation of radio waves using practical antennas.

Text Books:

1. C. A. Balanis, Antenna Theory and Design, John Wiley & Sons, 3rd Ed, 2005.
2. W. L. Stutzman, and G. A. Thiele, Antenna Theory and Design, John Wiley & Sons, 2nd Ed, 1998.

Reference Books:

1. R. E. Collin, Antennas and Radio Wave Propagation, Tata McGraw-Hill, 5th Edition, 2017.
2. K.D. Prasad, Antenna and Wave Propagation, Satya Prakashan, 3rd Edition, 2003

EC-19.301 **Microprocessor and Microcontroller** **Total Lectures: 40**
3-0-0-3

Objective: To develop an in-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques.

Pre-requisite: Digital electronics

1. **The 8086 Microprocessor Architecture :** Architecture, details of sub-blocks such as EU, BIU; memory segmentation and physical address computations, pin diagram and description of various signals, minimum and maximum mode of operations, supporting chips viz. 8284, 8288 and memory mapping [8]

2. **Programming of 8086:** Addressing modes of 8086, instruction set of 8086, assembly language programming, counters and time delays, stack structure of 8086 and subroutine. [7]

3. **Interfacing of 8085 / 8086 with Programmable Chips:** Interfacing of 8255 Programmable peripheral interface, 8251 USART, 8253/8254 Programmable Interval Timer and Direct Memory Access Controller 8237/8257 DMA, 8259 Programmable Interrupt Controller. [8]

4. **Introduction to Microcontrollers, Architecture and Memory Interfacing:** Overview of the 8051 family, 8051 Microcontroller's Architecture, Pin configuration, Common memory types and Tradeoffs, External Memory interfacing. [7]

5. **Programming and Interfacing of 8051:** Addressing modes of 8051, instruction set of 8051, assembly language programming of 8051, stack structure of 8085, delays, and subroutines, Applications of interrupts, timer/counter and serial port, Components of Integrated Development Environment for software development, Interfacing of 8051 with sensors, Keyboard, ADC, DAC, LCD, Stepper Motor and D.C motor [10]

Outcomes: Upon completion of this course, the student will be able to:

1. The student will learn the internal organization of some popular microprocessors and microcontrollers.
2. The student will learn hardware and software interaction and integration and memory.

Text Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Application with the 8085, Penram International Publishing, 6th Edition, 2013.
2. M. A. Mazidi, The 8051 Microcontroller & Embedded Systems, Pearson Education, 2nd Edition, 2006.

Reference Books:

1. I. Scott McKenzie and Raphael C.W. Phan, The 8051 Microcontroller, Pearson Education, 4th Edition, 2007.
2. D. V. Hall, Microprocessors and Interfacings; TMH, 3rd Edition, 2012.

EC-19.302 **VLSI Design** **Total Lectures: 40**

3-0-0-3

Objective:
1. Graduates who desire to pursue an engineering career in VLSI Design arena will be widely employed in positions they find appropriate and desirable.
2. G Graduates who desire to pursue higher degrees will be successful in gaining mission and advancing in programs they find appropriate and desirable.

Pre-requisites: Electronics Devices and Circuits, Digital Electronics.

1. **Basic VLSI Design Issues:** IC design techniques- hierarchical design, design abstraction and computer-aided design [4]

2. **MOS Transistor Theory:** Current-voltage characteristics of MOSFETS, threshold voltage and body effect, MOSFET design equations, second order effects, MOSFET capacitances [8]

3. **NMOS and CMOS Inverter:** NMOS and CMOS inverters, W/L ratio for NMOS and CMOS inverters, β_n/β_p ratio, noise margin, NMOS and CMOS Voltage transfer Characteristics, CMOS delay and power dissipation [8]

4. **MOS Inverter's Switching Characteristics:** Calculation of delay times, Inverter design with delay constraints [6]

5. **Stick Diagram & VLSI Circuit Design Techniques:** Stick diagrams, CMOS design style, design rules: lambda based design rules, layout design, Inverter equivalent of series and parallel MOS circuits, logic design with delay and power constraints, worst case design, complex logic design [14]

Outcomes:
1. Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing fundamental areas of VLSI design.
2. Ability to apply in-depth knowledge of VLSI design principles, systems, and devices to the solution of real time problems.
3. Ability to design and evaluate a component or system to meet desired needs within the field of VLSI design.

Text Books:
1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI, 3rd Edition, 2011.
2. Neil H.E. Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 4th Edition, 2011.

Reference Books:
1. Jab M. Rabaey, Anantha Chandra Kasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI, 2nd Edition, 2012.
2. Michal John Sebastian Smith, Application-Specific Integrated Circuits, Pearson Education, 6th Edition, 2009.

EC-19.303 **Principles of Analog Communication** **Total Lectures: 40**
3-0-0-3

Objective:
1. To develop a fundamental understanding on communication systems with emphasis on analog modulation techniques.
2. To appreciate the mathematical concepts that form the foundations of analog communication

Pre-requisite: Signals and Systems, Statistics and Probability Theory

1. **Linear Modulation Techniques:** Basic blocks of communication systems, Review of signals and systems, Linear Modulation, Time domain and frequency domain description of AM (DSB-FC), DSB-SC, SSB and VSB signals. Generation and detection of linear modulation techniques, Super-heterodyne receivers and design. [12]
2. **Angular Modulation Techniques:** Basic concepts, Frequency Modulation Spectrum Analysis of FM Wave, Generation and detection of narrow band and wide band frequency modulation, Phase modulation, FM detection techniques-phase locked loops, Commercial broadcasting systems. [8]
3. **Sources of Noise and their characterization:** Random Variables, Random process and their characterization. Noise in Analog communication System. SNR calculations for synchronous detection of DSB and SSB and envelope detection of AM, SNR calculations for angle modulation system. Pre-emphasis and de-emphasis. Threshold effect in angle modulation. [8]
4. **Multiplexing and Multiple Access Techniques:** Frequency division Multiplexing, time division multiplexing, multiple access techniques. [5]
5. **Sampling and Pulse Modulation:** Sampling theorem – ideal and natural sampling and reconstruction, Pulse-Amplitude Modulation, Pulse-Time Modulation. [7]

Outcome: Upon completion of this course, the student will be able to:
1. Apply the basic knowledge of signals and systems and understand the basics of communication system and analog modulation techniques.
2. Evaluate the communication system performance in the presence of noise and summarize the merits and demerits of all the conventional analog modulation system.

Text Books:
1. B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford university press, 4th Edition, 2009.
2. Taub and Schilling, Principles of Communication Systems, TMH, 4th Edition, 2013.

Reference Books:
1. Kennedy, Davis, Electronic Communication Systems , TMH, 6th Edition, 2017.
2. S. Haykins, Communication Systems , Wiley , 5th Edition, 2009.

EC-19.304 **Advance Radio Access Network (ARAN)** **Total Lectures: 40**
3-0-0-3

Objective: To acquire skills on different legacy and advance RAN's Architecture, Design & Optimization along with latest industries concepts on 5G, IOT, Volte, RAN Cloud etc.

Prerequisite: Digital Modulation Techniques & Data Transmission, Antenna and Wave Propagation, Basics of Mobile Communication

1. **Basics of Mobile Communication:** Microwave Theory, Propagation Models, Modulation Theory, Antenna Theory [4]

2. **Introduction to RAN:** Telecom E2E approach, RAN Life Cycle**,** RF basics,. Latest Industry Concepts – 5G, IOT, Volte, RAN Cloud [4]

3. **RAN Overview**: Introduction to Cellular Concepts, Introduction to Power Control, Introduction to Protocol Stacks, GSM, WCDMA, LTE (Overview, Architecture, Air Interface), Generalized Call Flows [12]

4. **RAN Design:** RF Design Overview, Initial Radio Network Design (Link Budget, Radio Network Dimensioning & Nominal Design), Final Radio Network Design, Radio Planning Tools & IBS Introduction, Radio Propagation Model Tuning, LRAN Initial Radio Network Design (Sample Report) [10]

5. **RAN Optimization:** Pre Launch Optimization (Process Overview, Introduction to Drive Testing (Data Collection Methodology, Data Post Processing),Post Launch Optimization, (Process Overview, Introduction to Counters and OSS, KPI Improvement Methodology) [10]

Outcome: After completion of this course, students would be able to

- Understand the industry level ways of working of RAN with different design and optimization techniques.
- Students will get heads up in terms of upcoming advance technology concepts.

Text Books:

1. Ericsson Academy (Ericsson Internal)
   - Air Interface
   - Protocol and Procedures
   - GSM, UMTS, LTE Fundamentals
   - RAN Design & Performance Management.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2007.

Reference Books:

1. John G. Prokis and Masoud Salehi, Digital Communication, McGraw-Hill, 5th Edition, 2008.
2. J. Schiller, Mobile communications, Pearson, 2nd Edition, 2004.

EC-19.305 **Signal Processing and Applications** **Total Lectures: 40**
3–1–0-4

Objective:

- To understand the fundamental characteristics of continuous- and discrete-time signals and systems in terms of both the time and transform domains and to develop the mathematical skills to solve problems involving convolution and sampling.

Pre-requisite: Mathematics I

1. **Representation and classification of Signals**: Signal classification - Continuous and discrete time, Periodic - aperiodic, even - odd, energy - power, Deterministic - random, real valued - complex exponential, sinusoidal, time scaling, time shifting, Sampling and discrete time processing of continuous-time signals, Concept of frequency in continuous-time and discrete-time signals. [6]
2. **Basics of Systems and Transformation**: Properties of systems – linearity, time invariant, causal, stable, inverse, static and dynamic, system impulse response, convolution, correlation, Transformation - Fourier series, continuous time and discrete time Fourier transform, Laplace transform, z-transform, its properties, limitations and inverse transforms, pole – zero concept, computation of impulse response and transfer function using transforms. [6]
3. **Analysis of Continuous time and discrete time systems:** Block diagram representation, linear time-invariant (LTI) systems, interconnection of LTI Systems, discrete time systems and their types, systems with finite and infinite duration impulse response, recursive and non-recursive structures, system realizations in direct , transpose, cascade and parallel forms. [8]
4. **DFT, FFT and DCT Algorithms:** Discrete Fourier transform (DFT), linear convolution using DFT, efficient computation of the DFT - Fast Fourier transform (FFT) algorithms, radix-2 & 4 FFT algorithms, discrete cosine transform (DCT) - DCT-1 and DCT-2, energy compaction property of DCT. [10]
5. **Digital Filter Design:** Review of analog filters – comb and notch types, Design of infinite Impulse Response (IIR) filter from analog filters - Bilinear and Impulse invariant transformation, Finite Impulse Response (FIR) filter - amplitude & phase responses, linear phase filters, transversal filters, windowing techniques, comparison between IIR and FIR filters. [10]

Outcome: After completion of the course, students will be able to

- Understand the process of sampling and spectral characteristics of periodic and aperiodic signals using Fourier analysis and determine the response of LTI system using Fourier analysis convolution.

Text Books:

1. A.V. Oppenheim, A.S. Willsky and S.H. Nawab, Signals and Systems, PHI, 2nd Edition, 1997.
2. S. K. Mitra, Digital Signal Processing A Computer Based Approach, Tata McGraw-Hill, 4th Edition, 2013.

Reference Books:

1. Michel J. Robert, Fundamentals of Signals and Systems, MGH International Edition, 2008.
2. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, Pearson Education, 4th Edition, 2012.

EC-19.306 **Digital Communication** **Total Lectures: 40**

3-0-0-3

Objective: The objective of this course is to introduce the students to the basic concepts of digital communication. The aim of this course is to study the fundamental aspects of digital communication systems. The understanding of the fundamentals of digital communication by studying theory, numerical and implementation of circuits.

Pre-requisite: Basics of Communication Systems and Techniques.

1. **Model of a Communication System:** Introduction, advantages of digital communication over analog communication, probability theory random process and random variables. **[6]**

2. **Digital Communication Techniques:** Sampling theorem and techniques, uniform and non-uniform quantization techniques, PCM, DPCM, DM, and ADM, compression standards **[8]**

3. **Multiplexing:** time division multiplexing and synchronization, Digital multiplexing hierarchy, Electrical representation of binary sequences Bandwidth requirement of PCM. **[2]**

4. **Information Theory and Coding:** Channel capacity, Shannon capacity, source entropy, Shannon-Fano, Huffman coding, linear block codes and syndrome decoding, cyclic codes, BCH codes, convolution, Viterbi coding and decoding. **[10]**

5. **Digital Modulation Techniques:** Base-band transmission, inter-symbol interference and adaptive equalization, digital modulation and demodulation techniques, bandwidth consideration of different digital modulation schemes, matched filter and probability of error analysis, carrier and timing recovery techniques. **[14]**

Outcome: After completion of the course, students will be able to

1. The students can understand the concepts of digital communication.
2. They acquire and apply the knowledge to implement the concepts for designing an efficient communication system.
3. They become able to identify, analyse and implement new ideas in digital communication systems for proposing alternate solutions.

Text Books:

1. B. P. Lathi, Modern Digital and Analog communication Systems, Oxford University Press, 4th Edition, 2018.
2. Taub and Schilling, Principles of Communication Systems, TMH, 4th Edition, 2013.

Reference Books:

1. Kennedy, Davis, Electronic Communication Systems , TMH, 6th Edition, 2017.
2. S. Haykins, Communication Systems , Wiley , 5th Edition, 2009.

EC-19.307 **Microwave Engineering** **Total Lectures: 40**
3-0-0-3

Objective: To acquire fundamental knowledge of Microwave and apply in engineering applications.

Pre-requisite: Electromagnetic Field Theory

1. **Introduction:** Microwaves, Generation: Brief idea of microwave tubes and microwave solid state devices, properties and applications. [3]

2. **Microwave Circuits:** Equivalent voltage and current definition in waveguides, concept of impedance, impedance matrix, admittance matrix, scattering matrix and transmission matrix**.** [7]

3. **Microwave Passive Devices:** Excitation of waveguides through probes, loops and apertures. Terminations: matched loads and short, attenuators, phase shifters, two hole directional coupler, E-plane tee, H-plane tee, magic tee, microwave propagation in ferrites, isolators and circulators. [10]

4. **Microwave Active Devices:** Reflex Klystron, Two cavity Klystron, Travelling Wave Tubes, Magnetrons, Gyrotron, construction, operation and practical applications of Gunn diode, Tunnel diode and IMPATT diode**.** [14]

5. **Microwave Measurements:** Detection of microwaves, measurement of microwave power, impedance, frequency, VSWR, Q-factor and scattering parameters. [6]

Outcome: After completion of the course, students would be able to apply microwave concepts and equations in engineering and solve voltage and current equations.

Text Books:

1. David M. Pozar, Microwave Engineering, John Willey & sons, 3rd Edition, 2005.
2. Samuel Y. Liao, Microwave devices and Circuits, Pearson Education, 3rd Edition, 2008.

Reference Books:

1. Annapurna Das & Sisir K Das, Microwave Engineering, Tata McGraw-Hill, 3rd Edition, 2014.
2. M. L. Sisodia and G. S. Raghuvanshi, Microwave Circuits and Passive Devices, New Age Publication, 1st Edition, 2017.

EE 19. 303 **Control System Engineering** **Total Lectures: 40**

3-0-0-3

Objective: The student gains the knowledge of the fundamental principles of analog and digital control system engineering, time response and frequency response analysis with its practical implementation. This course helps in understanding the design of Compensator and PID controller for the Automatic control of Industry.

Pre-requisite: Mathematics, Network Analysis & Synthesis

1. **Introduction:** Industrial control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of feedback. [8]

2. **Reduction Techniques:** Block diagram reduction and signal flow graph representation of systems. [4]

3. **Time Domain Analysis:** Standard test signals, time response of 1st and 2nd order systems for standard test inputs, time domain design specifications i.e. rise time, peak time, delay time, peak overshoot, settling time and steady state error etc., different types of feedback systems, Steady state errors for unit step, unit ramp and unit parabolic inputs. **C**oncept of stability: conditions for stable system, relative and marginal stability, Routh-Hurwitz criterion. Root-Locus technique. Construction of Root-loci. [12]

4. **Frequency Domain Analysis:** Relationship between time and frequency response. Polar plots. Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Introduction to Controller Design: Frequency-domain methods of design. Application of conventional Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers. [12]

5. **State Variables:** Analysis of systems, state vector, state space, advantages of state space techniques, state space representation, State variable analysis and design. [4]

Outcome: At the end of this course, students will demonstrate the ability to

- Understand the concept of stability and its assessment for linear-time invariant systems.
- Design simple feedback controllers.
- Knowledge of stability analysis and improvement of stability for control system.
- Benefit the graduates who wish to work in core sector industry as most of the core sector is state-of-art control.

Text Books:

1. K. Ogata, "Modern Control Engineering," Pearson Education/Prentice Hall of India, 4th Edition, 2003.
2. I. J. Nagrath and M. Gopal, "Control System Engineering," New Age International Publishers, 2nd Edition, 2003.

Reference Books:

1. Syed Hasan Saeed, "Automatic Control Systems (with MATLAB Programs)," S.K. Kataria & Sons Publishers, 6th Edition, 2008.
2. Samarjit Ghosh, "Control Systems: Theory and Applications," Pearson Education, 2nd Edition, 2012.

EE 19.203 **Network Analysis & Synthesis** **Total Lectures: 40**
3-0-0-3

Objective: This course helps in analysis of A.C & D.C circuits and it also help to design the circuit models for the minor and major projects.

Pre-requisite:

1. **Network Theorems:** Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks. [10]

2. **Solution of First and Second Order Networks:** Solution of first and second order differential equations for Series and parallel R-L, R-C, RL-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer. [8]

3. **Electrical Circuit Analysis Using Laplace Transforms:** Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances. [8]

4. **Two Port Network:** Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks. [6]

5. **Synthesis of Passive Network:** Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [8]

Outcome: At the end of this course, students will demonstrate the ability to

- Apply network theorems for the analysis of electrical circuits.
- Obtain the transient and steady-state response of electrical circuits.
- Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
- Analyse two port circuit behavior.

Text Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.

Reference Books:

1. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
3. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

EE-19.304 **Power Electronics** **Total Lectures: 40**
3-0-0-3

Objective:
- To introduce to students the theory and applications of power electronics systems for high efficiency, renewable and energy saving conversion systems
- To prepare students to know the characteristics of different power electronics switches, drivers and selection of components for different applications
- To develop students with an understanding of the switching behavior and design of power electronics circuits such as DC/DC, AC/DC, DC/AC and AC/AC converters

Prerequisite: Network Analysis and Synthesis, Basics of Electronics Engineering, Engineering Mathematics

1. **Introduction to Power Devices:** Review of power semiconductor devices, SCR, Static and dynamic characteristics, Turn-on and Turn-off methods and circuits, Ratings and protection of SCRs, Series and parallel operation of thyristor, Other members of thyristor family. [8]

2. **Controlled AC to DC Converter:** Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits, Single phase dual converters and their operation with circulating and non-circulating currents. [10]

3. **Controlled AC to AC Converter:** AC Voltage Controllers - Types of single-phase voltage controllers, Single phase voltage controller with R and RL type of loads, gate pulse requirements to trigger the SCRs of ac voltage controllers. Cycloconverters - Principles of operation, Single phase to single phase step up and step down cycloconverters. Three phase to single phase cycloconverter. [10]

4. **Controlled DC to DC Converter:** Introduction to dc chopper, Principle of chopper operation, Control strategies, Types of choppers and its operation. [5]

5. **Controlled DC to AC Converter:** Introduction to inverter, Single phase VSI: half bridge and full bridge inverters. Three phase bridge inverters with 180 degree and 120 degree modes of operation, Series and parallel inverters, Introduction to current source inverters. [7]

Outcome:
- The student will be able to understand the principle of operation of commonly employed power electronic converters
- The student will be capable of analyzing non-linear circuits with several power electronic switches
- The student will be equipped to take up advanced courses in Power Electronics and its application areas

Text Books:
1. Rashid, M., "Power Electronics", Prentice Hall of India Private Limited, 4th Edition, 2006.
2. P.S. Bimbhra, "Power Electronics," Khanna publishers, 5th edition, 2012.

Reference Books:
1. Mohan, N., Undel, T.M. and Robbins, W. P., "Power Electronics: Converter Applications and Design," John Wiley and Sons, 3rd Edition, 2007.
2. Jain, A., "Power Electronics and its Applications," Penram International Publishing (India) Pvt. Ltd., 4th Edition, 2008.
3. Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.N.K., "Thyristoried Power Controllers," New Age International (P) Limited, Publishers, 2nd Edition, 2004.

MA 19.201 **Mathematics III** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

Pre-requisite: Mathematics I and Mathematics II

1. **Linear Programming:** Introduction with formulation; Graphical method; Simplex method, Artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). [12]

2. **Numerical Methods:** Solution of system of equations (Gauss elimination and Gauss -Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector, Runge-Kutta method of order four). [08]

3. **Complex Analysis:** Function of complex variable, analytic function, Cauchy- Riemann equations(without proof); Integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula(without proof), zeros and singularities of complex functions, residues. [08]

4. **Integral Transform I**: Basics of Laplace transform and inverse Laplace transform; First and Second Shifting theorems; Convolution theorem (without proof); Laplace transform of Unit Step function, Dirac Delta function and periodic function. [06]

5. **Integral Transform II**: Solution of ordinary differential equations with initial conditions by Laplace transforms; Fourier series of periodic functions, even and odd functions, Fourier half-range series; Basics of Fourier transforms with properties. [06]

Outcome: After completion of the course, students would be able to apply the knowledge of linear programming, numerical methods, complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.
3. Jain R.K. and S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 2003.

MA 19.202 **Statistics and Probability Theory** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

Pre-requisite: Mathematics I, Mathematics II, and Mathematics III

1. **Introductory Ideas:** Recapitulation of basics of permutation, combination and probability theory; Law of addition and law of multiplication; Conditional probability; Total probability; Bayes' theorem (with proof)and it's applications. [08]

2. **Random Variables and Distribution:** Discrete and continuous random variables; Types of distributions with basic properties; Probability mass and density functions; Cumulative distribution function; Mean, variance and standard deviation of distributions; Discrete types (Binomial and Poisson) and Continuous types (Normal, Uniform and Exponential); Applications of basic ideas of these distributions. [10]

3. **Sampling and Testing of Hypothesis:** Sampling distribution of mean and variance; Central limit theorem; Simple and Composite hypothesis; Type I and Type II errors with graphical interpretations; Level of significance and tests of significance for large and small samples with applications. [08]

4. **Correlation and Regression:** Simple, partial and multiple correlations; Linear regression with applications. [06]

5. **Queuing Theory and Queuing Models:** Birth and death process; Pure birth and pure death process; Classification of queuing models: $[(M/M/1):(FCFS/\infty/\infty)]$, $[(M/M/1):(SIRO/\infty/\infty)]$, $[(M/M/1):(FCFS/N/\infty)]$, $[(M/M/C):(FCFS/\infty/\infty)]$; Applications of queuing models. [08]

Outcome: After completion of the course, students would be able to apply the knowledge of Statistics and Probability theory in engineering and solve curriculum problems.

Text Books:

5. S.Palaniammal, Probability and Random Processes, PHI, 2013.
6. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH, 2018.
2. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, 2002.
3. Dass and Verma, Higher Engineering Mathematics, S. Chand, 2019.

RM 19.101 **Research Methodology** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): Communication Skills

Objective(s):

- To understand a general definition of research design.
- To identify the overall process of designing a research study from its inception to its report.
- To be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- To understand the primary characteristics of quantitative research and qualitative research.
- To identify a research problem stated in a study

1. **Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research. [6]
2. **Problem Formulation:** Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature, Research Gaps. [10]
3. **Research Design:** Research Framework, Meaning & Significance of Research Designs, Features of a good Research Design, Types of Research Design. [10]
4. **Data Analysis and Simulation Tool:** Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis, SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [12]
5. **Report Writing:** Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [2]

Outcome(s): On successful completion of this course, the students will be able to

- Assess critically the following methods: literature study, case study, structured surveys, interviews, focus groups, participatory approaches, narrative analysis, cost-benefit analysis, scenario methodology and technology foresight.

Text Books:

1. R. Pannershelvam, "Research Methodology" Prentice Hall India, New Delhi, 2nd Edition, 2013.
2. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International (p) Limited, Publishers New Delhi, 4nd edition, 2018.

Reference Books:

1 William G.Zikmund, "Business Research Methods", Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, "Research Methods for Business Students" Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, "Business Research Methods" Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013

UC 19.201 **Introduction to Management and Leadership** **Total Lectures: 26**
2-0-0-2

Objective: This Course, Management and leadership focus on understanding seminal and contemporary leadership theories and principles. To provide a basis of understanding to the students with reference to the working of the business organization through the process of management.

Pre-requisite:

1. **Introduction to Management :** Nature of Management, Meaning, Definition, it's nature purpose, importance & Functions, Management as Art, Science & Profession-Management as social System Concepts of management-Administration-Organization **[4]**
2. **Evolution of Management Thought:** Contribution of F.W.Taylor, Henri Fayol ,Elton Mayo , Chester Barhard & Peter Drucker to the management thought. Various approaches to management (i.e. Schools of management thought)Indian Management Thought. **[5]**
3. **Functions of Management:** Planning - Meaning - Need & Importance, types levels - advantages & limitations. Organizing - Elements of organizing & processes, Delegation of authority - difficulties in delegation – Decentralization, Staffing - Meaning & Importance, Controlling - Process & Techniques, Coordination - Need – Importance. **[6]**
4. **Introduction to Leadership**: Leadership styles, qualities of a good leader, role of a leader, trait approach to leadership, behaviour approaches to leadership; Situational theories; Transformational Leadership transactional leadership, Neutralizers and substitutes to leadership. **[6]**
5. **Emerging Challenges to Leadership**: Leadership in changing workplace, Leader's role in fostering teamwork, Overcoming traditional thinking Methods to enhance creative problem solving, Climate for creative thinking, Leadership practices for innovation, Ethical leadership development, Cultural sensitivity, intelligence, and global leadership skills. **[5]**

Outcome: On successful completion of the course, students will be able to Work effectively and collaboratively with others in diverse management contexts.

Text Books:

1. Dr. L.M.Parasad, "Principles & practice of management", Sultan Chand & Sons - New Delhi, 2015
2. Stephen P.Robbins "Organizational Behavior" Pearson Publisher,16th Edition, 2014

Reference Books:

1. Principles of Management, By Tripathi, Reddy Tata McGraw Hill, 2012
2. Essential of Business Administration - K.Aswathapa Himalaya Publishing House, 2014
3. Hughes, R., Ginnett, R., & Curphy, G. Leadership: Enhancing the lessons of experience, McGraw Hill, 7th Edition, 2017
4. Northouse, P. G. "Leadership: Theory and Practice" Sage Publications, New Delhi, 7th Edition 2015.

UC 19.202 **Business Environment** **Total Lectures: 26**
2-0-0-2

Objective: To familiarize the students about the background of the spectrum of business and its environment (internal and external).

Pre-requisite: Good General knowledge.

1. **Dimensions of Business Environment**: Nature and characteristics of contemporary business; Types of business environment - general and task environment, Internal (Value system, Organization structure, Human Resource, Company image and brand value, Physical assets) and external Environment (micro and macro), Environmental analysis and strategic Management. [5]
2. **Social Environment**: Concept and salient features of Indian culture and values, Impact of culture on business, Cultural resources, Ethics and social responsibility of business, Consumerism. [5]
3. **Political and legal Environment*:*** Impact of competing political ideologies and role of government, Political Stability and Instability on Business Activities, Legal framework for establishing a business unit in India, Competitive Conditions, Foreign Direct Investment in India. [5]
4. **Economic Environment**: Economic systems – Market, Planned and Mixed economy; Indian economy – overview; Economic reforms in India; Economic policies – Determinants of National Income, Privatization, Fiscal policy and Monetary policy. [6]
5. **Technological Environment:** Features of technology; Impact of technology; Management of technology; status of technology in India; Policy for research and development in India. [5]

Outcome: Understanding real life situations vis-à-vis economic, social, legal, political and technological systems in the country and analyzing the impact of changes on different industries and trends in different sectors of the economy and society.

Text Books:
3. Business Environment, Francis Cherunilam, 1st Edition, 2018.
4. Essentials of Business Environment, K Aswathappa, HPH, 12th Edition, 2014.

Reference Books:
5. Business Environment, BN Ghosh, OUP, 2015
6. Business Environment: Text & Cases (3rd Edition), Justin Paul, McGraw Hill, 2016.
7. Business Environment, AC Fernando, Pearson, 2016

EE 19.101 **Elements of Electrical Engineering** **Total Lectures: 40**
3-1-0-4

Objective: This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

Pre-requisite: Nil

1. **DC Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation using mesh and nodal method. Network Theorems - Superposition, Thevenin, Norton and Maximum power transfer Theorems. Time-domain analysis of first-order RL and RC circuits. [8]

2. **AC Circuits:** Basic terminologies, representation of sinusoidal waveforms, average, rms and peak values of a.c. quantities, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). [8]

3. **Three Phase A.C. Circuits:** Three phase supply, phase sequence, star connection, delta connection, relationship between phase and line quantities in 3-phase circuits, measurements of three phase power under balanced condition. [6]

4. **Transformers:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, Transformer testing: open circuit and short circuit test, losses in transformers, regulation and efficiency. Basics of auto-transformer and three-phase transformer connections. [10]

5. **Electrical Machines:** DC Machines – construction, functions of each part, working principle, EMF and torque equations, types of dc machines. AC machines – classification of a.c. machines, construction, operating principles of ac machines. [8]

Outcome: At the end of this course, students will demonstrate the ability to

- To understand and analyse basic electric and magnetic circuits.
- To study the working principles of electrical machines.

Text Books:

1. Kothari, D. P., and I. J. Nagrath, "Theory and Problems of Basic Electrical Engineering," PHI Learning Pvt. Ltd., 1998.
2. Fitzgerald, Arthur Eugene, David E. Higginbotham, and Arvin Grabel, "Basic electrical engineering," McGraw-Hill Series in Electrical Engineering, Auckland: McGraw-Hill, 1981, 5th ed.(1981).

Reference Books:

1. H.Cotton, "Advanced Electrical Technology," CBS Publication. 1967.
2. Vincent Del Toro, "Electrical Engineering Fundamentals," 2nd Edition PHI Publication. 1972.
3. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", PHI Publication, 1st Edition, 2007.

EE 19.201 **Electrical Machines-I** **Total Lectures: 40**
3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction details and performance of D.C machines and Transformer.

Pre-requisite: Elements of Electrical Engineering

1. **Basic Concepts of Electrical Machines:** Introduction, Electromagnetic induction, flux linkage, statistically and dynamically induced emf, Classification and description of electrical machines, Generator and motor principles, Leakage flux, Losses and efficiency, Rating and loss dissipation, Electrical and mechanical degrees, Heating and cooling of electrical machines. [8]

2. **Introduction to D.C. Machines:** Constructional parts of d.c. machines and their function, Principle of operation, Armature winding: Lap and wave, Simplex and duplex, Method of excitation, Classification, Derivation of emf and torque equations, Process of commutation, Armature reaction, Interpoles, Compensating winding and equalizer rings. [6]

3. **D.C. Generators:** Operating characteristics: Magnetization, Internal and external characteristics, Critical resistance and critical speed, Process of building up of voltage, Causes of failure of voltage build-up and remedies, Parallel operation of d.c. generators, Applications. [7]

4. **D.C. Motors:** Basic equation for voltage, Power, Torque and speed, Condition for maximum power, Operating characteristics: Torque-current, Speed-current and Torque-speed characteristics. Comparison, Starters, Speed control methods, testing of d.c. machines: Swinburne, Hopkinson's and Series field tests. Calculation of efficiency, Applications. [7]

5. **Transformers:** Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses. Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Three-winding transformers. Cooling of transformers. [12]

Outcome: At the end of this course, students will demonstrate the ability to

- Understand the concepts of magnetic circuits.
- Understand the operation of dc machines.
- Analyse the differences in operation of different dc machine configurations.
- Analyse single phase and three phase transformers circuits.

Text Books:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

Reference Books:

1. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
2. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

EE 19.202 **Electrical Machines-II** **Total Lectures: 40**
3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction and performance of A.C machines and synchronous machines.

Pre-requisite: Electrical Machine-I

1. **Fundamentals of AC Machine Windings:** Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor. [8]
2. **Pulsating and Revolving Magnetic Fields:** Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field. [6]
3. **Induction Machines:** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines. [12]
4. **Single Phase Induction Motors:** Constructional features double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications. [5]
5. **Synchronous Machines:** Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division. [9]

Outcome: At the end of this course, students will demonstrate the ability to

- Understand the concepts of rotating magnetic fields.
- Understand the operation of ac machines.
- Analyse performance characteristics of ac machines.

Text Books:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

Reference Books:

1. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
2. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
4. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

EE 19.203 **Network Analysis and Synthesis** **Total Lectures: 40**
3-0-0-3

Objective: This course helps students in analyzing the A.C & D.C circuits and it also provides design exposure to circuit models for minor and major projects.

Pre-requisite: Elements of Electrical Engineering (EE 19.101)

1. **Network Theorems:** Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks. [10]
2. **Solution of First and Second Order Networks:** Solution of first and second order differential equations for Series and parallel R-L, R-C, RL-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer. [8]
3. **Electrical Circuit Analysis Using Laplace Transforms:** Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances. [8]
4. **Two Port Network:** Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks. [6]
5. **Synthesis of Passive Network:** Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [8]

Outcome: At the end of this course, students will demonstrate the ability to

- Apply network theorems for the analysis of electrical circuits.
- Obtain the transient and steady-state response of electrical circuits.
- Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
- Analyse two port circuit behaviors.

Text Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.

Reference Books:

1. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
3. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

EE 19.204 **Electrical Measurement and Instrumentation** **Total Lectures: 40**
3-0-0-3

Objective: To make students conversant with concepts of measurement and various electrical and electronics instruments, transducers and bridges.

Pre-requisite: Basic Electrical engineering, Basic Electronics Engineering

1. **Concepts of Measurements:** Introduction, accuracy and precision, repeatability, errors in measurement, sources of errors, types of errors, statistical analysis of measurement data, graphical representation of measurement, data as distributions, Gaussian graph and precision indices. [8]
2. **Analog Instruments:** Types of operating torques in an analog instrument, Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Shunts and multipliers. Applications of instruments for measurement of single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment. [10]
3. **Bridge:** DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, De-Sauty Bridge, Wein bridge. [7]
4. **Transducers:** Introduction , Classification, Selection Criteria, Characteristics, Construction, Working Principles and applications of following Transducers- RTD, Thermocouples, Thermistors, LVDT, Strain Gauges. [7]
5. **Potentiometers and Instrument Transformers:** Crompton's DC and AC polar and coordinate types. Applications, Electronic Multi-meter, Q meter, Vector Impedance meter. Oscilloscope in frequency, phase and amplitude measurements. Instrument transformers. Ratio and Phase angle errors and their reduction. [8]

Outcome: Students will be able to understand electrical and electronic measuring devices and instrumentation like bridges, transducers, CRO etc.

Text Books:

1. J. B. Gupta , "Electrical Measurements and Measuring Instruments", S. K. Kataria & Sons, Reprint Edition, 2012.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai and Co., 2005.

Reference Books:

1. Albert D. Helfrick, Wiliam D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning Private Limited, 2011.
2. Prithwiraj Purkait, Budhaditya Biswas, Santanu Das, Chiranjib Koley, "Electrical and Electronics Measurements And Instrumentatio", McGraw-Hill Education, 1st Edition, 2013.
3. F.W. Golding and Widdis, Electrical Measurements and Measuring Instruments, 5th Edition, 2010.

EE 19.501 **Energy Resources** **Total Lectures: 40**

3-1-0-4

Objective:
- To provide an exposure on various concepts of Non-renewable and renewable energy and also its domestics and industrial applications
- To understand the environmental and economic aspects of renewable energy sources

Prerequisite: Power Plant Engineering

1. **Commercial Energy:** Coal, Oil, Natural Gas, Nuclear power and Hydro – their utilization pattern, future projections of energy consumption, environmental impact of fossil fuels, Energy scenario in India – Growth of energy sector and its planning in India. [8]
2. **Bio Energy:** Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion - direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, types of biogas Plants, applications, alcohol production from biomass, bio diesel production, Urban waste to energy conversion, Biomass energy program in India. [8]
3. **Solar Energy:** Solar radiation at the earth's surface, measurements and estimation of average solar radiation, solar thermal flat plate collectors, concentrating collectors, solar thermal applications, solar electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells, Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant, Net metering concept. [8]
4. **Wind Energy:** Nature of the wind, power in the wind, factors influencing wind, wind data and energy estimation, wind speed monitoring, wind resource assessment, Betz limit, site selection, wind energy conversion devices, classification, applications, safety and environmental aspects, wind energy potential and installation in India -Repowering concept. [8]
5. **Other Types of Energy:** Ocean energy resources, principle of ocean thermal energy conversion (OTEC), ocean thermal power plants, ocean wave energy conversion, tidal energy conversion, small hydro, geothermal energy, geothermal power plants, hydrogen production and storage, Fuel cell: principle of working, various types, construction and applications. [8]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understanding of commercial energy and renewable energy sources
- Knowledge in working principle of various energy systems
- Capability to do basic design of renewable energy systems

Text Books:
1. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill, 4th edition2006.
2. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, 3rd edition, 2012.

Reference Books:
1. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 6th Edition 2011.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd, 2nd Edition, 2006.

EE 19.502 **Energy Management and Auditing** **Total Lectures: 40**
3-1-0-4

Objective:
- To provide a broad knowledge on current energy scenario and audit for various applications.
- To acquire the in-depth knowledge of the Energy management systems.

Prerequisite: Renewable Energy System

1. **Energy Scenario**: Role of Energy Managers in Industries , Energy monitoring, auditing & targeting , Economics of various Energy Conservation schemes, Total Energy Systems [8]
2. **Energy Audit**: Various Energy Conservation Measures in Steam, Losses in Boiler. Energy Conservation in Steam Systems, Case studies. [8]
3. **Basics of Energy Conservation:** Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor, energy consumption & energy saving potentials, Design consideration. [8]
4. **Refrigeration & Air conditioning:** Heat load estimation, Energy conservation in cooling towers & sprays ponds; Case studies Electrical Energy, Energy Efficiency in Lighting, Case studies. [8]
5. **Energy Management:** Organizational background desired for energy management motivation, detailed process of M&T-Thermostats, Boiler controls, proportional, differential and integral control, optimizers; compensators. [8]

Course Outcome: Upon successful completion of this course, students should be able to
- Perform energy audit on the systems and know in depth the energy management systems.

Text Books:
1. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.
2. Reay D.A, Industrial Energy Conservation, 1st Edition, Pergamon Press, 6th edition, 2008.

Reference Books:
1. L. C Witte, Philip S. Schmidt, D. R. Brown, Industrial Energy Management & Utilization, Hemisphere Publisher Corp., 1st edition, 1988.
2. Power System Engineering 2nd Ed. D P Kothari, I J Nagrath, McGraw-Hill, 4th edition, 2008.

EE 19.503 **Solar Energy Engineering** **Total Lectures: 40**
3-1-0-4

Objective:
- To develop the ability to understand / analyze the various solar energy design principles.
- To study the various applications of solar energy and storage systems.

Prerequisite: Renewable Energy System.

1. **Introduction:** Source of radiation, solar constant, solar charts, Measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder. [5]

2. **Solar Non-Concentrating Collectors**: Design considerations, Classification- air, liquid heating collectors, Derivation of efficiency and testing of flat plate collectors, Analysis of concentric tube collector, Solar green house. [6]

3. **Solar System Design**: Classification, Concentrator mounting, Focusing solar concentrators, Heliostats. Solar powered absorption A/C system, water pump, chimney, drier, dehumidifier, still, cooker. [12]
Photo-Voltaic Cell: Characteristics-cell arrays-power electric circuits for output of solar panels, choppers, inverters, batteries-charge regulators, Construction concepts.

4. **Energy Storage**: Sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change-Glauber's salt-organic compounds. [10]

5. **Solar Energy Applications**: Introduction and principle of operation of solar cooker, solar air heater, solar water heater, solar distillation, solar pond, solar thermal power generation – Greenhouse - Solar PV system. [7]

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze and design the solar energy system with energy storage devices and perform the selection based on techno-economic view point.

Text Books:
1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003.
2. Edward E. Anderson, "Fundamentals for solar energy conversion", Addison Wesley Publ. Co., 2nd Edition 2000.

Reference :Books
1. G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable energy Sources", Narosa Publishing House, New Delhi, 4th Edition,2007.
2. Energy Studies, Second Edition, by W. Shepherd and D. W. Shepherd, Imperial College Press, London,3rd Edition, 2004.

EE 19.504 **Wind Energy Technology** **Total Lectures: 40**

3-1-0-4

Objective: To provide the current status, importance, future trends and potential for Wind energy technologies as a complement to, or replacement for, conventional technologies.

Prerequisite: Renewable Energy System

1. **Wind Resource:** Wind characteristics: Meteorology of wind – wind speed distribution across the world – spatial and temporal factors – Eolian features - Biological indicators. Wind measurement: Anemometers – balloon trackers. Wind energy conversion systems (WECS) - classifications. [8]

2. **Wind Energy Conversion:** Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and Strip theory; Maximum power coefficient; Prandlt's tip loss correction; Rotor design and characteristics; Power, torque and speed characteristics – Wind turbine performance measurement – Loading analysis. [8]

3. **Wind Turbines Types:** Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator. [8]

4. **Wind Energy Application:** Wind pumps: Performance analysis, design concept and testing; Principle of Wind Energy Generators; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies. [8]

5. **Cost Economics**: Wind resource assessment and R & D costs, Fixed and variable costs, Value of wind energy, Life cycle costing and cash flow of wind power projects, Wind project owners / developers, Wind energy market. [8]

Course Outcome: Upon successful completion of this course, students should be able to

- Understand the atmospheric processes that produce wind energy.
- Explain the fundamental principle of wind turbine operation.
- Analyze the economics of wind energy.
- Explain recent commercial developments in wind energy and its future potential.

Text Books:

1. S. Rao & B. B. Parulekar, Energy Technology, Khanna publishers, 4th Edition, 2005.
2. T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, Wind energy Handbook, John Wiley & Sons, 6th Edition, 2011.

Reference Books:

1. Mukund. R. Patel, Wind and Solar Power Systems, Taylor & Francis, 2nd Edition 2001.
2. L .L. Freris, Wind Energy Conversion Systems, Prentice Hall, 4th Edition, 2010.

EE 19.505 **Advanced Energy Storage System** **Total Lectures: 52**
4-0-0-4

Objective:
- To develop the ability to understand / analyze the various types of energy storage.
- To study the various applications of energy storage systems.

Prerequisite: Power Plant Engineering

1. **Introduction:** Necessity of energy storage, types of energy storage, comparison of energy storage technologies, Applications. [7]

2. **Thermal Storage System:** Thermal storage, Types, Modelling of thermal storage units, Simple water and rock bed storage system, pressurized water storage system, Modelling of phase change storage system, Simple units, packed bed storage units, Modelling using porous medium approach, Use of Transys. [9]

3. **Electrical Energy Storage:** Fundamental concept of batteries, measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries, Lead Acid, Nickel-Cadmium, Zinc Manganese dioxide and modern batteries: zinc-Air, Nickel Hydride, Lithium Battery. [12]

4. **Fuel Cell:** Fuel Cell, History of Fuel cell, Principles of Electrochemical storage, Types, Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis, advantage and drawback of each type. [10]

5. **Alternate Energy Storage Technologies:** Flywheel, Super capacitors, Principles & Methods, Applications, Compressed air Energy storage, Concept of Hybrid Storage, Applications. [14]

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze various types of energy storage devices and perform the selection based on techno-economic view point.

Text Books:
1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons, 2nd edition, 2011.
2. Ru-Shiliu, Leizhang, Xueliang Sun, Electrochemical technologies for energy storage and conversion, Volume 1 & 2, Wiley publications,2nd Edition, 2012.

Reference Books
1. James Larminie and Andrew Dicks, Fuel cell systems Explained, Wiley publications, 1st edition, 2003.

EE 19.506 **Solar Photovoltaic Engineering** **Total Lectures: 40**

3-1-0-4

Objective:
- To attain a broad comprehension of solar photovoltaic systems used for various applications.
- To know in depth the types and design of various PV-interconnected systems.

Prerequisite: Renewable Energy System

1. **Photovoltaic Basics:** Structure and working of Solar Cells - Types, Electrical properties and Behavior of Solar Cells – Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays -Basics of Load Estimation. [8]

2. **Stand Alone PV Systems:** Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications - Typical applications for lighting, water pumping etc. [8]

3. **Grid Connected PV Systems:** Site selection and land requirements - Techno-economic analysis of solar PV power plants - Environmental considerations. Schematics, Components, Charge Conditioners, Interface Components - Balance of system Components - PV System in Buildings. [8]

4. **Design of PV Systems:** Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability - Simple Case Studies. [8]

5. **Solar Economics:** Application of economic methods to analyze the feasibility of solar systems to decide project / policy alternatives - Net energy analysis - and cost requirements for active and passive heating and cooling - for electric power generation - and for industrial process-heating. [8]

Course Outcome: Upon successful completion of this course students will be able to
- Explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems.

Text Books:
1. CS Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2nd Edition 2011.
2. Martin A. Green, Solar Cells: Operating Principles, Technology and System Applications, Prentice- Hall, 4thEdition, 2011.

Reference Books:
1. Nelson J., The Physics of Solar Cells, Imperial College Press, 2nd Edition, 2003.
2. Thomas Markvart, Solar Electricity, John Wiley and Sons, 2nd Edition, 2012.

EE 19.507 **Biomass and Small Hydel Plants** **Total Lectures: 52**
4-0-0-4

Objective:
- To provide understanding of the processes for converting biomass feedstocks to fuels by various approaches.
- To learn to evaluate technological, economic and business dimensions of energy production from biomass.
- To provide understanding of energy generation from small hydro power plant and hydel power plants management.

Prerequisite: Renewable Energy Sources

1. **Biomass Resources and Biomass Properties:** Biomass: definition, classification, availability, estimation of availability, consumption and surplus biomass, energy plantations. Potential of biomass and assessment. [8]
2. **Energy Conversions Techniques:** Thermo chemical conversion: Direct combustion, incineration, pyrolysis and gasification; Biomass stoves, improved chullahs and some exotic designs, Biological conversion: Biodegradation and biodegradability of substrate; Biochemistry and process parameters of biomethanation; Biogas digester types; Digester design and biogas utilisation; Bioconversion of substrates into alcohol: Methanol & ethanol Production, Chemical conversion: Hydrolysis and hydrogenation; Solvent extraction of hydrocarbons; Bioethanol; Chemicals from biomass. [11]
3. **Bio Diesel:** History, Production methods of Bio-diesel: Transesterification, Fuel quality, standards and properties, Availability of Raw materials for bio-diesel, Applications, Bio-diesel potential in India. [8]
4. **Waste To Energy** Introduction to Energy from waste, classification of waste as fuel, agro based, forest residue, industrial waste, Environmental monitoring system for land fill gases, Environmental impacts; Measures of mitigate environmental effects due to incineration. [7]
5. **Hydro Power:** Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works. [9]
6. **Hydel Plant Management:** Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in North East India. [9]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understand the challenges and problems associated with the use of various bioenergy sources with regard to future resource and the environment.
- Evaluate the cost-benefit of various biomass energy conversion processes.
- Identify remedies/potential solutions to the supply and environmental issues associated with biomass based energy resources.
- Conceptualize energy generation techniques and understand different small hydro power plant and hydel power plants management.

Text Books:
1. Capareda S, Introduction to biomass energy conversion, CRC Press, 4thEdition, 2014.
2. Harvey A. & Brown A, Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes. Practical Action publication, 2nd Edition, 2003.

Reference : Books
1. Brown RC and Stevens C, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons, 4th Edition, 2011.

EE 19.508 **Environmental Impact of Energy System** **Total Lectures: 52**

4-0-0-4

Objective: To achieve environmental improvements and know the environmental values and behavior.

Prerequisite: Power Plant Engineering.

1. **Impact of Energy Systems on Environment:** Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants. Methods of Environmental Impact Assessment. [12]
2. **Pollution Due To Thermal, Hydel and Nuclear Power Plants:** Potential sources of Pollution in thermal power plant, Air, water, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control. Various pollution control equipments such as dust collector, bag filter, electrostatic separator, working principle and selection criteria, designing the pollution control system, methods and limitation. Water pollution in thermal power plant, physical and chemical methods of pollution control, Land pollution effect of land pollution, measurement of land pollution. Limitations and advantages of pollution control systems. Hydrothermal plant environmental assessment, hydrothermal plant and rehabilitation measures for hydrothermal plant. Nuclear power plants and environmental pollution, pollution control measures. Effect of Hydroelectric power stations on ecology and environment. [14]
3. **Industrial and Urban Waste & Waste Energy Recovery:** Industrial waste, Waste and effluent treatment, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy. Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control. [10]
4. **Environmental and Pollution Control Laws:** United Nations Framework Convention on Climate Change (UNFCC), Protocol, Conference of Parties (COP) 19 Clean Development Mechanism (CDM), Prototype Carbon Funds (PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project. [10]
5. **Global Environmental Concern:** Global Environmental Issues, ozone layer depletion, Global Warming, Green House Gases Emission. [6]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understand environmental effects and act accordingly to improve the environmental conditions globally.

Text Books:

1. W. K. Foell, Management of Energy Environment Systems, John Wiley and Sons, 6th Edition, 2013.
2. M.C. MacedoJr, Energy Management and Control Systems, John Wiley and Sons, 4th Edition, 2004.

Reference Books:

1. J. G. Rau, D.C. Wood, Environmental Impact Analysis Handbook, McGraw Hill, 7th Edition, 2005.
2. J. M. Fowler, Energy & Environment, McGraw Hill,, ERIC, 2nd edition, 2009.

EE 19.509 **Power System and Smart Grid** **Total Lectures: 52**

4-0-0-4

Objective:

- To provide the students a systems perspective of modern electricity markets and a systems approach to address various issues faced by the electricity sector.
- To present the student a vision of how Smart Grid will transform the current electricity grid to a reliable and sustainable modern energy system.

Prerequisite: Transmission and Distribution, Power System Analysis.

1. **Supply Side and Demand Side of Electricity:** Basics of electricity, Fossil fuels and hydro power plants, Renewable and alternative energy, Supply curve, Load characteristics, Load curve and load duration curve, Demand side management. [11]
2. **Transmission and Distribution Network:** Physical law of electricity, AC vs. DC power flow, Optimal Power flow and unit commitment models, Distribution network basics. [10]
3. **Basic Elements of Smart Grid:** The origin of power grid, dependency on power grid, desirable features of power grid, reliability, security, economic, efficiency, environmental friendly, safety. [11]
4. **Key Characteristics of Smart Grid:** Demand-side participation, Impact of Smart Grid on reliability, Impact of Smart Grid on air pollutant emissions reduction. [10]
5. **Issues Related to Smart Grid:** Communication and sensing in a smart grid, smart grid threats, vulnerabilities, cyber security strategies. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Gain Knowledge about the economic fundamentals of power systems and electricity markets.
- Understand the concepts of various components of Smart Grid, and their impacts on the energy industry, including renewable integration, demand side management, and greenhouse gas emission reduction.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 4th Edition, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 4th Edition, 2009.

Reference Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2017.

EE 19.510 **Power System for Renewable Energy Sources** **Total Lectures: 52**
4-0-0-4

Objective: To know the grid integration of renewable energy sources, different machines, and power electronics devices uses in renewable energy power plants.

Prerequisite: Power System Analysis, Renewable Energy System.

1. **Introduction To Renewable Energy Grid Integration:** Concept of mini/micro grids, and smart grids. Review of synchronous generators, Introduction to power system stability problems: rotor angle stability, voltage stability and voltage collapse, classification of stability. Modelling of synchronous machines: transformations, synchronous machine representation in stability studies. [12]

2. **Introduction To Induction Machines:** Electrical characteristics, slip, speed torque characteristics etc. Self-excited induction generator, Constant speed Induction generators, Variable speed Induction generators, Doubly fed Induction generators. [10]

3. **Introduction To Power Electronic Devices:** AC/DC converters, PWM, THD. Permanent magnet synchronous generator, solar PV systems, fuel cell, aqua electrolizer. [10]

4. **Issues in Integration of Different Generators:** Issues in integration of synchronous generator based, induction generator based and converter based sources together. Network voltage management (discusses the issue of voltage levels). [10]

5. **Power Quality Management:** Voltage dips, harmonics and flickers. Frequency management. Influence of WECS on system transient response – IEEE standard and Polices. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Analyze the power quality management in renewable power plants.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 2nd Edition, 2009.

Reference : Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2006.

EE 19.512 **Power Electronics for Renewable Energy Source** **Total Lectures: 52**

4-0-0-4

Objective:
- To impart knowledge on Standalone, Grid connected and Hybrid renewable energy systems.
- To understand the different types of Electrical Machines and Power Converters employed for renewable energy conversion systems

Prerequisite: Power Electronics, Renewable Energy System.

1. **Introduction:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission), Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. [12]

2. **Electrical Machines For Renewable Energy Conversion:** Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG. [8]

3. **Power Converters:** Solar: Block diagram of solar photo voltaic system, Principle of operation: line commutated converters (inversion-mode), Boost and buck-boost converters, selection of inverter, battery sizing, array sizing, Wind: three phase AC voltage controllers, AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. [12]

4. **Analysis of Wind and PV Systems:** Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system, Grid connection Issues, Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system. [10]

5. **Hybrid Renewable Energy Systems:** Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Wind-PV, Maximum Power Point Tracking (MPPT). [10]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understand the concepts of Standalone, Grid connected and Hybrid Energy System
- Understand different types of Electrical Machines and Power Converters employed for Renewable Energy Conversion Systems.

Text Books:
1. Leon Freris, David Infield, Renewable Energy in Power Systems, John Wiley & Sons, 2008.
2. Rashid .M. H, Power Electronics Hand book, Academic press, 1st edition, 2007.

Reference Books:
1. Rai. G.D, Non-Conventional Energy Sources, Khanna publishes, 2nd Edition, 2010.
2. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, John Wiley & Sons, 4th Edition, 2011.
3. S. N. Bhadra, D. Kastha, Wind Electric Systems, Oxford University Press, 5th Edition, 2005.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of ME

Course structure for

B.Tech ME

ME 19.201 **Mechanics of Solids** **Total Lectures: 40**

Credit 3-0-0-3

Prerequisite (s): ME 19.101, MA 19.101

Objective(s):

- *To acquaint with the basic concepts of stress and deformation in solids.*
- *To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.*
- *Learn the fundamental concepts of the method of superposition, flexibility method, and stiffness method as applied to problems involving statically determinate and indeterminate axial and torsional members, and beams.*

1. **Compound Stress and Strains:** Introduction, objective of the course, stresses on inclined sections, strain energy, impact loads and stresses, state of plane stress, principal stress and strain, maximum shear stress, Mohr's stress circle, three dimensional state of stress & strain, generalized Hook's law. **[6]**

2. **Beams:** Axial force, shear force and bending moment diagrams for statically determinate (uniform and variable loading) beams including beams with internal hinges for different types of loading. Pure Bending**,** normal stresses in beams, shear stresses in beams due to transverse and axial loads, composite beams. Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams, combined bending & torsion of solid & hollow shafts. **[12]**

3. **Columns, Struts and Trusses:** Buckling and stability, slenderness ratio, combined bending and direct stress, struts with different end conditions, Euler's theory for pin ended columns, effect of end conditions on column buckling, Rankine Gordon formulae, examples of columns in mechanical equipments and machines. Truss- Introduction, simple truss and solution of simple truss, method of joints and method of sections. **[10]**

4. **Thin and Thick cylinders:** Introduction, difference between thin walled and thick walled pressure vessels, Thin walled cylinders, hoop and axial stresses and strain, volumetric strain. **[6]**

5. **Curved Beams:** Bending of beams with large initial curvature, position of neutral axis for rectangular and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression. **[6]**

Outcome(s):

- Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems for simple tri- dimensional elastic solids.
- Solve problems relating to pure and non-uniform bending of beams and other simple structures.
- Solve problems relating to torsional deformation of bars and other simple tri- dimensional structures.
- Understand the concept of buckling and be able to solve the problems related to isolated bars.

AHEP4 Mapping with Module outcomes	• C2: Student will understand the engineering mechanics principles and apply them to analyze the practical problems. • C3: Student can identify the analytical approach to describe the simple mechanical components. • C5: Student can apply advanced problem-solving skills, technical knowledge and understanding, to establish rigorous and creative solutions that are fit for purpose for all aspects of the problem.

Text Books:

1. R.K. Bansal, "A textbook of strength of materials", New Delhi: Laxmi Publications, 2010
2. Khurmi, R. S., "Strength of Materials: Mechanics of Solids". S. Chand Limited, 2005

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.202 **Kinematics of Machines** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME 19.101

Objective(s):

- *To provide basic concept of kinematics and kinetics of machine elements.*
- *Know different machine elements and mechanisms.*
- *Select Suitable Drives and Mechanisms for a particular application.*
- *Develop ability to come up with innovative ideas.*

1. **Basics Of Mechanisms:** Terminology and definitions - degree of freedom mobility, Kutzbach criterion, Grashoff's law, kinematic inversions of 4-bar chain and slider crank chains, mechanical advantage, transmission angle, description of common mechanisms- single, double and offset slider mechanisms, quick return mechanisms, straight line mechanism. **[8]**

2. **Kinematics:** Displacement, velocity and acceleration analysis in simple mechanisms- Graphical Method of velocity and acceleration analysis for different mechanisms- instantaneous centre of velocity - angular velocity ratio theorem. coriolis acceleration. **[8]**

3. **Kinematics of Cam:** Classifications, displacement diagrams, parabolic simple harmonic and cycloidal motions, layout of plate cam profiles, derivatives of follower motion, high speed cams, circular arc and tangent cams, standard cam motion, pressure angle and undercutting. **[8]**

4. **Friction drives:** Introduction, belt and rope drives, open and crossed belt drives, velocity ratio, slip, power transmission, effect of mass of belt on power transmission, maximum power transmission, initial tension and maximum tension, pivots and collars, uniform pressure and uniform wear. **[8]**

5. **Gears:** Spur gear terminology and definitions, fundamental law of toothed gearing and involutes gearing, inter changeable gears, gear tooth action, terminology, interference and undercutting , non-standard gear teeth , helical, bevel, worm, rack and pinion gears (basics only), gear trains , parallel axis gear trains, epicyclic gear trains, differentials , automotive transmission gear trains. **[8]**

Outcome(s):

- Identify mechanisms and predict their motion.
- Calculate the degrees of freedom of mechanisms.
- Draw velocity and acceleration diagrams of various mechanisms.
- Construct CAM profile for the specific follower motion.
- Select appropriate power transmission mechanism.

AHEP4 Mapping with Module outcomes	• C2: Student can understand of engineering principles and the ability to apply them to analyse key engineering processes. • C3: Student can describe the performance of systems and components through the use of analytical methods • C4: Student can understand of the use of technical literature and other information sources

	• C5: Student can investigate and define the problem, identifying any constraints. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems. • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Rattan S. S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Edition 2014.

2. Shigley J. E and Uicker J.J, "Theory of Machines and Mechanisms", Oxford University Press, 5th Edition 2017.

Reference Books:

1. Thomas B, "Theory of Machines", Pearson Education India, 3rd Edition 2010.

2. Norton R. L, "Kinematics and dynamics of machinery", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1st Edition 2009.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.203 **Engineering Thermodynamics** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): MA 19.101

Objective(s):

- *Identify and use units and notations in thermodynamics*
- *State and illustrate the first and second laws of thermodynamics*
- *Identify and explain the concept of entropy, enthalpy, specific energy, reversibility and irreversibility*
- *Apply the first and second laws of thermodynamics to formulate and solve engineering problems for (i) closed systems, (ii) open systems, and (iii) power cycles*
- *Ability to understand and effectively communicate the fundamentals of thermodynamic analyses and to articulate the basic environmental, economic, and sustainability considerations to the non-thermodynamicist*
- *Use thermodynamic (steam) tables, charts, and equation of state (e.g. the ideal gas law) to obtain appropriate property data to solve thermodynamics problems*

1. **Basic Concepts and Definitions:** Introduction and definition of thermodynamics, dimensions and units, systems, surroundings, property, energy, thermodynamic path, process and cycle, thermodynamic equilibrium, quasi static process, energy and its forms, work and heat, gas laws. **[8]**
   Zeroth and First Law of Thermodynamics: Zeroth law of thermodynamics, temperature scale, First law of thermodynamics, calculation of work in various processes and sign convention, first law of thermodynamics applied to open systems, steady flow systems and their analysis, steady flow energy equations for boilers, condensers, turbine, compressors, pumps and throttling process, etc., PMM-I.

2. **Second Law of Thermodynamics:** Limitations of first law of thermodynamics, thermal reservoir, heat engine, heat pump and refrigerator, statement and equivalence of the Kelvin Plank and Clausius statements, reversible and irreversible processes, Carnot cycle, Carnot engine, Carnot theorem and its corollaries, thermodynamic temperature scale, PMM-II. **[10]**
   Entropy: Clausius inequality, concept of entropy, calculation of entropy change, principle of entropy increase, temperature-entropy diagram, Second law analysis of a control volume, statement of third law of thermodynamics, available and unavailable energy, availability and irreversibility, second law efficiency.

3. **Properties of Steam**: Pure substance, property of steam, triple point, critical point, sub-cooled liquid, saturation states, superheated states, phase transformation process of water, graphical representation of P-V-T data, Properties of steam. Steam tables and Mollier chart. **[8]**
   Ideal Gas and Real Gas: Ideal gas, Real gas, Internal energy, enthalpy and specific heats of an ideal gas, equations of state, Dalton's law of partial pressures, Gibbs Dalton law, Thermodynamic properties of gas mixtures.

4. **Thermodynamic Relations:** Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation**.** **[8]**
   Power Cycles: Otto cycle, Diesel cycle, Dual cycle, Brayton cycle and Ericsson cycle.

5. Vapour Power Cycle: Rankine cycle, comparison of Carnot and Rankine cycle, modified Rankine cycle, effect of operating conditions on its efficiency, properties of ideal working fluid in vapour power cycle, Reheat cycle, regenerative cycle, bleeding extraction cycle, feed water heating co-generation cycle. **[6]**

Outcome(s):

- *Understand the thermodynamics implication and thermodynamics explanation for the states of matter.*
- *Understand and apply basic energy conservation equations for kinetic, potential and flow energies.*
- *Understand the concepts of enthalpy, entropy and the basic laws of thermodynamics.*
- *Understand and solve thermodynamic cycle problems, including the Carnot ideal cycle, the Otto cycle, the Diesel Cycle, Rankine and Brayton*
- *Understand thermodynamic tables, charts, and equation of state (e.g. the ideal gas law) to obtain appropriate property data to solve thermodynamics problems*

AHEP4 Mapping with Module outcomes

- C1: Student will understand and knowledge of mathematical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical, tools and notations proficiently in the analysis and solution of engineering problems.
- C2: Student will understand the engineering thermodynamics principles and apply them to analyze the practical problems.
- C3: Student will able to identify, classify and describe the performance of thermodynamic systems and components through the use of analytical methods and modelling techniques.
- C4: Student will understand the use of technical literature and other information sources.
- C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems.

Text Books:

1. Nag, P.K, "Engineering Thermodynamics", Tata McGraw-Hill, 5th Edition. 2013

2. Cengel Y.A and Boles M.A, "Thermodynamics: An Engineering Approach", Tata McGraw Hill, 7th Edition 2011.

Reference Books:

1. Sonntag, R. E, Borgnakke C. and Van Wylen G.J, "Fundamentals of Thermodynamics", John Wiley, 7th Edition. 2009

2. Moran, M. J and Shapiro H. N, "Fundamentals of Engineering Thermodynamics", John Wiley & Sons, 6th Edition. 2010.

ME 19.204 **Fluid Mechanics** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.101

Objective(s):

- *To know properties of fluid.*
- *To calculate hydrostatic forces on submerged surfaces.*
- *To apply Bernoulli equations.*
- *To calculate friction losses in pipes.*
- *To apply conservation of mass, momentum & energy principle.*
- *To apply boundary condition for different conditions.*

1. **Introduction:** Physical properties of fluids, concept of shear stress, Newtonian and Non-Newtonian fluids **[8]**
   Fluid Statics: Pressure-density-height relationships, manometers, force on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform acceleration and uniform rotation about the axis.
2. **Kinematics of Fluid Flow:** Types of fluid flow, stream lines, streak lines, path lines, stream tubes, stream function and velocity potential, flow nets. **[10]**
   Dynamics of Fluid Flow: Euler's equation of motion along a streamline and its integration, Bernoulli's equation and momentum equation. Boundary Layer Analysis, Boundary Layer Thickness, Boundary Layer over a flat plate.
3. **Dimensional Analysis And Hydraulic Similitude:** Dimensional analysis, Buckingham's pi theorem, important dimensionless numbers and their significance, geometric, kinematic and dynamic studies. **[8]**
   Flow Past Immersed Bodies: Lift and drag, expressions for lift and drag.
4. **Flow Through Pipes:** Laminar and turbulent flow in pipes, general equation for head loss-Darcy-Weisbach and Fanning's equations, Moody's diagram, energy losses through pipe fitting, flow through network of pipes, power transmission through pipelines. **[7]**
5. **Fluid Flow Measurements:** Introduction, venturimeter, orifice meter, Pitot tube, notches and weirs. **[7]**
   Introduction To Compressible Flow: Velocity of sound in a fluid, Mach number, propagation of pressure waves in a compressible fluid

Outcome(s):

- *An understanding of fluid mechanics fundamentals, including concepts of mass and momentum conservation.*
- *An ability to apply the Bernoulli equation to solve problems in fluid mechanics.*
- *An ability to apply control volume analysis to problems.*
- *An ability to use potential flow theory to solve problems.*
- *An ability to perform dimensional analysis for problems.*
- *Knowledge of laminar and turbulent boundary layer fundamentals.*

AHEP4 Mapping with Module outcomes	• C2: Student can understand of fluid mechanics principles and the ability to apply them to analyse key engineering processes. • C4: Student can understand of the use of technical literature and other information sources.

Text Books:

1. Som S and Biswas G, "Introduction to Fluid Mechanics and Fluid Machines",Tata McGraw-Hill, 2nd Edition, 2007.

2. Bansal R. K., "Fluid Mechanics and Hydraulic Machines" Laxmi PublicationPvt. Ltd. 2005.

Reference

1. Young D. F, Munson B, Okiishi T. H and Huebsch W. W, "Fundamentals of Fluid

ME 19.205 **Material Science** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): PY 19.101

Objective(s):

- *To acquaint students with the basic concepts of Material Science.*
- *To impart the knowledge on mechanical behaviour of materials.*
- *To acquire knowledge in various class of materials (like Ferrous, Non-Ferrous Alloys and Advanced Materials) and their applications.*
- *To impart knowledge on Heat Treatment, Microstructure and Phase diagrams.*
- *To acquire knowledge in destructive and non-destructive testing of materials.*

1. **Introduction to Engineering Materials & Material Structure:** Introduction to engineering materials, development in materials science, classification of material, crystal structures (BCC, FCC and HCP systems), imperfections in crystals, point defects, line defects, surface and bulk defects, slip, twinning. **[8]**

2. **Phase Diagrams:** Solid solutions, binary alloy system, lever rule, Iron-carbon equilibrium diagram, TTT diagrams**.** **[8]**

3. **Heat Treatment:** Annealing, normalizing, tempering, hardening (case hardening and surface hardening). **[8]**

4. **Engineering Materials:** Ferrous metals, alloy steels, tool steels, stainless steels, cast irons, effect of alloying elements on mechanical properties of steel. Copper and i ts alloys, aluminium and their alloys, bearing materials. Polymers, polymer types, polymer synthesis and processing; ceramics, their crystal structures and properties, composites, particle reinforced composites, fibre reinforced composites, structural composites, nanoparticle composites. **[8]**

5. **Mechanical Properties and Their Testing:** Destructive Testing**,** tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, formability, hardness testing, different hardness tests, Vickers, Rockwell, Brinell, impact test, ductile and brittle fracture, creep, generalized creep behaviour. Non-destructive testing (NDT), visual Inspection, magnetic particle inspection, dye penetrant inspection, ultrasonic inspection, Selection of NDT. **[8]**

Outcome(s):

- *The students will be able to understand the knowledge of materials & their applications.*
- *Students will be able to design the alloy system of ferrous and non-ferrous metals based on their knowledge of phase diagrams and metal characteristics.*
- *The students will also be able to understand the heat treatment processes and destructive and non-destructive testing of materials.*

AHEP4 Mapping with Module outcomes

C1: Student can understand the knowledge of characteristics of particular materials and processes

C2: Student can Understand of engineering principles and the ability to apply them to analyse key engineering processes.

C4: Student can understand of the use of technical literature and other information sources.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

Text Books:

1. V. Raghavan, "Material Science & Engineering", Prentice Hall India Ltd., 6th Edition.
2. A. K. Bhargava, C.P. Sharma. "Mechanical Behaviour & Testing of Materials", PHI Learning Private Ltd., 2014

Reference Books:

1. Avner S. H, "Introduction to Physical Metallurgy", Tata-McGraw Hill Publishing Co., New Delhi, 26th Edition 2009.
2. Dieter G. E, "Mechanical Metallurgy", McGraw Hill Publishing Co., New York, Latest Edition.

ME 19.206 **Design of Machine Elements - I** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.101, ME 19.201

Objective(s):

- *Develop an ability to apply knowledge of mathematics, science, and engineering*
- *To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.*
- *To develop an ability to identify, formulate, and solve engineering problems.*
- *To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice*.

1. **Introduction:** Engineering design - an applied decision theory with respect to functional requirements, aesthetic consideration and ergonomic consideration-traditional design methods-synthesis in design, standardization, preferred numbers, derived series of preferred numbers, types of Fits, tolerance with respect to Indian standard, calculation examples, interchangeability, surface Roughness and its designation on drawing. **[4]**

2. **Design against Static and Fluctuating Load:** Factor of safety, design of simple machine parts, design of Cotter Joint, knuckle Joint and Hooke's Joint, theories of Failures, maximum principal stress theory, maximum shear stress theory, distortion-energy theory of failures. Methods to reduce stress concentration. Fluctuating stresses, fatigue failure, endurance limit, low cycle and high cycle fatigue, notch sensitivity, reversed stress-design for finite and infinite life, cumulative damage in fatigue, Soderberg and Goodman lines, modified Goodman's diagram, Gerber equation, fatigue design under combined stresses. **[11]**

3. **Shaft, Keys and Couplings:** Transmission shafts, shaft design on strength basis, shaft design on torsional rigidity bases, ASME code for shaft design, design of hollow shaft, design of keys, design of couplings- muff coupling, rigid flange coupling, flexible coupling, design of shaft for lateral rigidity, Castigliano's theorem, area moment method. **[6]**

4. **Welded, Riveted and Threaded Joints:** Design of riveted joints and simple welded connections under concentric loads only, eccentric load in plane of weld, welded joints subjected to bending moment, Welded joints subjected to torsional moment, welded joints subjected to fluctuating forces. Basic type of screw fastening, terminology of screw thread, ISO metric screw thread, materials and manufacture, simple analysis of bolted joints, eccentrically loaded bolted joints in shear, eccentric load perpendicular to the axis of the bolt, eccentric load circular base, elastic analysis of bolted joints, bolted joints under fluctuating load. **[9]**

5. **Power Screw and Springs:** Forms of threads, multiple threaded screws, terminology of power screw, torque requirement for lifting of load and for lowering of load, self-locking screw, design of screw jack, differential and compound screws. Types of springs, style of end, stress and deflection equation, series and parallel connections, spring material, design of helical springs, concentric springs, multi-leaf spring, design of load spring. **[10]**

Outcome(s):

- Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.
- Demonstrate knowledge on basic machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.
- Be able to approach a design problem successfully, taking decisions when there is not a unique answer.

AHEP4 Mapping with Module outcomes	• C1: Student will understand and knowledge of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems. • C2: Student can understand of engineering principles and the ability to apply them to analyse key engineering processe. • C4: Student can understand of the use of technical literature and other information sources. • C5: Student can investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems • C12: Student will develop the ability to apply relevant practical skills • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Bhandari, V. B. “Design of machine elements”. Tata McGraw-Hill Education, 2010
2. Gupta, J. K., and R. S. Khurmi. "A textbook of machine design." SI Edition 2005

Reference Books:

1. Norton, Robert L. "Machine design: an integrated approach", Prentice-Hall Inc: NJ, USA, 1996
2. Shigley, Joseph E., and Charles R. Mischke. "Machine Engineering Design.", McGraw-Hill Book Company, 1989
3. Spotts, Merhyle Franklin. “Design of machine elements”. Vol. 730. Englewood Cliffs: Prentice-Hall, 1985.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.208 **Production Technology-I** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.112

Objective(s):

- *To analyze and understand the metal cutting phenomenon.*
- *To study the conventional machining processes such as lathe, drilling, milling, shaping.*
- *To select process parameters and tools for obtaining desired machining characteristic.*

1. **Metal Cutting Theory:** Introduction to manufacturing, classification of manufacturing processes. Tool materials, tool geometry, mechanics of metal cutting, tool failures, tool wear in metal cutting, tool life, cutting forces and power, machinability, cutting fluids. **[10]**
2. **Turning Operations:** Introduction, constructional features of a center lathe, cutting tools, operations performed on a center lathe, taper turning methods, thread cutting methods, special attachments, limitations of a center lathe, capstan and turret lathes, turret indexing mechanism, tool layout of turret and capstan machines, automatic lathes, tool layout for automatic lathes, machining time estimation. **[8]**
3. **Hole Making and Milling Process:** Introduction, constructional features of a drilling, types of drilling machines, drill geometry, reaming, boring, tapping, other hole making operations, machining time estimation, boring machine. Introduction, types of milling machines, constructional features of a milling, cutters, milling operations, dividing head, milling mechanics, machining time estimation, machining center. **[8]**
4. **Other Machining processes:** Introduction to shaper, planner, slotter and broaching. Gears types and gear making, machining of gears, gear finishing. Introduction to jig and fixtures. **[8]**
5. **Abrasive Machining:** Grinding machines, various grinding operations; Grinding wheels, preparation for wheel operation. Lapping, honing, super finishing **[6]**

Outcome(s): *At the end of the course, the student will be able to understand working of lathe, shaper, planer, drilling, and milling and machines. Comprehend speed and feed mechanisms of machine tools. Estimate machining times for machining operations on machine tools. Be able to select proper metal removing processes for the typical application.*(C2, C3, C4, C6, C13)

Text Books:

1. Rao P. N, "Manufacturing Technology", Tata McGraw-Hill, Fourth Edition.
2. Lindberg Roy A, "Processes and Materials of Manufacture", PHI, Fourth edition.

Reference Books:

1. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Fourth Edition, John Wiley & Sons.
2. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, 7th Edition, Pearson.

AHEP4 Mapping with Module outcomes	• C2: Using first principles of mathematics, students can solve problems related to mechanics of machining. • C3: Considering limitations of machining, students can select machining process parameter. • C4: Student can refer literature for appropriate machining parameter for machining different materials. • C6: Student will understand of, and the ability to apply, an integrated or

	systems approach to solving machining related problem. • C13: Student can understand the knowledge of characteristics of particular materials, equipment, processes, or products for machining on different machine tools.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.301 **Dynamics of Machines** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME 19.101, ME 19.202

Objective(s):

- *Understand Kinematics and Dynamics of different machines and mechanisms.*
- *To facilitate students to understand the function of flywheels, the concept of balancing of rotating and reciprocating masses.*
- *To understand the principles in mechanisms used for governing of machines*
- *To give awareness to students on the phenomenon of vibration and its effects.*

1. **Static and Dynamic force analysis:** Constraint and applied forces, static Equilibrium of two and three forces members, principle of virtual work, and friction in mechanisms. Dynamic analysis of 4-bar linkage and slider-crank mechanism, velocity and acceleration of a piston, angular velocity and angular acceleration of connecting rod, Engine force analysis, Dynamically equivalent system, inertia of connecting rod, Inertia force in reciprocating engine, crank shaft torque. **[10]**
   Engine dynamics and flywheel: Turning moment diagram of an I. C engine, Fluctuation of crankshaft-speed, flywheel and its effect on cyclic fluctuation of speed of an engine.

2. **Balancing:** Static balancing & dynamic balancing, Balancing of several masses, rotating in different planes, Balancing of reciprocating mass, Balancing of in-line engine, Balancing of V-engines, Balancing of radial engines. **[8]**

3. **Governors:** Types of governors, analysis of Watt, Porter , Prowell, Hartnell, Hartung governor, Sensitiveness of a governor, hunting, isochronisms and stability of a governor, effect and power of a governor, effect of friction on dynamics of governor. **[8]**

4. **Gyroscope:** Angular velocity, angular acceleration and gyroscopic torque, gyroscopic effect on aeroplanes, naval ships, two wheelers and four wheelers. **[6]**

5. **Mechanical Vibrations:** Types of vibrations, Single degree free & damped vibrations, Logarithmic decrement, Forced vibration of single degree system under harmonic excitation, vibration isolation. **[8]**

Outcome(s):

- Students will have an understanding of static force relationships and inertia forces and their effect that exist in machines.
- Students will demonstrate the dynamics of flywheel and their motion.
- Analyse balancing of rotating masses in a single and several planes.
- Understand concepts of vibrations in various machineries, their harmful effects and remedies.

AHEP4 Mapping with Module outcomes	• C1: Student will apply; integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline. • C2: Student will understand the engineering mechanics principles and apply them to analyze the practical problems.

	• C5: Student can investigate and define the problem, identifying any constraints. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems. • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Rattan S. S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Edition 2014.

2. Shigley J. E and Uicker J.J, "Theory of Machines and Mechanisms", Oxford University Press, 5th Edition 2017.

Reference Books:

1. Thomas B, "Theory of Machines", Pearson Education India, 3rd Edition 2010.

2. Norton R. L, "Kinematics and dynamics of machinery", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1st Edition 2009.

3. Bhave S., " Mechanical Vibrations: Theory and Practice ", Pearson India Ltd., 1st Edition 2010

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.302 **I. C. Engines** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME 19.203, ME 19.204

Objective(s):

- *To teach students the fundamentals, operations, and performance of internal combustion engines and their different types.*
- *To provide students with the theoretical and experimental ability to operate, analyse, and design internal combustion engines.*
- *To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency an demission*

1. **Introduction to I C Engine:** Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, Stratified charge engine, Scavenging in 2 Stroke engines. **[9]**
   Spark Ignition Engines: Spark ignition engine mixture requirements, Carburetion, Theory of carburettor, SP and MPFI, Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control, combustion chamber design for SI engines.
2. **Compression Ignition Engines:** Combustion in CI engine, Ignition delay, Knock and its control, Combustion chamber design of CI engine, Turbocharging, Supercharging. **[6]**
3. **Engine Systems and Components:** Ignition systems- Battery, Magneto and Electronic, Lubrication systems, Engine starting system, Engine cooling system, Intake and exhaust system, Drive train- Cam shaft and Valves. **[7]**
4. **Pollutant Formation Control:** Pollutant, Sources and types, Nox formation, Hydrocarbon emission mechanism, Carbon monoxide formation, Particulate emissions, Effect of pollutant, Emission standards, Catalytic converters and particulate traps, Method of measurement **[12]**
   Alternate Fuels: Methanol, Ethanol, Hydrogen, Natural gas, Biogas, Bio diesel, Liquefied petroleum gas, Properties, suitability, Engine Modifications, Merits and Demerits.
5. **Performance Characteristic and Testing of I C Engine:** Standards for testing of I.C. Engine, Mean effective pressure, Mean effective pressure, indicated power, brake power, friction power, Methods to determine power and efficiencies, Variables affecting performance of engine, characteristic curves, heat balance sheet, Methods of improving engine performance. **[6]**

Outcome(s):

- *Demonstrate a basic understanding of different types of internal combustion engines and their operations.*
- *To analyze the ideal models of engine ecycles.*
- *To understand the effect of supercharging and turbocharging on engine performance.*
- *To understand fuel-metering systems: carburetors and fuel injectors, in SI and CI engines.*

AHEP4 Mapping with Module outcomes	• C2: Student will understand the various principles of engines technology and their applications. • C4: Student can understand of the use of technical literature and other information sources. • C6: Student will apply the various design aspects and system approach in solving engineering problems. • C7: Student will understand the requirement for engineering activities to promote sustainable development of various engines for futuristic aspects. • C15: Student will understand the contexts in which engineering knowledge can be applied (eg. operations and management, application and development of technology, etc).

Text Books:

1. Ganesan V, "Internal combustion Engines", Tata McGraw Hill, 3rd Edition, 2007.

2. Mathur M. L. and Sharma R. P, "Internal Combustion Engines", Dhanpat Rai & Sons, 2005.

Reference Books:

1. Heywood John B, "Internal combustion Engines Fundamentals", McGraw Hill, 2nd Edition, 2018.

Pulkrabek W. W, "Engineering Fundamentals of theInternal Combustion Engine, Pearson Education Limited, 2nd Edition, 2013.

ME 19.303 **Fluid Machinery** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.204

Objective(s):

- *To impart the knowledge on pumps and turbines.*
- *To understand the basic principles of pneumatics and hydraulics.*
- *To identify pneumatic and hydraulic components and their functions*
- *To understand different types of turbine and its applications.*
- *To compute the efficiency of different types of turbine and pumps.*

1. **Introduction:** Introduction, Application of momentum and momentum equation to flow through hydraulic machinery, Euler's fundamental equation. **[6]**
   Impact of Jet: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), effect of inclination of jet with the surface.

2. **Hydraulic Turbines:** Classification of turbines. **[15]**
   Impulse Turbines: Pelton turbine, constructional details, velocity triangles, power and efficiency calculations, governing of Pelton wheel.
   Reaction Turbines: Fransis and Kaplan turbines, constructional details, velocity triangles, power and efficiency calculations, degree of reaction, draft tube, cavitation in turbines, principles of similarity, unit and specific speed, performance characteristics, selection of water turbines.

3. **Centrifugal Pumps:** Classifications of centrifugal pumps, vector diagram, work done by impellor, efficiencies of centrifugal pumps, specific speed, model testing, cavitation and separation, performance characteristics. **[6]**

4. **Positive Displacement Pumps:** Reciprocating pump theory, slip and coefficient of discharges, indicator diagram, effect and acceleration, work saved by fitting air vessels, comparison of centrifugal and reciprocating pumps, positive rotary pumps, Gear and Vane pumps, performance characteristics. **[8]**

5. **Other Machines:** Hydraulic accumulator, Intensifier, Hydraulic press, Lift and Cranes, theory of hydraulic coupling and torque converters, performance characteristics, Hydraulic ram, Jet pumps, Airlift pumps. **[5]**

Outcome(s):

- *Able to identify hydraulic problem.*
- *Able to learn any possible improvements on fluid machinery.*
- *Able to compute efficiency of various fluid machineries.*

AHEP4 Mapping with Module outcomes	• C2: Student can understand of engineering principles of hydraulic machines and the ability to apply them to analyze key engineering processes • C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems.

Text Books:

1. Bansal R. K., "Fluid Mechanics and Hydraulic Machines" Laxmi Publication Pvt. Ltd.,2005.

2. Modi, P. N., and S. M. Seth. Hydraulics and Fluid Mechanics: Including Hydraulic Machines (in SI Units). Standard Book House, 14th ed.,2002.

Reference Books:

1. Sayres A. T, "Hydraulic and Compressible Flow Turbomachines", Tata McGraw Hill,1990.

2. Sawhney G. S. "Thermal And Hydraulic Machines", PHI Learning Pvt. Ltd., 2nd ed., 2011.

ME19.304 **Refrigeration and Air Conditioning** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.203, ME 19.305

Objective(s):

- *To understand the principles of refrigeration and air conditioning.*
- *To calculate the cooling load for human comfort & different applications.*
- *To select the right equipment for a particular application.*
- *To understand the effect of temperature and pressure on moist air.*

1. **Introduction:** Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP). **[6]**
   Air Refrigeration System: Carnot refrigeration cycle; Temperature Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems.
2. **Vapor Compression Refrigeration Systems:** Simple Vapor Compression Refrigeration systems-Limitations of Reversed Carnot cycle with vapor as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP. **[11]**
   Multistage Vapor Compression Refrigeration Systems: Necessity of multistage compression, Compound VC cycle, Inter cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves.
3. **Vapor Absorption Refrigeration Systems:** Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; **[6]**
   Refrigerants: Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants.
4. **Psychrometry:** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer. **[7]**
5. **Air Conditioning:** Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air-conditioning system; year round air conditioning; unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor; Inside design conditions; comfort conditions; components of cooling loads; internal heat gains; system heat gain: external heat gain; Transport air conditioning. **[10]**

Outcome(s):

- *Able to understand basic principles of refrigeration*
- *Able to understand simple and multiple vapour-compression cycle, gas refrigeration cycles and absorption cycles.*
- *Ability to understand the principles of thermal comfort & ventilation*
- *An ability to use refrigerant property tables and psychrometric chart.*

AHEP4 Mapping with Module outcomes	• C1: Student will understand and knowledge of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems. • C2: Student will understand the refrigeration principles and apply them to analyze the practical problems. • C3: Student will understand the assembly of refrigeration systems and air conditioning systems. • C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems. • C7: Student will understand of the requirement for engineering activities to promote sustainable development and ability to apply quantitative techniques where appropriate. • C15: Student will understand the contexts in which engineering knowledge can be applied (eg operations and management, application and development of technology, etc).

Text Books:

1. Stocker W. F. and Jones J.W., "Refrigeration & Air conditioning", Tata McGraw-Hill, New Delhi, 2nd Edition,1982.
2. Arora C. P., "Refrigeration & Air conditioning", Tata McGraw-Hill, New Delhi, 7th Edition, 2006.

Reference Books:

1. Prasad M, "Refrigeration & Air conditioning", New Age International (P) Limited, New Delhi, 3rd Edition,2006.
2. Rajput, R. K. Refrigeration And Air-Conditioning. SK Kataria & Sons, 1st Edition, 2009.

ME 19.305 **Heat and Mass Transfer** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): MA 19.201, ME 19.203, ME 19.204

Objective(s):

- *Identify and understand the various mechanisms of heat and mass transfer that characterize a given physical system.*
- *Formulate models for heat conduction processes. Apply analytical and numerical methods to solve one- and two-dimensional conduction problems.*
- *Analyze and design complex heat transfer applications, such as heat exchangers.*
- *Combine thermodynamics and fluid mechanics principles to analyze heat convection processes.*
- *Integrate radiation aspects into real-world global heat transfer problems.*

1. **Basics Concepts:** Heat transfer in engineering, Mechanisms of heat transfer, temperature field and temperature gradient, conduction, convection and radiation heat transfer, concept of driving potential, combined mechanism of heat transfer. **[10]**
   Fundamental equations of conduction: General different equation of heat conduction in Cartesian, cylindrical and spherical coordinate system, one dimensional steady state heat conduction, systems without internal heat generation, systems with variable thermal conductivity, composite systems, critical radius of insulation, Special one dimensional steady state situations – heat generation, pin fins

2. **Multidimensional steady state conduction:** Introduction, Mathematical analysis of 2-D systems, graphical analysis of 2-D systems, electrical analogy for 2-D systems, Numerical method of solution for 2-D systems, three dimensional systems. **[8]**
   Transient heat conduction: Introduction, systems with negligible internal resistance – lumped parameter method, systems with negligible surface resistance, heat flow in an infinitely thick plate, systems with finite surface and internal resistance.

3. **Fundamental of convective heat transfer:** Introduction, convective heat transfer coefficient, basic equation, boundary layer concept, laminar heat transfer over flat plate, fully developed heat transfer through smooth pipes, the case of contact heat flux and constant wall temperature boundary condition, dimensional analysis, Correlation of heat transfer in turbulent flow, use of hydraulic diameter, free convection heat transfer phenomena. **[12]**
   Heat Exchangers: Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method.

4. **Thermal Radiation:** Basic concept, Theory of thermal radiation, electromagnetic spectrum, Wien's displacement law, Stefan-Boltzmann equation, Concept of black, gray bodies without participating media, radiation shields, View factors, Equivalent emissivity of grooved surfaces electrical network analogies. **[8]**

5. **Mass Transfer**: Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy. **[2]**

Outcome(s):

- *Analyze problems involving steady state heat conduction in simple geometries.*
- *Develop solutions for transient heat conduction in simple geometries.*
- *Understand the fundamentals of convective heat transfer process.*
- *Analyze heat exchanger performance by using the method of heat exchanger effectiveness.*
- *Calculate radiation heat transfer between black body surfaces.*

AHEP4 Mapping with Module outcomes	• C1: Student will apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline. • C2: Student will understand the heat transfer principles and apply them to analyze the practical problems. • C3: Student can identify the analytical approach to solve the heat transfer problems. • C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems.

Text Books:

1. Holman J. P, "Heat Transfer", McGraw Hill Higher Education., 10th Edition 2010

2. Nag P. K, "Heat & mass transfer", Tata McGraw Hill Publishing Company Ltd., 3rd Edition 2005.

Reference Books:

1. Yunus Cengel, "Heat and Mass Transfer: Fundamentals and Application", Tata McGraw Hill Publishing Company Ltd., 4th Edition2011

2.Bergman TL, Incropera FP, DeWitt DP, Lavine AS. "Fundamentals of heat and mass transfer". John Wiley & Sons; 7th Edition 2011

ME 19.306 **Metrology and Quality Control** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): PY 19.101

Objective(s):
- *Describe various instruments and their characteristics.*
- *Solve the problems on angle measurements.*
- *Explain the types of control chart to use, depending on given data.*
- *Solve problems based on quality control and acceptance sampling.*

1. **Introduction to Metrology:** Principles of Engineering metrology, Measurement standards, Types and sources of errors, Accuracy and Precision, introduction to uncertainty in measurement, linear and angular measuring instruments and their applications. **[8]**

2. **Form Measurement:** Principles and Methods of straightness – Flatness measurement – Thread measurement, Gear measurement, Interferometry, Types of Interferometer, Flatness, Roundness measurement - Applications. Control Gauges and Comparators. Surface texture measurement with stylus type instruments, Tomlinson surface meter, Talysurf and profilograph. **[8]**

3. **Advancements in Metrology**: Introduction & applications of: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology, Automatic inspection system, Machine vision for online-offline inspection. **[4]**

4. **Quality Management:** Concept of Quality and quality control, elements of quality & its growth, purpose, setup, policy & objective, factors controlling & quality of design and conformance, balance between cost and quality and value of quality. Specification of quality, planning through trial lots and for essential information. QMS (ISO 9000, TS16949, ISO14000), Quality Audit, FMECA, Zero defects, TPM. Six Sigma. **[10]**

5. **Statistical Quality Control:** Importance of statistical method in quality control, measuring of statistical control variables and attributes. Measurement/inspection, different types of control charts (X Bars, R, P. charts) and their constructions and their application. **[10]**
   Acceptance Sampling: Sampling inspection & percentage inspection, basic concept of sampling inspection, operating characteristic curves, conflicting interests of consumer and producer, producer and consumers risks, AWQL, LTPD, ADGL, single and double sampling plans.

Outcome(s): *After successful completion of this course the student will be able to:*
- *Make various comparative measurements.*
- *Understand fundamentals of gears, thread measurements and measurements of surface finish.*
- *Control chart techniques in quality control.*
- *Purpose and use of sampling and its benefit.*

AHEP4 Mapping with Module outcomes

C1: Student will apply; integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline.
C3: Considering limitation of different techniques, students can apply various measurement techniques.
C4: Student can understand of the use of technical literature and other information sources.
C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

Text Books:

1. Anand Bewoor & Vinay Kulkarni, "Metrology and Measurement", McGraw –Hill, 2009.
2. Mahajan M., "Statistical quality Control",Dhanpat Rai & Sons, Latest Edition.

Reference Books:

1. Jain R. K, "Engineering Metrology", Khanna Publishers, Latest Edition.
2. Gupta I. C, "Engineering Metrology", Dhanpatrai Publications, Latest Edition

ME 19.307 **Production Technology-II** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.205, ME 19.208, ME 19.112

Objective(s):

- *To understand the basic principles of metal forming, welding and casting processes*
- *To know the various types of melting practices*
- *To broaden the understanding of casting design principles*

1. **Metal Forming:** Nature of plastic deformation, deformation mechanism, hot and cold working, rolling principal, rolling stand arrangement, roll passes, sheet metal working processes bending, bend force, press work tool and types of dies. Forging, Extrusion and other Processes: Forging operations, forging design, drop forging die design; Extrusion-principle, forward and backward extrusion, impact extrusion, hydrostatic extrusion, extruding tubes; Wire drawing- rod and tube drawing, tube making, swaging. **[10]**
2. **Metal Fabrication Process:** Introduction to fabrication process, gas welding and cutting. Electric arc welding-principle of arc, arc welding equipment, electrodes, carbon arc welding, TIG GMAW, SAW, arc cutting Resistance welding, Other welding process: Thermit welding, electro slag welding, EBW, laser beam welding, forge welding, friction welding, diffusion welding, explosion welding, Welding design: heat input, heat flow, distortion, metallurgy of welding, defects in welding, brazing, braze welding and soldering **[8]**
3. **Metal Casting Process:** Introduction, Casting terms Patterns: Pattern allowance-pattern materials-types of patterns- colour codes Moulding materials: Moulding sand composition-testing sand properties-sand preparation-moulding sand properties-types of sand moulds-moulding machines Cores: Core sand, types of cores, core prints, chaplets, forces acting on the moulding flasks, Gating system: Elements of gating system, gates, pouring time, sprue, gating ratio, slag trap system, risering design-caine's method, modulus method, chills-feeding aids. **[9]**
4. **Powder Metallurgy & Rapid Prototyping:** Introduction, basic process, powder manufacturing, powder mixing and blending, composting, sintering. Introduction to rapid prototyping, role of rapid prototyping & rapid tooling, features and classifications. **[5]**
5. **Non Traditional Machining:** AJM, WJM, EDM, ECM, USM: working principle, components of set up, field of application, Parameters affecting machining characteristics, Material removal mechanism. **[8]**

Outcome(s): *Student will be able to*

- *Choose forming techniques for various applications*
- *Develop welding techniques for various alloys*
- *Develop welding application concepts*
- *Develop suitable casting techniques for specific applications*
- *Design of gates and risers in castings*

AHEP4 Mapping with Module outcomes

C1: Student can understand the knowledge of characteristics of particular materials, equipment, processes, or products for machining on different machine tools.
C3: Considering limitations of machining, students can select metal forming process.
C4: Student can refer literature for appropriate machining parameter for machining different materials.
C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving metal forming problem.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

Text Books:

1. Rao P. N, "Manufacturing Technology", Tata McGraw-Hill, Fourth Edition.
2. Lindberg Roy A, "Processes and Materials of Manufacture", Fourth edition PHI Latest Edition.

Reference Books:

1. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Fourth Edition, John Wiley & Sons.
2. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, 7th Edition, Pearson.

ME19.308 **Design of Machine Elements -II** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s) ME19.101, ME 19.201, ME 19.206

Objective(s)

- *Develop an ability to apply knowledge of mathematics, science, and engineering*
- *To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.*
- *To develop an ability to identify, formulate, and solve engineering problems.*
- *To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

1. **Design of Gears:** Different types of gears – spur, helical, bevel and worm gears, Beam strength, wear strength, dynamics loads on gears, estimation of module based on beam strength and wear strength, Thermal consideration design of worm gears. **[14]**

2. **Friction Clutches and Brakes:** Different types of clutches, torque transmitting capacity for multidisc clutches, cone clutches, centrifugal clutches, Friction materials for clutches lining, energy equation and thermal considerations. Different types of brakes, Energy equations, Design of block brake, Design of band brake, Design of disc brake, Thermal consideration. **[9]**

3. **Rolling Contact Bearings:** Types of rolling contact bearings, Selection of bearing type, Static load carrying capacity, Equivalent bearing load, Load life relationship, selection of bearing life, Selection of bearing from manufacture's catalogue, Selection of taper roller bearings, Design of cyclic loads and speeds lubrication of bearing contact bearings, Mounting of bearings. **[6]**

4. **Sliding Contact Bearing:** Basic mode of lubrication, Petroff's equation, Mckee's Investigation, Reynold's equation, Raimondi Boyd method, Bearing design- selection of parameters, Bearing materials and construction, selection of lubricant. **[6]**

5. **Miscellaneous Machine Elements:** Engine crank shaft, connecting rod, cylinder head, pressure vessels. **[5]**

Outcome(s)

- Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.
- Demonstrate knowledge on machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.
- Be able to approach a design problem successfully, taking decisions when there is not a unique answer.

AHEP4 Mapping with Module outcomes	• C1: Student will understand and knowledge of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems. • C3: Student will understand the assembly of systems and components modelling

	techniques. • C5: Student can investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems. • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Bhandari, V. B. "Design of machine elements". Tata McGraw-Hill Education, 2010
2. Gupta, J. K., and R. S. Khurmi. "A textbook of machine design." SI Edition 2005

Reference Books:

1. Norton, Robert L. "Machine design: an integrated approach", Prentice-Hall Inc: NJ, USA, 1996
2. Shigley, Joseph E., and Charles R. Mischke. "Machine Engineering Design.", McGraw-Hill Book Company, 1989
3. Spotts, Merhyle Franklin. "Design of machine elements". Vol. 730. Englewood Cliffs: Prentice-Hall, 1985.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.309 **Thermal Engineering System** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.203

Objective(s):

- *Thermodynamics is an essential part of engineering curricula, and has a broad application area such as transportation vehicles, power generation and cooling systems.*
- *The course will cover the basic principles of thermodynamics and will give students knowledge about how thermodynamics is applied in engineering practice.*

1. **Steam Generator and Draft:** Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox and etc, boiler mountings and accessories; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation. Introduction to high pressure boiler **[8]**
2. **Steam & Gas Nozzles:** Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, off design operation of nozzle, Effect of friction on nozzle, critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. **[8]**
3. **Steam Turbines:** Introduction; classification of steam turbine; impulse turbine; working principal; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; internal losses in steam turbine; governing of steam turbine. **[10]**
4. **Compressors:** Classification, single and multistage reciprocating compressors, isothermal and volumetric efficiencies, centrifugal and axial flow compressors, surging, choking and stalling. **[6]**
5. **Steam Condensers:** Component of steam condensing plant; types of condensers; air leakage in condensers; Dalton's law of partial pressure; Condenser vacuum, sources of air leakage & its disadvantages, vacuum efficiency; calculation of cooling water requirement; air expansion pump. **[8]**

Outcome(s):

- *Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques,*
  including the use of empirical data and property tables
- *Tto the analysis of representative fluid and thermal energy components and systems.*
- *Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques,*
  including the use of empirical data and property tables
- *To the design analysis of auxiliary fluid and thermal energy components and systems representative of the systems encountered in the practice of electrical, industrial, and related disciplines of engineering.*

AHEP4 Mapping with Module outcomes

- C1: Student will get Knowledge and understanding of scientific principles and methodology necessary to underpin their education in their engineering discipline, to enable appreciation of its scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies.
- C2: Student can understand of engineering principles and the ability to apply them to analyze key engineering processes.
- C3: Student can describe the performance of systems and components through the use of analytical methods and modelling techniques.
- C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software.
- C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems.

Text Books:

1. Yadav R, "Steam & Gas Turbines and Power Plant Engineering", Central Publishing House, 7th Edition, 2009.
2. Kearton W. J, "Steam Turbine Theory and Practice", CBS Publisher & Distribution Pvt. Ltd, 2011.

Reference Books:

1. Ballaney P. L, "Thermal Engineering", Khanna Publishers, 24th Edition, 2007.
2. Chattopadhyay P, "Boiler Operation Engineering", Tata McGraw Hill, 11th Edition, 2008.

ME 19.310 **Renewable Energy Technology** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME 19.203, ME 19.305

Objective(s):

- *To familiarize students with the various renewable energy sources.*
- *Awareness of the potential of renewable energy technologies, for sustainability in particular.*
- *Suitable applications of solar, wind, biomass, hydro, geothermal and ocean energy.*
- *Awareness and development of suitable social and economic models with implications.*

1. **Importance and applicability of renewable energy sources**: Energy Resources and Their Utilization, Environmental Aspects of Electric Energy Generation. **[8]**
   Technology and economics of solar thermal systems: Solar Radiation and Its Measurement, Solar Thermal Energy Collectors, Solar Thermal Energy Conversion Systems. Solar Photovoltaic System
2. **Technology and economics of wind power:** Types of turbines and their aerodynamics. Theories of wind turbines. WECS components and state of art Feasibility of large wind turbines. Wind Farms. **[10]**
   Technology and economics of small hydro: Types and theories of small, mini, and micro hydro turbines. Hydroelectric systems and advantages at small hydro levels. Conversion apparatus and feasibility.
3. **Technology and economics of geothermal, wave and tidal energy systems:** Geothermal Energy, Wave and tidal turbines. Harnessing wave energy, applicability and feasibility, Electric Power Generation by Ocean Energy. **[8]**
4. **Technology and economics of biogas and biopower:** Biofuel production and gasification. Biopower generation methods with technical details: steam, combined cycle, cogeneration. **[6]**
5. **Fuel Cells, Hydrogen and Hybrid systems:** Fuel Cells, Hydrogen Energy System, Hybrid Systems. **[8]**
   Environmental Impact: Environmental impacts of renewable energy sources and remedial measures. Global Climate Change.

Outcome(s): *Upon successful completion of this course, the student will be able to:*

- *Identify appropriate renewable technology for application.*
- *Implement concepts of clean development mechanism (CDM) and carbon credits.*
- *Utilize energy management and renewable energy systems in everyday life.*
- *Select eco-friendly, cost effective, energy efficient alternatives to unsustainable practices.*

Text Books:

1. Rai, G. D., "Non-Conventional Energy Sources", Khanna Publication, First Edition, 2010.
2. Tiwari, G. N. and Ghosal, M. K., Renewable energy resources: basic principles and applications. Alpha Science International, First Edition, 2005.

Reference Books:

1. Khan, B.H., "Non-Conventional Energy Resources", Tata McGraw-Hill, First Edition, 2006.
2. Kothari DP, Singal KC, Ranjan R. Renewable energy sources and emerging technologies. PHI Learning Pvt. Ltd.;2nd Edition 2011.

ME 19.311 **CAD/CAM** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s) ME 19.101, ME 19.206, CS 19.101

Objective(s)

- *Understand the applications and benefits of CAD*
- *Understand geometric transformation.*
- *Understand various representations of curves and surfaces.*
- *Understand the various concepts and characteristics in geometric modelling.*
- *Understand the basic concepts of CAM. Analyze the components and systems of NC and CNC machine tools. Understand and apply various programming methods for specific jobs.*
- *Classify various CAPP systems.*
- *Understand FMS and CIMS with reference to components, advantages and applications.*

1. **Fundamentals of CAD**: Introduction: Design Process: Application of computers in design: Creating manufacturing database: benefits of CAD. Computer Hardware; Graphic input devices; display devices; Graphics output devices; Central processing unit (CPU). CAD software and Database: Software configuration of a graphics system: functions of a graphics package: geometric modeling: Database structure and control; Graphics standard: GKS and IGES. **[4]**

2. **Geometric Transformations, Curves and Surfaces**: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrices. Application of geometric transformations. Polygon, meshed and ruled surfaces: Bezier curves; B-spline curves. **[10]**

3. **Geometric Modeling**: Wireframe model: solid modeling: representation, volumetric properties, surface modeling, concepts of hidden-line removal and shading: Kinematics analysis and simulation. Application of CAD techniques to finite Element Mesh Generation. Computer Aided Manufacturing (CAM) **[8]**

4. **Introduction of CAM**: Basic concepts of manufacturing system and CAD/CAM. NC/CMNC Machine Tools; NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system. **[12]**

5. **Computer Aided Process Planning and Automation**: Introduction and benefits of CAPP. Types of CAPP systems, machinability data selection systems in CAPP. Introduction to Automation **[6]**

Outcome(s)

- *Understand the capabilities of general Computer Aided Designing Systems and CAD Systems for designing mechanical parts and elements in 2D and 3D dimensions.(C1, C2, C4)*
- *Use effectively CAD / CAM systems in order to produce the final NC code for the manufacturing of various mechanical parts and carry out exchange of data between CAD and CAM systems.(C5,C6, C12)*
- *Describe the principles of various manufacturing processes, manufacturing technology (C17)*

AHEP4 Mapping with Module outcomes	• C1: Student will apply quantitative and computational methods in order to solve engineering problems and to implement appropriate action. • C2: Student can understand of engineering principles and the ability to apply them to analyse key engineering processes. • C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software. • C5: Student can define the problem, identifying any constraints including environmental and sustainability limitations; ethical, codes of practice and standards. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems • C12: Student will develop the ability to apply relevant practical skills • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Groover, Mikell P. "Automation, production systems, and computer integrated manufacturing". Prentice Hall Press, 2007.
2. Zeid Ibrahim, "CAD/CAM : Theory & Practice", Tata Mc Graw Hill Publication, 1998

Reference Books:

1. Rao, Posinasetti Nageswara. "CAD/CAM: principles and applications". Tata McGraw-Hill Education, 2004.
2. Radhakrishnan, Pezhingattil, S. Subramanyan, and V. Raj "CAD/CAM/CIM". New Age International, 2008.
3. Leondes, Cornelius T. "Computer aided and integrated manufacturing systems: a 5-volume set". Vol. 5. World scientific, 2003.

Assessment Diet Theory

Components	**Mid Term Examination (Internal)**	**Class Work**	**End Term Examination (External)**	**Total**
Weightage	40%	10%	50%	100%

UC 19.101 **Social and Professional Ethics** **Total Lectures: 26**

2-0-0-2

Objective: To create an awareness on professional ethics and human values, To instill moral and social values and loyalty and to appreciate the rights of others.

1. **Basic Human Values:** Morals, Values and Ethics – Truth, Rights Conduct (Righteousness), Love, non-violence and peace, Humility and character. Core areas of ethics: Social ethics, Personal ethics Integrity and Trustworthiness, Honesty, Loyalty, Courage, Prudence, Confidence, Confidentiality. **[5]**

2. **Theories of Ethics:** Kohlberg and Gilligan's analysis of moral development, - Deontology, Utilitarianism, Virtue Theory Rights Theory, Casuist Theory of Consequentialism – Robert Nozick's Theory of Entitlement and Property Rights. **[4]**

3. **Professional Ethics:** Introduction, meaning of work ethics, professional ethics for Journalists, Physicians, Lawyers, Engineers and Accountants. Intellectual property Rights, scope of ethics, code of conduct, business values and inner consciousness, Ethics at the workplace cybercrime, plagiarism, misconduct, fraudulent use of institutional resources, etc. **[7]**

4. **Corporate Social Responsibility:** Evolution of Corporate Social Responsibility (CSR) in India, CSR models, CSR to different stakeholders, Corporate Social Responsibility Initiatives of Major Companies of India, Promoting value based governance in organization. Whistle blower policy. **[6]**

5. **Ethics and Environment:** Introduction to environmental Issues- Industry and Environmental Pollution, Ethics of Controlling environmental pollution – Impact of environmental pollution on human health – Rights, Duties and care in environmental protection - Sustainable development. **[4]**

Outcome: The students will understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories.

Text Books:

1. B.N Ghosh "Business Ethics and Corporate Governance", McGraw Hill Education, Chennai, 2016
2. John R Boatright, "Ethics And The Conduct Of Business", Pearson Education, New Delhi, 2013.

Reference Books:

1. Raju Ramachandran, "Professional Ethics: Changing Profession and Changing Ethics", LexisNexis, Butterworths, 2nd Edition 2014.
2. Andrew Crane and Dirk Matten, "Business Ethics", Oxford University Press, 2nd Edition, 2015.
3. S.K Mandal "Ethics in Business and Corporate Governance" McGraw Hill Education, New Delhi, 2013.
4. R. Subramanian "Professional Ethics", Oxford University Press, 2015.

MA 19.101 **Mathematics I** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: (10+2) Higher Secondary Mathematics

1.	**Differential Calculus I:** Review of basic concepts, partial differentiation, Euler's theorem on homogeneous functions, Maclaurin's and Taylor's series (one and two variables) and Jacobians.	[06]
2.	**Differential Calculus II:** Maxima and minima of functions of two variables, asymptotes, Tracing of simple cartesian curves and standard polar curves.	[06]
3.	**Integral Calculus:** Basics of Beta and Gamma functions, Length of plane curves(cartesian and polar), area bounded by the curves(cartesian and polar), multiple integrals (double and triple integrals, change of order of integration), volumes, conversion from cartesian to polar form, physical interpretations and applications.	[12]
4.	**Matrix Theory**: Rank of matrix, linear dependence and independence of vectors, solution of system of simultaneous linear equations, Eigen values, Eigen vectors of a matrix, statement of Cayley-Hamilton theorem (without proof) , reduction of a matrix to diagonal form, quadratic forms, linear transformation of a quadratic form, and applications.	[08]
5.	**Three-dimensional Geometry:** Direction cosines and direction ratios of a straight line, equation of a plane, plane passing through intersections of two planes, equations of straight line, shortest distance between two skew lines, equation of a sphere, intersection of plane and sphere.	[08]

Outcome: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. Shanti Narayan and Mittal, Analytical Solid Geometry, S. Chand, 2018.

Reference Books:

1. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Pal and Bhunia, Engineering Mathematics, Oxford University Press, 2015.
3. Dass and Verma, Higher Engineering Mathematics, S.Chand, 2019.

PY19.101 **Engineering Physics** **Total Lectures: 40**

Pre-requisite: Fundamental knowledge of Basic Physics **3-0-0-3**

Objective:

1. To provide students with a basic understanding of the Physics that may be required by engineers in the course of their careers
2. To enhance knowledge related to lasers and its different components to make it suitable for various purposes
3. To introduce most important concepts of superconductivity, crystallography and fiber optics to the students
4. To introduce the learners to the basics of modern physics and Quantum Mechanics

1.	**Modern Physics**: Introduction to Black body radiation spectrum, Photo-electric effect, Compton effect. Wave particle Dualism. de Broglie hypothesis – de Broglie wavelength, extension to electron particle. Davisson and Germer Experiment. Matter waves and their Characteristic properties, Phase velocity, group velocity and Particle velocity, Relation between phase velocity and group velocity, Relation between group velocity and particle velocity. Expression for deBroglie wavelength using group velocity.	**[8]**
2.	**Quantum Mechanics:** Heisenberg's uncertainity principle and its physical significance. Application of uncertainty principle (Non-existence of electron in the nucleus, explanation for decay and kinetic energy of electron in an atom). Wave function, Properties and physical significance of wave function, Probability density and Normalization of wave function. Setting up of one dimensional time independent Schrodinger wave equation. Eigen values and Eigen functions. Application of Schrodinger wave equation – Energy Eigen values for a free particle. Energy Eigen values and Eigen functions for a particle in a potential well of infinite depth.	**[7]**
3.	**Electrical Conductivity in Metals**: Free–electron concept. Classical free-electron theory – Assumptions. Drift velocity, Mean collision time and mean free path. Relaxation time. Expression for drift velocity. Expression for electrical conductivity in metals. Effect of impurity and temperature on electrical resistivity of metals. Quantum free-electron theory – Assumptions. Fermi – Dirac Statistics. Fermi-energy, Fermi factor. Density of states (No Derivation). Expression for electrical resistivity / conductivity. Temperature dependence of resistivity of metals. electron in a periodic potential, origin of the energy gap, band theory of solids, distinction of solids into metals, semi-conductors and insulators.	**[8]**
4.	**Dielectric & Magnetic Properties of Materials**: Dielectric constant and polarization of dielectric materials. Types of polarization. Equation for internal field in liquids and solids (one dimensional). Ferro and Piezo electricity. Frequency dependence of dielectric constant. Important applications of dielectric materials. Classification of dia, para and ferro-magnetic materials. Hysterisis in ferromagnetic materials. Soft and Hard magnetic materials. Applications.	**[7]**
5.	**Lasers and Optical Fibers**: Einstein's coefficients (expression for energy density). Requisites of a Laser system. Condition for laser action. Principle, Construction and working of CO2 laser and semiconductor Laser. Applications of Laser – Laser welding, cutting and drilling. Measurement of atmospheric pollutants. Holography–Principle of Recording and reconstruction of images, applications of holography. Propagation mechanism in optical fibers. Angle of acceptance. Numerical aperture. Types of optical fibers and modes of propagation. Attenuation. Applications–Block diagram discussion of point to point communication.	**[10]**

Outcome: The student will be able to understand many modern devices and technologies based on lasers and optical fibers. Student can also appreciate various material properties which are used in engineering applications and devices.

Text Books:

1. S. O. Pillai, "Solid State Physics", New Age International, Sixth Edition, 2009
2. V. Rajendran, "Engineering Physics," TMH, Fifth Edition , 2013

Reference Book:

1. G. K. Shivkumar, "Engineering Physics," Prism Book Pvt. Ltd.
2. Stephen T. Thornton, "Modern Physics for Scientists and Engineers",Cengage Learning, 4th ed.,2013

CY 19.102 **Environmental Studies** **Total Lectures: 52**

Prerequisite(s): NIL **Credit: 3-1-0-4**

Objective(s):
- To teach the principal resources, renewable energy systems and biosphere.
- To explore the environmental impact of various energy sources and also the effects of different types of pollutants.

1. **Multidisciplinary nature of environmental studies:** Definition, scope and importance, Need for public awareness. [2]

2. **Natural Resources:** Renewable and non-renewable resources: Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. [8]
Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.
Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

3. **Ecosystems & Biodiversity:** [14]
Ecosystems: Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow and nutrient cycling in the ecosystem. Food chains, food webs and ecological pyramids. Ecological succession
Structure and function of the following ecosystem - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
Biodiversity and its conservation: Introduction – Definition, genetic, species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values. Biodiversity at global, national and local levels. Hot-sports of biodiversity. India as a mega-diversity nation, Threats to biodiversity: habitat loss, illicit poaching, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

4. **Environmental Pollution:** Definition, cause, effects and control measures of : Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. [8]
Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

5. **Social Issues, Human Population and the Environment:** From Unsustainable to Sustainable development: Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people: its problems and concerns. Global Climate Change, global warming, acid rain, ozone layer depletion. Wasteland reclamation. Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.Environment Protection Act 1986. Air (Prevention and Control of Pollution) Act 1981., Water (Prevention and control of Pollution) Act 1974, Wildlife Protection Act 1972., Forest Conservation Act 1980. [13]

Field work [7]
- Visit to a local area to document environmental assets river/forest/grassland/hill/mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.

Outcome(s): Upon successful completion of the course, students should be able to:
- Measure environmental variables and interpret results
- Evaluate local, regional and global environmental topics related to resource use and management
- Propose solutions to environmental problems related to resource use and management
- Interpret the results of scientific studies of environmental problems
- Describe threats to global biodiversity, their implications and potential solutions.

Text Books:

1. ErachBharucha “Environmental Studies”, University Grants Commission, 2004.
2. G. Boyle, Renewable energy: Power for a sustainable future’. Oxford University press. 2004.

Reference Books:

1. C. William, P. Saigo, B Woodworth, “Environmental Science: A Global Concern”, Sixth Edition McGraw-Hill Higher Education, 2001.
2. R.T. Wright, D.F. Boorse, “Environmental Science” 11th Edn, PHI, 2010.

EE 19.101 **Elements of Electrical Engineering** **Total Lectures: 40**

3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

Pre-requisite: Nil

1.	**DC Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation using mesh and nodal method. Network Theorems - Superposition, Thevenin, Norton and Maximum power transfer Theorems. Time-domain analysis of first-order RL and RC circuits.	**[8]**
2.	**AC Circuits:** Basic terminologies, representation of sinusoidal waveforms, average, rms and peak values of a.c. quantities, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel).	**[8]**
3.	**Three Phase A.C. Circuits:** Three phase supply, phase sequence, star connection, delta connection, relationship between phase and line quantities in 3-phase circuits, measurements of three phase power under balanced condition.	**[6]**
4.	**Transformers:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, Transformer testing: open circuit and short circuit test, losses in transformers, regulation and efficiency. Basics of auto-transformer and three-phase transformer connections.	**[10]**
5.	**Electrical Machines:** DC Machines – construction, functions of each part, working principle, EMF and torque equations, types of dc machines. AC machines – classification of a.c. machines, construction, operating principles of ac machines.	**[8]**

Outcome: At the end of this course, students will demonstrate the ability to

- To understand and analyse basic electric and magnetic circuits.
- To study the working principles of electrical machines.

Text Books:

1. Kothari, D. P., and I. J. Nagrath, "Theory and Problems of Basic Electrical Engineering," PHI Learning Pvt. Ltd., 1998.
2. Fitzgerald, Arthur Eugene, David E. Higginbotham, and Arvin Grabel, "Basic electrical engineering," McGraw-Hill Series in Electrical Engineering, Auckland: McGraw-Hill, 1981, 5th ed.(1981).

Reference Books:

1. H.Cotton, "Advanced Electrical Technology," CBS Publication. 1967.
2. Vincent Del Toro, "Electrical Engineering Fundamentals," 2nd Edition PHI Publication. 1972.

Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", PHI Publication, 1st Edition, 2007.

CS 19.101 **Programming Language** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

1. To learn principles of programming by the structured native language 'C'.
2. To comprehend the rudiments, constructs, syntax, and statements with essentials of efficient compiling, running and debugging processes.

1.	**Introduction:** The role of programming languages, programming paradigms, language description and syntax structure, basics of structured and object-oriented programming, functional programming, logic programming, concurrent programming.	[10]
2.	**Fundamentals of 'C' language**: Character set, variables data types constants, arithmetic,relational and logical operators, type conversion,increment,decrement, bitwise and assignment operators, conditional expressions, statements and blocks, *if-else*,*switch*, loops-*do-while*, *while*, *for*;*break*, *continue* and *goto* statements, labels.	[10]
3.	**Functions, pointers and Arrays**: Basics of functions, automatic, external, static and register variables, scope rules, and header files, recursion and C preprocessor, arrays, pointers and addresses, pointers and arrays address arithmetic, character pointers and functions, pointer arrays, pointers to functions, pointers and multidimensional arrays, command line arguments.	[10]
4.	**Structures and unions:** Basics of structures and functions, arrays of structures, pointers to structures, self-referential structures, unions.	[5]
5.	I/O and File Processing: Concept of files, standard input and output, formatted output, file access in different modes, reading from and writing to a file.	[5]

Outcome(s): Students would be able to apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner.

Text Books:

1.Brain W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second edition, Pearson Education, 2013,

2.Ravi Sethi&K.V.Viswanatha, Programming Languages-Concepts, and Constructs, Second edition, Pearson Education,2013,

Reference Books:

1.Herbert Schildt, C: The Complete Reference, Fourth Edition, McGraw-Hill Education, 2017

2.E Balagurusamy, Programming in ANSI C, Tata McGraw - Hill Education,6th edition,2012

PY 19.111 **Physics Laboratory** **0-0-2-1**

Pre-requisite: Nil

Objective:
1. To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
2. To apply the analytical techniques and graphical analysis to the experimental data.

List of Experiments:

1. To study of material constant, temperature coefficient of current and planck's constant.
2. To determine the specific resistance of a given wire by using the Carey Foster's bridge.
3. To determine the ballistic constant, K of a moving coil ballistic galvanometer with a standard capacitor of known capacity.
4. To determine the high resistance by the method of leakage of a condenser with the help of ballistic galvanometer.
5. To study the variations of resistivity with temperature and hence determines the energy band gap of the given semiconductor with help of four probe method.
6. To convert a galvanometer into a voltmeter of a given range.
7. To convert a galvanometer into an ammeter of a given ranges.
8. To plot graph showing the variation of magnetic field with distance along the axis of a circular coil carrying current and to estimate from it the radius of the coil.

Outcome: Students will be convergent with operation of equipments and verify the principle of Physics by doing the experiments. Students will be able to apply the analytical techniques and graphical analysis for finding out the experimental results.

EE 19.111 **Electrical Laboratory** **0-0-2-1**

Objective: The objective is to provide a basic exposure of installation and operation of electrical equipment.

Prerequisite: Nil

Perform any ten of the list.

1. To Study of the various apparatus used in Electrical Engineering.
2. To perform residential house wiring using fuse, indicator, switch, Socket, plug and lamp.
3. To design a Stair case wiring for illuminating a lamp.
4. To design Tunnel wiring for illuminating three lamps.
5. To construct a fluorescent tube and to measure voltage across tube rod, voltage across choke and current.
6. To conduct the polarity test on the given transformer.
7. To conduct the open circuit & short circuit tests on the given single phase transformer and to determine equivalent circuit parameters.
8. To control the speed of DC machine by field current control method.
9. To control the speed of DC machine by Armature Voltage control method.
10. To measure three phase power by using two wattmeter methods.
11. To verify Superposition Theorem using resistive circuit.
12. To verify Thevenin's Theorem using resistive circuit.

Outcome: Students will be convergent with installation and operation of electrical equipment.

Text Books:

1. J.B. Gupta, Theory and Performance of Electrical Machines, S.K. Kataria and Sons, 3rd Edition, 2002.
2. Kothari, D. P., and I. J. Nagrath. Theory and Problems of Basic Electrical Engineering. PHI Learning Pvt. Ltd., 1998.

Reference Books:

1. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 5th Edition, 2013.
2. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", PHI Publication, 1st Edition, 2007.

CS 19.151 **Programming Language Laboratory** **Total Hours:26**
Credit: 0-0-2-1

Prerequisite(s): NIL

Objective(s):

- To make students familiar with syntax and structure of C-programming.
- To learn problem solving techniques using C programs implementation.

List of Practicals

1. Implement the logic of Data Types & Operators.
2. Implement the logic of Type Conversions.
3. Implement the logic of Arithmetic, Relational, and logical operators.
4. Implementation of Bitwise, unary, assignment operators.
5. Implementation of Increment and Decrement operators.
6. Implementation of Conditional operators.
7. Implement the logic of Increment and Decrement operators.
8. Implement programs in order to cover Control Structure, If-Else statements, Nested If-Else statements, Switch-case statement, Loops- For, While, Do-While, Break Continue, Go-To Statements, and Labels.
9. Implement programs in order to cover processing an array, passing arrays to functions, Multidimensional arrays.
10. Implement programs to cover all possible String operations.
11. Implement programs in order to cover Function prototypes and passing arguments to a function, Recursion.
12. Implement programs in order to cover Pointers declaration, operations on pointers, Array of pointers, pointers to arrays.
13. Implementation of structure and union programs.
14. Implement the use of Storage classes in C programming.
15. Implement programs for Reading and writing from/to a file.

Outcomes On completion of this course student will be able to:

- Apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner

UC 19.102	Communication Skills	Total Lectures: 26
		2-0-0-2

Objective:	This Course aims to develop and enhance the linguistic and communicative competence of the students. The students will be exposed to various forms of personal and professional communication. The self-learning tasks designed will facilitate to enhance effective communication skills.	
1.	**Introduction to Communication:** Need for Effective Communication, The Process of Communication, Use of language in communication; Barriers to Communication: Types of barriers (Semantic, Intrapersonal, Interpersonal, And Organizational); Miscommunication; Noise; Overcoming measures. **Technology-based Communication:** Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software.	[5]
2.	**Listening and Reading Skills:** Listening as an active skill; Types of Listeners; Listening for general content; Listening to fill up information; Intensive Listening; Listening for specific information; Developing effective listening skills; Barriers to effective listening skills. **Reading Skills**: Previewing techniques; Skimming; Scanning; Understanding the gist of an argument; Identifying the topic sentence; recognizing coherence and sequencing of sentences; Improving comprehension skills.	[6]
3.	**Writing Skills**: Sentence formation; Use of appropriate diction; Paragraph and Essay Writing; Coherence and Cohesion. Common Errors. **Letter Writing:** Formal, informal and demi-official letters; **Job Application:** Cover letter, Differences between bio-data, CV and Resume. **Report Writing**: Basics of Report Writing; Structure of a report; Types of reports.	[6]
4.	**Non-verbal Communication and Body Language:** Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language.	[3]
5.	**Interview Skills:** Types of Interviews; Ensuring success in job interviews; Appropriate use of non-verbal communication. **Group Discussion:** Differences between group discussion and debate; Ensuring success in group discussions. **Presentation Skills:** Oral presentation and public speaking skills.	[6]

Outcome:	The students would hone the skills of reading, writing, listening, and speaking and become adept at communicating in the current modern context.
Text Books:	1. Raman, M., & Singh, P. (2017). Business Communication (2nd edition.). New Delhi: Oxford University Press.
	2. Lesikar, Raymond V and Marie E. Flatley. Basic Business Communication: Skills for Empowering the Internet Generation: Ninth Edition. New Delhi: Tata McGraw-Hill,
Reference Books:	1. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Publishing Company Limited
	2. Bonet, Diana. The Business of Listening: Third Edition. New Delhi: Viva Books, 2004.

MA 19.102 **Mathematics II** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: Mathematics I

1.	**Computational Methods:** Introduction and importance of numerical analysis, calculus of finite differences, interpolation schemes for equal and unequal intervals (Newton's forward and backward interpolation formulae), divided difference, interpolation for unequal intervals (Newton's divided difference and Lagrange interpolation formulae), Solution of algebraic and transcendental equations by Newton-Raphson method. Applications to Engineering.	[12]
2.	**Ordinary Differential Equations I:** First order and first degree differential equations (variable separable, homogeneous and non-homogeneous, linear, Bernoulli's equation, and exact equations).	[06]
3.	**Ordinary Differential Equations II:** Linear differential equations of second order with constant and variable coefficients (complementary functions and particular integrals), and applications.	[06]
4.	**Partial Differential Equations:** Formation of partial differential equations, Lagrange's multipliers method for solution of first order differential equations, separation of variables for nonlinear differential equations and applications.	[06]
5.	**Vector Calculus:** Vector and scalar point functions, conservative fields, gradient of scalar point functions, divergence and curl of vector point functions (Solenoidal and irrotational vectors), directional derivative of scalar point functions, work done along a curve, Integration of vectors, line integral (work done), surface integral, volume integral, physical interpretations and applications.	[10]

Outcome: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj, New Delhi, 40th Edition, 2007.

Reference Books:

1. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Pal and Bhunia, Engineering Mathematics, Oxford University Press, 2015.
3. Dass and Verma, Higher Engineering Mathematics, S.Chand, 2019.

CY 19.101 **Engineering Chemistry** **Total Lectures: 39**

Prerequisite(s): NIL **Credit: 3-0-0-3**

Objective(s):

- To purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers their preparation, properties and uses.
- To develop the basics of protecting engineering materials from the natural forces.
- To understand the present day up-to-date knowledge of the contemporary energy sources.
- To build up the basis of the future Engineering materials like superconductors, conducting organic polymers, Nano materials etc.

1.	**Water treatment:** Hardness, types of hardness, degree of hardness and its estimation (EDTA methods). Numerical problems on degree of hardness.Boiler troubles: sludge and scale formation, Prevention of sludge and scale formation in boilers. Softening of hard water (Lime-Soda, Permutit, Ion Exchange and calgon methods). Numerical problems based on water treatment (Lime-Soda process).	[8]
2.	**Polymers:** Classification, Functionality, Types of polymerization, Mechanism of Addition polymerization. Plastics: thermoplastic and thermosetting resins. Preparation, Properties and Uses of Polyamides, Bakelite, Polyesters, Rubber, Vulcanization of Rubber, Synthetic Rubber viz. Buna-S, Buna-N, Butyl and Neoprene rubbers. Silicones-polysiloxanes and sulphur based polymers.	[8]
3.	**Electrochemistry and Corrosion:** Electrochemical Changes, Electrochemical cell and its classifications (Galvanic cell, electrolytic cell). Types of electrodes. Origin of electrode potential, Electrochemical Series. Electromotive force, Nernst equation of electrode potential. **Corrosion:** Definition and its significance, Theories of corrosion, Mechanism of corrosion, types of corrosion, Corrosion control (Corrosion inhibitors, Cathodic protection - sacrificial anodic and impressed current cathodic protection).	[8]
4.	**Fuels and Lubricants:** Introduction - Importance of fuels in Industries. Classifications of fuels, Comparison of solid, liquid & solid fuels, Calorific value of a fuel. Determination of calorific value by Bomb calorimeter. Refining and cracking of petroleum, knocking. Octane Number and Cetane Number. L.P.G., Coal gas and Producer gas.**Lubricants:** Introduction and Classification of Lubricants. Properties of Lubricants, Lubricant Oil, Grease, Emulsions.	[9]
5.	**New Engineering Materials:** Introduction: Superconductors, high and low temperature superconductors, organic electronic materials, Fullerenes and Nano materials, Industrial applications of fullerenes and Nano materials.	[6]

Outcome(s): The student will be able to understand the basis of the future Engineering materials like of lubricants, superconductors, conducting polymers, Nano materials etc and purification of the most valuable natural resource of the future-water.

Text Books:

1. Jain and Jain, "Engineering Chemistry," 16th Edition, Dhanpat Rai Publishing Company, 2015.
2. S.S. Dara, "A Text Book of Engineering Chemistry," 12th Edition, S. Chand & Company Limited, 2014.

Reference Books:

1. Peter Atkins, Julio de Paula, and James Keeler, "Atkins' Physical Chemistry" Eleventh Edition, Oxford University Press, 2017.
2. William D. Callister, "Materials Science and Engineering: An Introduction, Eighth Edition, John Wiley & Sons, Inc., 2010.

ME-19.101 **Applied Mechanics** **Total Lectures: 40**
3-1-0-4

Prerequisite Basic Mathematics and Physics

Objectives:
1. This course will help the student to acquire knowledge of basic engineering mechanics concepts and enhance their ability to solve open ended engineering problems.
2. To provide the student with a clear and thorough understanding of the theory and applications of engineering mechanics, covering both statics and dynamics.
3. To provide the student with a thorough understanding of the concept, drawing, and the use of free-body diagrams.
4. To be able to determine the Centre of Gravity and Moments of Inertia of simple geometric shapes and understand the physical applications of these properties.
5. To understand the use and be able to perform calculations related to friction forces in engineering applications.

1.	**Introduction:** Idealization of Mechanics, concept of Rigid Body, External Forces (Body forces & surface forces), Laws of Mechanics. **Force Systems and Equilibrium:** Introduction to vector, Statically Equivalent Force systems, Free Body Diagram, Equations of equilibrium and their applications to various system of forces.	**[10]**
2.	**Distributed Forces and Moment Of Inertia:** Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, Principle axes and Principle Moment of Inertia.	**[6]**
3.	**Friction:** Introduction of friction, Laws of friction, wedge, screw, belt, rolling friction.	**[6]**
4.	**Tension, Compression and Shear:** Normal stress and strain, Linear elasticity, Hooke's Law and Poisson's Ratio, Shear stress and shear strain, Relationship between modulus. **Beams:** Different support & load conditions, SFD, BMD	**[9]**
5.	**Kinematics of Particles:** Introduction, Rectilinear motion, Plane curvilinear motion, Rectangular coordinates, Tangential and normal coordinates, polar coordinates, Relative motion (Translating Axes), constrained motion of connected particles. **Kinetics of Particles:** Introduction, Force, Mass and acceleration, Newton's second law of motion, Equation of motion and solution of problems, Work and Energy, Impulse and Momentum.	**[9]**

Outcome: The students shall develop the ability to identify, formulate, and solve engineering problems related to forces and motion.

Text Books:
1. Hibbeler, Gupta R. C., "Engineering Mechanics," 11th ed., Pearson India, 2010.
2. Merian, J.L, Kraige, L.G., "Engineering Mechanics Vol I & II," 5th edition, Wiley India 2010.

Reference Books:
1. Timoshenko, S, Young, D.H, Rao, J.V, "Engineering Mechanics," 4th edition TMH, 2010.
2. Irving. H. Shames, "Engineering Mechanics," Prentice Hall Book Company, 1966.

EC 19.101 **Basics of Electronics Engineering** **Total Lectures: 40**

3-1-0-4

Prerequisite Basic Knowledge of Engineering and Applied Physics

Objective: To learn the fundamental principle and applications of electronics and communication engineering and devices.

1.	**Introduction:** Brief history of major inventions in ECE, Electronic test and measurement equipments, Specifications for electronic components.	**[3]**
2.	**Semiconductors**: Material and its properties, Formation of energy band diagram, Currents in semiconductors, Fermi-Dirac energy distribution, Types of semiconductors – Intrinsic and Extrinsic, Mass action law, Hall effect.	**[5]**
3.	**Diodes**:Introduction, Characteristic of ideal and real diode, Current components in diode, load characteristics, Breakdown in diode, Zener diode, Varactor diode, Tunnel diode, Clippers and Clampers, Rectifiers – Half and Full-wave rectifiers.	**[8]**
4.	**Transistors:** Introduction to pnp and npn transistors, current components, active, cutoff and saturation regions, CC, CB and CE configuration, Operating point, Biasing circuits, Bias Stability, Thermal runway and thermal stability.	**[8]**
5.	**Signals**: Definition, Classification of signals – Analog and Digital, Deterministic and Random signals, Power and Energy of signals, Bandwidth, Bit and Baud rate.	**[4]**
6.	**Basics and Applications of Communication**: Definition, Block representation of communication system, Modulation – Definition, Need of modulation, Frequency translation, Types of modulation - Analog and Digital, Multiplexing – TDM and FDM. Introduction to - Optical Fiber, Transmission line, Waveguides, Satellite communication and RADAR.	**[12]**

Outcome: Students will be able to understand the basic concepts of Electronic and Communication Engineering and devices .They are able to implement mini projects based on concepts of ECE.

Text Books:

1. George Kennedy, Bernard Davis, “Electronics Communication Systems”, Tata McGraw-Hill, 3rd Edition, 2007.
2. Behrouz Forouzan, “Data Communication and Networking”, McGraw-Hill, 4th Edition, 2006.

Reference Books:

1. David A. Bell, “Electronics Devices and Circuits”, PHI, 4th edition, 2008.
2. Wayne, Tomasi, “Advanced Electronic Communication Systems”, PHI, 6th edition, 2013.
3. Robert L. Boylestad, Louis Nashelsky, “Electronics Devices and Circuits Theory”, Prentice Hall, 10th Edition, 2009.

ME-19.111 **Computer Aided Engineering Drawing** **0-0-4-2**

Objective:

1. To improve the visualization skills.
2. To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
3. To impart the knowledge on understanding and drawing of simple engineering products.

1.	**Introduction to Computer Aided Sketching:** Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and free hand practice. Board Drawing vs. Computer- Aided Drawing. Introduction to Solid works Environments. Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP &LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, dimensioning, line conventions, material conventions and lettering.	[8]
2.	**Orthographic Projections**: Horizontal planes, Vertical planes, Front view, Top view, Side view, Projections, First and Third angle of projection, Projections of points, Principles of orthographic projections, Sketching of different views of given objects. Introduction to sketching in Solid works : 2-Dimenional Sketching, Sketching in Solidworks, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity.	[12]
3.	**Projections of Lines, Planes and Solids:** Lines inclined to both the principal planes, projection of Lamina inclined to both principal planes, Projections of solids: Axis inclined to both the reference planes and Intersection of solids. Introduction to part module in Solidworks: Extrude, Revolve, Sweep, Hole, Filleting, and Chamfering features.	[12]
4.	**Sections of solids and sectional orthographic views:** Sectional orthographic projections - Full, Half, Partial, revolved and removed surfaces. Introduction to drawing module in Solidworks: Standard 3 views, Auxiliary view, Section View, Projected view.	[12]
5.	**Isometric Projection:** Terminology, Isometric scale, Box method, Coordinate or offset method, Four-center method, isometric projection of arcs. Solid models practice using Solidworks part module.	[8]

Outcomes:

1. Students will be able to improve their visualization skills so that they can apply these skills in developing new products.
2. Students will be able to know and understand the conventions and the methods of engineering drawing using Solidworks.
3. Students will be able to prepare simple drawings of engineering products.

Text Books:

1. N.D. Bhatt, "Engineering Drawing", Charotar Publishing House, 2013.
2. Prof. Sham Tickoo, SandeepPremDass “Solid works 2013 for Engineers and Designers” Wiley Publication, 2013.

Reference Books:

1. Randy H. Shih, “Solid works 2013 and Engineering Graphics: An Integrated Approach”, SDC Publications. 2013

CY 19.111 **Engineering Chemistry Laboratory** **Total Hours:26**
Credit: 0-0-2 - 1

Prerequisite(s): NIL

Objective(s):

- To introduce students to water chemistry and purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers, lubricants, fuel and their properties and uses.

LIST OF EXPERIMENTS

Choice of 10-12 experiments from the following

1. To determine the temporary and permanent hardness in the given water sample by complexometric titration using EDTA as standard solution.
2. To determine the percentage of Available Chlorine in the given sample of Bleaching powder. Iodometrically.
3. To determine the alkalinity of water sample.
4. To prepare urea formaldehyde resin.
5. To determine the strength of given HCl solution by titrating it against NaOH solution using pH meter.
6. To determine the strength of given acid solution by titration it against sodium hydroxide solution using conductometer.
7. To determine molecular weight of a polymer using Ostwald viscometer.
8. Determination of viscosity of given lubricating oil by Redwood viscometer.
9. Determination of cloud and pour point of given lubricating oil.
10. Determination of the flash and fire point of given lubricating oil.
11. Determination of acid value of given lubricating oil.
12. To determine the calorific value (HCV) of a sample of fuel.
13. Proximate Analysis of Coal.
14. Determination of the percentage of Fe in the given steel sample.

Outcomes The students will learn to:

- Estimate the Hardness of water, alkalinity of water.
- Familiar with the important practical applications of electrochemistry, lubricants, solids, their properties and applications, and the polymer materials.

ME-19.112 **Mechanical Workshop** **0-0-2-1**

Objectives:

1. Practice on manufacturing of components using workshop trades including fitting, carpentry, sheet metal and welding.
2. Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping.
3. Study and practice on machine tools and their operations.

List of Jobs:

1. **Fitting Shop:** Prepare job that contain various fitting operation like filing, marking, measuring, cutting, drilling etc.
2. **Carpentry Shop:** Making of carpentry joint (T, L joint etc).
3. **Sheet Metal Shop:** Making job from sheet (funnel, tray etc).
4. **Machine Shop:** Perform various operations like, turning, step turning, facing, chamfering, knurling etc on Lathe.

Outcomes:

At the end of the course, the student will be able to:

1. To acquire skills in basic engineering practice.
2. To identify the hand tools and instruments.
3. To acquire measuring skills.
4. To provides the knowledge of job materials in various shops.
5. Students will be able to analyze the material on the basis of their properties and thus assigning different weight age to their use for technical purposes.

Text Books:

1. Hajara Chaudhary, Workshop Technology Vol I & II, Media Promoters and Publishers PVT. LTD, Mumbai.
2. B.S. Raghuvanshi, Workshop Technology, Dhanpat Rai & Sons. New Delhi.

Reference Books:

1. H S Bawa, Workshop Technology, TMH. New Delhi.

EC 19.111 **Electronics Lab** **0-0-2-1**

Pre-requisite: Nil

Objective:
1. To gain practical knowledge by applying the experimental methods to correlate with the theory of Electronics Engineering.
2. To apply the analytical techniques and graphical analysis to the experimental data.
3. To enable the students to simulate and test the Electronics circuits using Multisim software.

Practical to be performed on Hardware:

1. To plot V-I characteristics of junction diode and Zener diode.
2. To design a half wave rectifier with and without filter circuit and find the ripple factor.
3. To design a full wave rectifier with and without filter circuit and find the ripple factor.
4. Study of clipper and clamper circuits and their implementation on breadboard.
5. To plot the characteristics of Transistor under Common Emitter configuration
6. To plot the characteristics of Transistor under Common Base Configuration
7. To plot the characteristics of Transistor under Common Collector configuration
8. To perform soldering and de-soldering to make banana probe, BNC probe and connection on PCB.

Practical to be performed using Multi-Sim Software:

9. An Introduction to Electronic Circuit Simulation using Multi-Sim Software.
10. To verify Ohm's law and Kirchhoff's law.
11. To Simulate half wave and full wave bridge rectifier.
12. To plot V-I characteristics of junction diode.

Outcome: Student will be able to understand the operation of electronic test equipment and hardware/software tools to characterize the behavior of devices and circuits.

CS 19.201 **Discrete Mathematics** **Total Lectures: 40**

Credit:3-1-0-4

Prerequisite(s): None

Objective(s):

- To Introduce fundamental concepts and applications of discrete structure in the field of computer science

1.	**Sets, Relations and Functions**: Set theory, combination of sets, multi-sets, ordered pairs, set identities, relations, operations on relations, properties of relations, composite relations, equality of relations, order of relations, functions, classification of functions, operations on functions, recursively defined functions.	[8]
2.	**PartiallyOrderedSets:**Definition,combinationofpartialordersets,Hassediagram,lattices:definition,propertiesof lattices: bounded, complemented, modular and complete lattice, orphisms of lattices.	[6]
3.	**Algebraic Structures & Counting:** Groups, subgroups and order, cyclic groups, cosets, Lagrange's theorem, normal subgroups, permutation and symmetric groups, group homomorphism's, rings, fields, basics of linear algebra, integers modulo n.Counting principles, permutations, combinations, summations, principle of inclusion and exclusion, pigeon-hole principle, generating functions and recurrence relations.	[10]
4.	**Propositional Logic:** Proposition, well-formed formula, truth tables, tautology, satisfiability, contradiction, algebra of proposition, theory of inference, natural deduction, predicate logic: first order predicate, well-formed formula of predicate, quantifiers, and inference theory of predicate logic.	[8]
5.	**Graph Theory:** Graphs, types of graphs, sub graphs, Eulerian chains and cycles, Hamiltonian chains and cycles, graph traversal algorithms, chromatic number, plannar graph.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:

- Understand the theory and techniques of logic, graphs and trees, and algebraic systems.
- Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.

Text Books:

1. Bernard Kolman, Robert C., BusbSharon, Cutler Ross, Discrete Mathematical Structures, PHI, 6thEdition, 2009.
2. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, 7th Edition, 2011.

Reference Books:

1. SwapanKumarChakraborty,BikashKantiSarkar,DiscreteMathematics,OxfordHigher Education,2011
2. C.L.Liu, D. P. Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, Tata Mcgraw-Hill, 3rdEdition, 2008.
3. Seymour Lipshutz, Marc Lipson, Discrete Mathematics, 3rd edition, 2010

CS-19.202 **Objected Oriented Programming** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 19.101(Programming Language)

Objective(s): The objective of this courseis to:

- Cover issues related to the definition, creation and usage of classes, objects and methods.
- Discuss the principles of inheritance and polymorphism.
- Provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- Cover the basics of API and to explore the java abstract programming interface.

1.	**Overview:** Introduction to OOP, OOP concepts, interactive Development Environments: Eclipse/Net Beans, basics of OOP, importance of Java Primitive datatypes, typecasting, arrays, Array List, operators and control structures, identifiers, constants and literals.	[9]
2.	**Classes and Inheritance:** Class fundamentals, objects, constructors, this keyword, garbage collection, the finalize () method, overloading methods, understanding static & final, exploring the string class. Inheritance basics, using super, multilevel hierarchy, constructor inhierarchy, method overriding, dynamic method dispatch, the object class, using abstract classes, interface.	[10]
3.	**Package, and Exception Handling:** Packages, access protection, importing packages,interfaces,exception-handlingfundamentals,exceptiontypes,usingtry and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, user defined exception, assertions	[10]
4.	**Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managing threads, thread class built-in functions.	[4]
5.	**I/O and String Handling:** I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer.	[7]

Outcome(s): Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP practices(e.g., interfaces and APIs) and proper program structuring(e.g.,by using access control identifies, automatic documentation through comments, error exception handling).
- Use of development environment like Eclipse for collaborative programming

Text Books:

1. Herbert Schildt, Java The Complete Reference, Herbert Schildt, 8th Edition, 2011.
2. Bert Bates and Kathy Sierra, Head First Java, O'Reilly,2005

Reference Books:

1. AllenB. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
2. Paul Deitel, Harvey Deitel, Java How To Program (Early Objects), 10thEdition, 2014.
3.E. Balaguruswamy, Programing with Java A Primer, Tata Mc. Graw Hill, 2007

CS-19.203 **Data Structures** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS 19.101 (Programming Language)

Objective(s):
- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1.	**Introduction:** Basic terminology, elementary data organization, algorithm, efficiency of an algorithm, time and space complexity, asymptotic notations, time-space trade-off, abstract data types.	[4]
2.	**Array& Linked list:** Definition, single and multidimensional arrays, representation of arrays: row major order, and column major order, application of arrays, sparse matrices and the irrepresentations. Singly linked lists, doubly linked list, circular linked list, insertion, deletion, traversal, polynomial representation and addition, generalized linked list.	[10]
3.	**Searching & Sorting:** Sequential search, binary search, comparison and analysis, hash function, collision resolution strategies, insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort.	[10]
4.	**Stack & Queue:** Primitive stack operations: push and pop array and linked list implementation of stack, application of stack: prefix and postfix expressions, evaluation of postfix expression, recursion, and tower of Hanoi problem. Queue operations, circular queues, array and linked list implementation of queues, dequeue and priority queue	[8]
5.	**Tree:** Binary trees, binary tree representation, tree traversal algorithms: in order, pre order and post order, threaded binary trees, Huffman algorithm, binary search trees AVL trees.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:
- Be knowledgeable of certain abstract data types (ADT)
- Be able to make a critical assessment of different implementations of an ADT
- Be familiar with a number of fundamental computational problems, and beware of real world instances of those problems

Text Books:
1.Lipschutz, "Data Structures" Schaum's Outline Series, TMH, Revised Edition Feb. 2014
2. Horowitzand Sahani, Fundamentals of Data Structures, University Press, 2ndEdition, 2008.

Reference Books:
1.AaronM.Tenenbaum,YedidyahLangsamandMosheJ.Augenstein,DataStructures Using and C++, PHI, 2nd Edition, 2012.
2. D. Samanta, Classic Data Structures, PHI, 2nd Edition, 2009
3. JeanPaulTrembleyandPaulG.Sorenson,AnIntroductiontoDataStructures With applications, McGraw Hill, 2nd Edition, 2003.

CS-19.204 **Database Management Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS 19.203 (Data Structures).

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS & RDBMS in the organization.

1.	**Introduction & Relational Data Model:** database system concepts and architecture, data modeling using theentity-relationship (ER) model, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model.	[10]
2.	**Structured Query Language (SQL)**: SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views.	[6]
3.	**Database Design:** Functional dependencies and normalization of relational databases, first normal form (1NF), 2NF, 3NF, boyce-coddnormal form (BCNF), multivalued dependency, 4NF, join dependency, 5NF.	[8]
4.	**Transaction Processing:** Introduction, properties, recoverability, serializability, concurrency control techniques: two phase locking protocol, concurrency control based on time-stamp ordering, database recovery techniques: recovery concepts, recovery techniques based on deferred and immediate update, the ARIES recovery algorithm.	[8]
5.	**Database Security:** Vulnerabilities in database, authentication, SQL injections, Encryptions & public Key infrastructures, privacy issues and preservation process	[8]

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.

Text Books:

1. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Management Systems, Edition, Pearson Education, 2013.
2. Raghu Ramakrishnan, Database Management Systems, 3rd Edition, Tata McGraw Hill, 2008.

Reference Books:

1. G.W. Hansen, and J.V. Hansen, Database Management and Design, 2nd Edition, Prentice Hall India, 2000.
2. Korth and Schilberschatz, Database System Concepts, 5th Edition, Tata McGraw Hill, 2006.
3. C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CS19.205 **General Purpose Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 19.101 (Programming Language)

Objective(s): Python is a general-purpose, versatile and popular programming language. It's great as a first language because it is concise and easy to read, and it is also a good language to have in any programmer's stack as it can be used for everything from software development and scientific applications.

1.	**Introduction**: The basic elements of python, python syntax, python operators, basic input, branching programs, control structures, strings, tuples, lists, sets, dictionaries and input iteration, Mutability with deferent types, Ranges and iterators	[7]
2.	**Functions and Module**: Functions and scoping flow of execution, specifications, recursion, global variables, eval&exec , variable arguments, default arguments, system functions and parameters, input and output, modules , making your own module, importing modules.	[7]
3.	**Classes and Object-Oriented Programming**: Abstract data types and classes, class attribute, instances, constructor, self, inheritance, encapsulation and information hiding, polymorphism, getter & setter	[8]
4.	**Testing and Debugging**: Exceptions and assertions, types of testing – black-box and glass-box, debugging, handling exceptions, assertions.	[6]
5.	**Advance Python:** Regular expressions – REs and Python, plotting using mat plot lib and Multithreaded Programming, GUI & event handling programming using Tkinter & pygame. Introduction to machine learning and deep learning	[12]

Outcome(s): Upon completion of this course students will be

- Familiar with Python syntax.
- Able to use python to implement a given logic.

Text Books:

1. John V Guttag, Introduction to Computation and Programming using Python, Prentice Hall of India, 2nd Edition, 2013.
2. Martin C. Brown, Python: The Complete Reference,McGraw Hill, 2018

Reference Books:

1. Zed A. Shaw, Learn Python the hard way: a very simple introduction to the terrifyingly beautiful world of computers and code, 3rd edition, 2014.
2. Richard L. Halterman, Learning to Program with python, 2011.
3. Allen Downey, Think Python How to Think Like a Computer Scientist, Version 2.0.17, Green Tea Press Needham, Massachusetts, 2012.

CS19.206 **Theory of Computation** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS14.201(Discrete Structures)

Objective(s): The goal of this course is to

- Provide students with an understanding of basic concepts in the theory of computation.
- To understand variety of issues in the mathematical development of computer science theory, particularly finite representations for languages and machines, as well as gain a more formal understanding of algorithms and procedures.

1.	**Finite Automata and Regular Expression:** Finite state systems, basic definitions, regular languages and regular expression, finite automata ,Equivalence of DFA and NDFA , Kleen's theorem, pumping lemma for regular sets, regular expression with algebraic method Using Arden's Theorem, closure properties of regular sets, minimization of finite automata, Mealy and Moore machine - conversion of Mealy machine into Moore machine and vice versa.	[11]
2.	**Context-Free Grammars:** Context-free grammars, union, concatenation of CFG, derivation trees, simplification of context-free grammars, Chomsky normal form, Greibach Normal form, ambiguous context-free grammar.	[9]
3.	**Context-Free Languages and Pushdown Automata:** Pushdown automata and context-free languages, pumping lemma for CFL, closure properties of CFL, decision, algorithms for CFL.	[8]
4.	**Turing Machine:** Turing machine model, techniques for Turing machine construction, Turing machines as language acceptor, combining Turing machines, properties of recursive and recursively enumerable languages, universal Turing machine.	[8]
5.	**Chomsky Hierarchy of Languages:** Regular grammars, unrestricted grammars and Turing machines, context-sensitive grammars and linear bounded automata.	[4]

Outcome(s):

- Be able to prove the equivalence of languages described by finite state machines and regular expressions.
- Be able to construct pushdown automata and the equivalent context free grammars.
- Be able to prove the equivalence of languages described by pushdown automata and context free grammars.
- Be able to construct Turing machines and Post machines.
- Be able to prove the equivalence of languages described by Turing machines and Post Machines.

Text Books:

1.Peter Linz, An Introduction to Formal Languages and Automata, Third Edition, Jones and Bartlett, 2016.

2. Hopcroft, Motwani, Ullmann, Introduction to Automata Theory, Languages and Computation, Pearson Education, 2nd Edition, 2005.

Reference Books:

1. Daniel I. A. Cohen, Introduction to Computer Theory, Prentice-Hall, 2nd Edition, 1997.

2. Martin, Introduction to Languages and the theory of Computation, Tata Mcgraw Hill, 3rd Edition, 2006

3. Michael Sipser, Introduction to the Theory of Computation, 3rdEdition, Cengage Learning,2013

CS 19.208 **Computer Organization and Architecture** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): EC 19.202 (Digital Electronics) (Optional)

Objective(s):

- To have a thorough understanding of the basic structure and operation of a digital computer.
- To discuss in detail the operation of the arithmetic unit including the algorithms &
- Implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
- To study the different ways of communicating with I/O devices and standard I/O interfaces. To study the hierarchical memory system including cache memories and virtual memory.

1.	**Introduction:** Von-Neuman architecture, register transfer and micro operations: register transfer language, arithmetic micro-operations, logic micro-operations, shift micro-operations, bus and memory transfers, computer organization and design: instruction cycle, computer registers, common bus system, computer instructions, addressing modes, design of a basic computer. General register organization, stack organization, instruction formats, data transfer and manipulation, program control, RISC, CISC	[10]
2.	**Computer Arithmetic:** Hardware implementation of addition and subtraction, multiplication algorithms, Booths multiplier, array multiplier, division algorithms, floating point arithmetic: floating point representation, add, subtract, multiplication, division.	[8]
3.	**Memory & I/O Organization:** Memory hierarchy, RAM, ROM chips, memory address map, memory connection, associative memory, cache memory and virtual memory: paging and segmentation, auxiliary memory: magnetic disks, magnetic tapes, Input-output interface, Asynchronous data transfer, modes of transfer, priority interrupt, DMA, IOP.	[8]
4.	**Hardwired and Micro programmed Control:** Hardwired control, micro programmed control: micro instruction, micro program sequencing, wide-branch addressing, microinstruction with next-address field, prefetching microinstruction.	[7]
5.	**Pipelining & Parallel Processing: P**ipeline and vector processing: pipeline structure, speedup, efficiency, throughput and bottlenecks, arithmetic pipeline and instruction pipeline. Flynn's Classification performance matrices for parallel system	[7]

Outcome(s): On the successful completion of the course, the student will be able to:

- Understand basic structure of a digital computer.
- Perform arithmetic operations of binary number system.
- Know the organization of the control unit, arithmetic and logical unit and I/O memory unit

Text Books:

1. M. Morris Mano, Computer System Architecture, Pearson Education, 3rd edition, 2008.
2. Carl Hamacher, Zvonko Vranesic and SafwatZaky, Computer Organization, Tata McGraw Hill, 5thedition, 2002.

Reference Books:

1. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/ Software interface, Elsevier, 3rd edition, 2005.
2. William Stallings, Computer Organization and Architecture–Designing for Performance, Pearson Education, 6thedition, 2000.
3.Kai Hwang, Advance Computer Architecture, Tata Mc Graw Hill,18th edition,2008

EC 19.202 **Digital Electronics** **Total Lectures: 40**

Pre-requisite: Basics of Electronics Engineering **3-0-0-3**

Objective: The aim of this course is to present the principles and techniques of combinational and sequential digital logic design and optimization at a gate level. The use of transistors for building gates is also introduced.

1. **Number Systems and Boolean Algebra:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic, Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [5]
2. **Logic Gates and Simplification of Boolean Functions:** Basic Logic gates, Universal gates, K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method. [5]
3. **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]
4. **Sequential Circuits and Programmable Logic:** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters, PAL, PLA. [10]
5. **Introduction to Verilog HDL:** Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools. Gate Level Modeling: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State Gates, Array of Instances of Primitives, Design of Flip-flops with Gate Primitives, Delays, Strengths and Construction Resolution, Net Types, Design of Basic Circuits. [10]

Outcomes: Upon successful completion of this course, students should be able to:

1. Gain fundamental knowledge of the basic logic gates such as AND, OR, NAND NOR, EX-OR and their implementation in Logic Circuits.
2. Design multipliers, Combinational Circuits and registers.

Text Books:

1. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Patparganj, Delhi, 4thEdition, 2009.
2. Floyd, T. L. and Jain, R.P., "Digital Fundamental", Pearson Education, Patparganj, Delhi, 8thEdition, 2009.

References

1. Puri, V. K., "Digital Electronics: Circuits and Systems", Tata McGraw-Hill, Patel Nagar, New Delhi, 4thEdition, 2001.
2. Jain, R. P., "Modern Digital Electronics", Tata McGraw-Hill, Patel Nagar, New Delhi, 4th Ed.

MA 19.201 **Mathematics III** **Total Lectures: 40**

3-1-0-4

Pre-requisite: Mathematics I and Mathematics II

Objective: To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1.	**Linear Programming:** Introduction with formulation; Graphical method; Simplex method, Artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method).	[12]
2.	**Numerical Methods:** Solution of system of equations (Gauss elimination and Gauss - Seidel methods);Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector, Runge-Kutta method of order four).	[08]
3.	**Complex Analysis:** Function of complex variable, analytic function, Cauchy- Riemann equations(without proof); Integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula(without proof), zeros and singularities of complex functions, residues.	[08]
4.	**Integral Transform I**: Basics of Laplace transform and inverse Laplace transform; First and Second Shifting theorems; Convolution theorem (without proof); Laplace transform of Unit Step function, Dirac Delta function and periodic function.	[06]
5.	**Integral Transform II**: Solution of ordinary differential equations with initial conditions by Laplace transforms; Fourier series of periodic functions, even and odd functions, Fourier half-range series; Basics of Fourier transforms with properties.	[06]

Outcome: After completion of the course, students would be able to apply the knowledge of linear programming, numerical methods, complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books:

1. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.
3. Jain R.K. and S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 2003.

MA 19.202 **Statistics and Probability Theory** **Total Lectures: 40**

3-1-0-4

Pre-requisite: Mathematics I, Mathematics II, and Mathematics III

Objective: To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

1.	**Introductory Ideas:** Recapitulation of basics of permutation, combination and probability theory; Law of addition and law of multiplication; Conditional probability; Total probability; Bayes' theorem (with proof)and it's applications.	[08]
2.	**Random Variables and Distribution:** Discrete and continuous random variables; Types of distributions with basic properties; Probability mass and density functions; Cumulative distribution function; Mean, variance and standard deviation of distributions; Discrete types (Binomial and Poisson) and Continuous types (Normal, Uniform and Exponential); Applications of basic ideas of these distributions.	[10]
3.	**Sampling and Testing of Hypothesis:** Sampling distribution of mean and variance; Central limit theorem; Simple and Composite hypothesis; Type I and Type II errors with graphical interpretations; Level of significance and tests of significance for large and small samples with applications.	[08]
4.	**Correlation and Regression:** Simple, partial and multiple correlations; Linear regression with applications.	[06]
5.	**Queuing Theory and Queuing Models:** Birth and death process; Pure birth and pure death process; Classification of queuing models: $[(M/M/1):(FCFS/\infty/\infty)]$, $[(M/M/1):(SIRO/\infty/\infty)]$, $[(M/M/1):(FCFS/N/\infty)]$, $[(M/M/C):(FCFS/\infty/\infty)]$; Applications of queuing models.	[08]

Outcome: After completion of the course, students would be able to apply the knowledge of Statistics and Probability theory in engineering and solve curriculum problems.

Text Books:

1. S.Palaniammal, Probability and Random Processes, PHI, 2013.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH, 2018.
2. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, 2002.
3. Dass and Verma, Higher Engineering Mathematics, S. Chand, 2019.

UC 19.201 **Introduction to Management and Leadership** **Total Lectures: 26**
2-0-0-2

Objective: This Course, Management and leadership focus on understanding seminal and contemporary leadership theories and principles. To provide a basis of understanding to the students with reference to the working of the business organization through the process of management.

Pre-requisite:

1.	**Introduction to Management :** Nature of Management, Meaning, Definition, it's nature purpose, importance & Functions, Management as Art, Science & Profession- Management as social System Concepts of management-Administration-Organization	**[4]**
2.	**Evolution of Management Thought:** Contribution of F.W.Taylor, Henri Fayol, Elton Mayo, Chester Barhard& Peter Drucker to the management thought. Various approaches to management (i.e. Schools of management thought) Indian Management Thought.	**[5]**
3.	**Functions of Management:** Planning - Meaning - Need & Importance, type's levels - advantages & limitations. Organizing - Elements of organizing & processes, Delegation of authority - difficulties in delegation – Decentralization, Staffing - Meaning & Importance, Controlling - Process & Techniques, Coordination - Need – Importance.	**[6]**
4.	**Introduction to Leadership**: Leadership styles, qualities of a good leader, role of a leader, trait approach to leadership, behaviour approaches to leadership; Situational theories; Transformational Leadership transactional leadership, Neutralizers and substitutes to leadership.	**[6]**
5.	**Emerging Challenges to Leadership**: Leadership in changing workplace, Leader's role in fostering teamwork, Overcoming traditional thinking Methods to enhance creative problem solving, Climate for creative thinking, Leadership practices for innovation, Ethical leadership development, Cultural sensitivity, intelligence, and global leadership skills.	**[5]**

Outcome: On successful completion of the course, students will be able to Work effectively and collaboratively with others in diverse management contexts.

Text Books:

1. Dr. L.M.Parasad, "Principles & practice of management", Sultan Chand & Sons - New Delhi, 2015
2. Stephen P.Robbins "Organizational Behavior" Pearson Publisher, 16th Edition, 2014

Reference Books:

1. Principles of Management, By Tripathi, Reddy Tata McGraw Hill, 2012
2. Essential of Business Administration - K.Aswathapa Himalaya Publishing House, 2014
3. Hughes, R., Ginnett, R., &Curphy, G. Leadership: Enhancing the lessons of experience, McGraw Hill, 7th Edition, 2017
4. Northouse, P. G. "Leadership: Theory and Practice" Sage Publications, New Delhi, 7th Edition 2015.

UC 19.202 **Business Environment** **Total Lectures: 26**

2-0-0-2

Objective: To familiarize the students about the background of the spectrum of business and its environment (internal and external).

Pre-requisite: Good General knowledge.

1.	**Dimensions of Business Environment**: Nature and characteristics of contemporary business; Types of business environment - general and task environment, Internal (Value system, Organization structure, Human Resource, Company image and brand value, Physical assets) and external Environment (micro and macro), Environmental analysis and strategic Management.	[5]
2.	**Social Environment**: Concept and salient features of Indian culture and values, Impact of culture on business, Cultural resources, Ethics and social responsibility of business, Consumerism.	[5]
3.	**Political and legal Environment*:*** Impact of competing political ideologies and role of government, Political Stability and Instability on Business Activities, Legal framework for establishing a business unit in India, Competitive Conditions, Foreign Direct Investment in India.	[5]
4.	**Economic Environment**: Economic systems – Market, Planned and Mixed economy; Indian economy – overview; Economic reforms in India; Economic policies – Determinants of National Income, Privatization, Fiscal policy and Monetary policy.	[6]
5.	**Technological Environment:** Features of technology; Impact of technology; Management of technology; status of technology in India; Policy for research and development in India.	[5]

Outcome: Understanding real life situations vis-à-vis economic, social, legal, political and technological systems in the country and analyzing the impact of changes on different industries and trends in different sectors of the economy and society.

Text Books:

1. Business Environment, Francis Cherunilam, 1st Edition, 2018.
2. Essentials of Business Environment, K Aswathappa, HPH, 12th Edition, 2014.

Reference Books:

1. Business Environment, BN Ghosh, OUP, 2015
2. Business Environment: Text & Cases (3rd Edition), Justin Paul, McGraw Hill, 2016.
3. Business Environment, AC Fernando, Pearson, 2016

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

BCA

CA 19. 101 **Computer Fundamentals** **Total Lectures: 40**
Credits : 3-0-0-3

Prerequisite(s): NIL
Objective(s): To understand the fundamentals of computers like basic working and structure of computer, data representation, and office automation and networking.

1	**Introduction to Computers**: Definition, Block Diagram, characteristics, Applications in Modern Society, History, Classification of computers and Generation of computers.	[6]
2	**Functional Units of Computer Processing System**: Hardware, CPU, Memory and secondary storage devices, Input devices, Output Devices, Information Concept and Processing: Data, Information, Knowledge and Wisdom.	[8]
3	**Data representation**: Representation of Data, Bits and Bytes, Number System: Decimal, Binary, Octal, Hexadecimal, Conversions b/w number system, Arithmetic Operations in Binary Number, ASCII, EBCDIC and BCD Codes.	[8]
4	**Software Concepts**: Types of Software, Generation of Programming Language: Machine Language, Assembly Language, High Level Language, Translator: Assembler, Interpreter, Compiler, Operating System: Functions, types of operating system: Batch Processing, Multiprogramming, Multiprocessing, Multitasking, Time Sharing and Real Time System, MS-DOS, MS-Windows.	[9]
5	**Data Communication and Computer Networks**: The Basic Communication System, Data Transmission Modes, Network types, Network Topologies, Internet and its Applications: E-mail, World Wide Web, Intranet, Extranet, Computer Threats: Virus, Worm, Trojan horse, Malware.	[9]

Outcome(s): After completion of the course, students would be able to:

- Understand the concept of input/output devices of Computers and how it works.
- Learn the working of computer network and web communication.

Text Books:

[1]. P.K.Sinha ,P.Sinha, Computer Fundamentals, 6th ed., BPB Publications, 2015.
[2]. R. Thareja, Fundamentals of Computers, 2nd ed., Oxford University Press India, 2016.

Reference Books:

[1]. ITL Education Solutions Limited, Introduction to Computer Science, 2nd ed., Pearson Education, 2011.
[2]. V. Rajaraman, Fundamentals of Computers, 6th ed., PHI, 2015

CA 19. 102 **Operating System** **Total Lectures: 40**
Credits: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- Understand the fundamental operating system abstractions like processes, threads, files, semaphores, IPC and deadlocks.
- Understand operating system from user's perspective as well as from system's perspective.
- Understand the principles of concurrency and synchronization.
- Understand basic resource management techniques.
- Understand different theoretical principles in depth through hands on high level programming.

1	**Introduction:** Definition and types of operating systems, Batch Systems, multi programming, time sharing, distributed and real-time systems, Operating system structure, Operating System Components and Services, System calls, System Programs, Virtual Machines.	**[6]**
2	**Process Management:** Process and Thread Concept, Process States, Process Control Block, Operations with examples from UNIX (fork, exec) and/or Windows, Inter-process communication (shared memory and message passing), Scheduling Algorithms, Performance Evaluation.	**[9]**
3	**Process synchronization and Deadlocks:** critical section problems, semaphores, classical Inter process communication problems. Deadlocks-System model, Characterization, Deadlock prevention, Avoidance and Detection, Recovery from deadlock, Combined approach to deadlock handling.	**[9]**
4	**Memory Management:** Logical and Physical Address Space, Swapping, Contiguous Allocation, paging and segmentation, demand paging, virtual memory page replacement algorithms.	**[8]**
5	**File and I/O Management:** Directory systems, File System Implementation issue, access methods, Allocation Methods, Free Space Management, Disk Structure, Disk Scheduling, Disk Management, Control of Various Devices, Device Drivers, Interrupt Driven and Poll Driven Data Transfer.	**[8]**

Outcome(s): By learning the course, the students will be able to,

- describe, contrast and compare differing structures for operating systems
- understand and analyse theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files

Text Books:

[1]. P. B. Galvin, A. Silberschatz, G. Gagne, Operating System Concepts, 9th ed., Wiley India, 2015.
[2]. Andrew S. Tanenbaum, Modern Operating Systems, 4th ed.,Prentice-Hall Inc., 2015.

Reference Books:

[1]. Deitel, Operating Systems,3rd ed., Pearson Education,2012
[2]. Stallings, Operating Systems: Internals and Design Principles, 7th ed., Pearson education, 2013.

CA 19.103

C- Programming **Total Lectures: 40**
Credits :3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To learn the basics of programming skills through C-Programming language.
- To understand the fundamentals concepts like syntax, and statements with essentials of efficient compiling, running and debugging processes.

1	**Introductory Concepts:** Introduction to computers, Computer characteristics, Types of programming languages, Introduction to C, identifiers and keywords,Data types: declaration and definition, Type conversion.	[8]
2	**Operators:** Arithmetic, relational, logical, bitwise, unary, assignment, Increment and Decrement operators, conditional operators and their hierarchy, associativity,Data input/output.	[6]
3	**Control Structure and Array:** Introduction, Conditional Statements; Simple If-Else; Nested Statements, switch, Loops- For, While, Do-While; Break, Continue, Go-To Statements, Labels, printf, scanf function. Defining an array, processing an array, passing arrays to functions, Multidimensional arrays, Arrays and strings.	[13]
4	**Function and Pointer:** A brief overview, Defining a function, accessing a function, function prototypes, passing arguments to a function, recursion, Pointers: Declaration, operations on pointers, array of pointers, pointers to arrays.	[7]
5	**Advance C Concepts:** Structure, Union, storage classes in C, Concept of files, file access in different modes, reading from and writing into a file, Library Functions.	[6]

Outcome(s): At the end of the course student will be able to:

- Describe the process of problem solving through C.
- Write a justifiable C program for a given algorithm.
- Trace the certain C program manually.

Text Books:

[1]. Y. Kanetkar, Let us C, 16th ed. BPB Publication, 2018.
[2]. B. W. Kernighan and D. M. Ritchie, The C Programming Language, 2nd ed., Pearson Education, 2013.

Reference Books:

[1]. H. Schildt, C: The Complete Reference, Fourth edition, McGraw- Hill Education, 2000.
[2]. E. Balagurusamy, Programming in ANSI C, 4th ed., TMH Education, 2008.

CA 19. 104 **Data Structures** **Total Lectures:40**
Credits 3-0-0-3

Prerequisite(s): CS-19.103 (C- Programming)

Objective(s):
- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems,
- To promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1.	**Introduction:** Overview of data structure, types of data structures and operations. Applications of data structures.	[4]
2.	**Pointer and dynamic memory allocation:** Pointer declaration and initialization, accessing a variable through its pointer, meaning and advantages of dynamic memory allocation, Memory allocation functions.	[9]
3.	**Array, Sorting and Searching Techniques:** Representation of single and multidimensional array. Insertion Sort, Selection Sort, Merge Sort, quick sort, Linear Search, Binary Search.	[9]
4.	**Stack & Queue:** Definition and representation of stack, operations on stack, Infix, Postfix, Prefix Expressions, Conversion from Infix to Postfix (Algorithms only). Types of queues, Primitive Operations on Queues.	[9]
5.	**Linked List & Tree:** Introduction to Linked List, implementation of Linked List, operations on linked list: creation, deletion, search and display, Tree introduction, Traversal of Binary Trees.	[9]

Outcome(s): On the successful completion of the course, the student will be able to:
- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:
[1]. Lipschutz, Data Structures, Schaum's Outline Series, TMH, Revised ed. Feb. 2014.
[2]. Horowitz and Sahani, Fundamentals of Data Structures, 2nd ed., University Press, 2008.

Reference Books:
[1]. Langsam , Augenstein and Tannenbaum, Data Structure Using C and C++, 3rd ed., PHI, 1996.
[2]. M. A. Weiss, Data Structures and Algorithm analysis in C++, 3rd ed., Addison Wesley,

CA 19. 106 System Analysis and Design

Total Lectures:40
Credits : 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To introduce the concept of system analysis for managing the projects
- To analyze and document systems, design new systems and implement their plans.

1	**Introduction to system:** Definition, characteristics and elements of system, types of system, System development life cycle, Role of system analyst.	**[6]**
2	**System Planning and Initial Investigation:** Introduction, bases for planning in system analysis, initial investigation, fact finding, information gathering, information gathering tools, fact analysis, determination of feasibility.	**[7]**
3	**Structured Analysis and Feasibility Study:** Tools of structured analysis: DFD, data dictionary, flow charts, Gantt charts, decision tree, decision table, structured English, pros and cons of each tool. Feasibility Study Objective, types, Steps in feasibility analysis, feasibility report, oral presentation, cost and benefit analysis, classification of costs and benefits.	**[10]**
4	**Designing:** System Design Objective, logical and physical design, design methodologies, structured design, form-driven methodology (IPO charts), and structured walkthrough. Input/ Output and Form Design: Objectives of input and output design, form design, classifications of forms, requirements of form design.	**[9]**
5	**System Testing and Implementation:** Objectives of testing test plan, testing techniques/types of system tests, quality assurance goals in system life cycle, System implementation.	**[8]**

Outcome(s): By learning the course, the students will be able to,

- Describe different approaches to systems analysis and design.
- Describe the five phases of the systems development life cycle (SDLC).
- Describe in detail the systems planning, systems analysis, systems design, systems implementation, and systems operation and support phases of the SDLC.

Text Books:

[1]. A wad Elias M, System Analysis and Design,,2nd ed., Galgotia Pub.(P) Ltd., 2008

Reference Books:

[1]. H. Igor, Introduction To System Analysis and Design, 5th ed., PHI, 2001
[2]. M. Lejk and D. David , An Introduction to System Analysis Techniques, 1st ed., PHI, 1998

CA 19. 107 **Foundation course in Mathematics** **Total Lectures: 40**
Credits :3-1-0-4

Prerequisite(s): Nil

Objective(s):

- To acquire fundamental knowledge of (10+02) higher Mathematics and apply in science and engineering disciplines.

1	**Matrix:** Addition, Subtraction and Multiplication of matrices, column matrix, row matrix, unit matrix, diagonal matrix, zero matrixes.	[6]
2	**Determinants:** Definition, Properties of Determinants, multiplication of Determinants, Value of Determinants up to third order, Minors and Co-factors.	[8]
3	**Algebra:** Factorial Functions, Permutations and Combinations.	[7]
4	**Calculus:** Differentiation, Integration of Standard functions, Definite Integrals.	[11]
5	**Statistics:** Frequency Distribution, Mean, Median, Mode, and Standard Deviation and Variance.	[8]

Outcome(s): After completion of the course, students would be able to apply fundamentals of (10+02) higher mathematical knowledge in science and engineering and also solve curriculum problems.

Text Books:

[1]. R.D. Sharma, 11th and 12th Mathematics, Dhanpatrai Publication, 2018.
[2]. Dass and Verma, Higher Engineering Mathematics, S.Chand, 2019.

Reference Books:

[1]. Majumder, Engineering Mathematics , Volume I, Central,1995.
[2]. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.

CA 19.108 **Python Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): C Programming (CA 19.103)

Objective(s): Python is a general-purpose, versatile and popular programming language. It's great as a first language because it is concise and easy to read, and it is also a good language to have in any programmer's stack as it can be used for everything from web development to software development and scientific applications.

1.	**Basics of Python Programming**: History of python, installation of python , execution of python program, python character set, token, data type, inbuilt functions in python, operators and expressions, translating mathematical formulae into equivalent python expressions.	[7]
2.	**Python Program Flow Control** : Conditional blocks using if, else and elif, simple for loops in python For loop using ranges, use of while loops in python Loop, nested loops, break and continue	[8]
3.	**Functions:** syntax and basics of a function, parameters and arguments in a function, local and global scope of a variable, return statement, recursive function and lambda function	[8]
4.	**Strings and Lists:** Basic inbuilt python functions for string, immutable strings, strings operators and operations, creating and accessing the elements of the list, python inbuilt functions for lists.	[9]
5.	**Tuples, sets and dictionary:** creating tuples, inbuilt functions for tuples, operations on tuples, creating sets and set operations, creating dictionary, simple program on dictionary	[8]

Outcome(s): Upon completion of this course students will be

- Familiar with Python syntax.
- Able to use python to implement a given logic.

Text Books:

1. John V Guttag, Introduction to Computation and Programming using Python, Prentice Hall of India, 2nd Edition, 2013.
2. Swaroop C H. , A Byte of Python, URL: https://python.swaroopch.com

Reference Books:

1. Zed A. Shaw ,Learn Python the hard way: a very simple introduction to the terrifyingly beautiful world of computers and code, Third edition, 2014.
2. Richard L. Halterman,Learning to Program with python, 2011.
3. Allen Downey ,Think Python How to Think Like a Computer Scientist, Version 2.0.17, Green Tea Press Needham, Massachusetts,2012.

CA 19. 133 Office Automation Laboratory

Total Hours: 26

0-0-4-2

Prerequisite(s): NIL

Objective(s): To familiarize the students in preparation of documents and presentations with office automation tools like, MS Word, MS Excel, MS PowerPoint and MS Access.

MS Word Exercise:

1. Working with Documents., Formatting Documents.
2. Setting Page style.
3. Creating Tables.
4. Drawing.
5. Mail Merging and Printing Documents.

MS Excel Exercise:

6. Spread Sheet & its Applications, Opening Spreadsheet, Menus.
7. Entering & Deleting Data.
8. Setting Formula.
9. Formatting Spreadsheets.
10. Working with sheets.
11. Creating Charts.
12. Using Tools.

MS Access Exercise:

13. Starting Access, Access Screen, Creating a New Database.
14. Creating Tables and Working with Forms.
15. Creating queries.
16. Finding Information in Databases.
17. Creating Reports.
18. Types of Reports.
19. Printing & Print Preview – Importing data from other databases viz. MS Excel etc.

MS Power Point Exercise:

20. Creating a presentation.
21. Formatting a Presentation.
22. Adding Effects to the Presentation.
23. Printing Handouts.

Outcome(s): By learning the course, the students will be able

- to perform documentation
- to perform accounting operations
- to perform presentation skills

CA 19.134 **Data Structure Laboratory** **Total Hours: 26**

0-0-4-2

Prerequisite(s): CS-19.135 (C Programming Laboratory)

Objective(s):

- To develop skills to design and analyze simple linear and nonlinear data structures
- To Strengthen the ability to identify and apply the suitable data structure for the given real
- world problem
- To Gain knowledge in practical applications of data structures

1. Implement the logic of One Dimensional Array.
2. Implement the logic of Two Dimensional Array.
3. Implement the logic of Linked List and its various operations.
4. Implementation of stack using array and Link List.
5. Implement various stack operations.
6. Implementation the logic of Queue using array.
7. Implement various operations on queue.
8. Implement all the types searching algorithms (minimum 4 programs are desired)
9. Implement all types of sorting algorithms (minimum 5 programs are desired)

Outcome(s): At the end of this course, the student will

- Be able to design and analyze the time and space efficiency of the data structure.
- Be capable to identity the appropriate data structure for given problem.
- Have practical knowledge on the application of data structures.

CA 19.135 **C Programming Laboratory** **Total Hours: 26**

0-0-4-2

Prerequisite(s): NIL

Objective(s):

- To make students familiar with syntax and structure of C-programming.
- To learn problem solving techniques using C programs implementation.

1. Implement the logic of Data Types & Operators.
2. Implement the logic of Type Conversions.
3. Implement the logic of Arithmetic, Relational, and logical operators.
4. Implementation of Bitwise, unary, assignment operators.
5. Implementation of Increment and Decrement operators.
6. Implementation of Conditional operators.
7. Implement the logic of Increment and Decrement operators.
8. Implement the 10 programs in order to cover Control Structure, If-Else statements, Nested If-Else statements, Switch-case statement, Loops- For, While, Do-While, Break Continue, Go-To Statements, and Labels.
9. Implement the 8 programs in order to cover processing an array, passing arrays to functions, Multidimensional arrays.
10. Implement the 5 programs to cover all possible String operations.
11. Implement the 4 programs in order to cover Function prototypes and passing arguments to a function, Recursion.
12. Implement the 5 programs in order to cover Pointers declaration, operations on pointers, Array of pointers, pointers to arrays.
13. Implementation of structure and union programs.
14. Implement the use of Storage classes in C programming.
15. Implement 4 programs for Reading and writing from/to a file.

Outcome(s): On competition of this course student will be able to:

- Apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner.

CA-19.136 **Python Programming Laboratory** **Total Hours:26**

Credit:0-0-4-2

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Prerequisite: (CS 19.135) C Programming Laboratory

Objectives: The objective of this course is to:

- Become comfortable with Python programming, starting from basics of data types to deep learning.
- Provide the foundation of to explore any expansions of Python whether it is machine learning, deep learning, web development or gaming. It will also put focus to learn various skills to design object-oriented software.

Contents:

- Code different data types and operations on list, dictionaries, sets, String etc
- Code basic programs like factorial, Fibonacci etc. to understand functions and recursions.
- Implement different built-in functions in Python like eval, exec, map, lambda etc.
- Implement the concept of class, objects, inheritance and polymorphism
- Implement constructor and self
- Code programs to implement exceptions and assertions
- Implement regular expressions

CA 19. 201 **Computer Organization** **Total Lectures:40**
Credits 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To understand the basics of combinational as well as sequential logic.
- To get familiar for analyzing the performance of digital circuits

1	**Boolean Algebra:** Laws and theorems of Boolean algebra. De-Morgan's theorem, XOR and XNOR gates, Half and Full Adder and Subtractor circuits.	**[5]**
2	**Fundamental Concepts:** Products, Sum of products and Product of sums, Form of Boolean expressions, Truth Tables and Karnaugh maps and Karnaugh simplification. Multiplexers, decoders, characteristics of digital integrated digitals.	**[8]**
3	**Design of Simple Computer:** Micro Operation, Macro Operation, Bus and Memory Transfers, Arithmetic and Logic Micro Operations, Shift Micro Operation, Instruction and Instruction Types	**[8]**
4	**Instruction Cycle:** Timing and Control Instruction Cycle, Memory Reference Instructions, Input Output and Interrupts, Machine Language Instructions	**[8]**
5	**I/O and Memory Organization:** Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Programmed I/O, Interrupt I/O Direct Memory Access. Memory Hierarchy, Main Memory, Auxiliary Memory, Associative, Cache Memory, Virtual Memory and Memory Management Hardware	**[10]**

Outcome(s): After successful completion of the course, student will be able to

- Develop a digital logic and apply it to solve real life problems.
- Analyze, design and implement combinational logic circuits.
- Classify different semiconductor memories.
- Analyze, design and implement sequential logic circuits.

Text Books:

[1]. M. Mano, Digital Design, 4th ed., Prentice Hall of India, 2008
[2]. R. P. Jain, Modern Digital Electronics, 3rd ed., TMH, 2003.
[3]. W. Stallings, Computer Organization and Architecture, 9th ed., Pearson,2013

Reference Books:

[1]. J. F.Wakerly, Digital Design, 4th ed, Pearson, 2008.
[2]. C.H.Roth. Fundamentals of Logic Design, 6th ed., Thomson Learning, 2013.

CA 19.203 **Database Management System** **3-0-0-3**

Total Lectures:40

Prerequisite(s): Nill

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS & RDBMS in the organization.

1.	**Introduction**: An Overview of Database Management System, Comparison of Database System and File System, Characteristics of Database Approach, DBMS Architecture, Data Models, Schema and Instances, Data Independence. Data Modeling Using Entity Relationship Model: Entity, Entity Types, Entity Set, Notation for ER Diagram, Attributes and Keys, Concepts of Composite, Derived and Multivalued Attributes, Super Key, Candidate Key, Primary Key, Relationships, Relation Types, Weak Entities, Inheritance, Specialization and Generalization.	**[10]**
2.	**Relational Data Model:** Relational Model Terminology: Domains, Attributes, Tuples, Relations, Characteristics of Relations, Relational Constraints: Domain Constraints, Key Constraints, Relational Database Schema, Relational Database Design By ER To Relational Mapping. Introduction to SQL.	**[11]**
3.	**Normalization:** Functional Dependencies, Armstrong's Inference Rule, Normal Form up to Boyce Codd Normal Form.	**[4]**
4	**Relational Algebra:** Selection, Projection, Set Theoretic Operations Union, Intersection, Set Difference And Division, Inner, Outer, Left Outer, Right Outer and Full Outer Join.	**[8]**
5.	**Transaction Processing And Concurrency Control:** Definition of Transaction, Desirable ACID Properties, Serializable And Non Serializable Transactions, Concurrency, Lost Update, Dirty Read, Concurrency Control Techniques: Locking, 2PL	**[7]**

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.

Text Books:

[1] R. Elmasri & S. B. Navathe, Fundamentals of Database Management Systems, 7th ed., Pearson Education, 2016.

[2] R. Ramakrishnan, Database Management Systems, 3rd ed., Tata McGraw Hill, 2008.

Reference Books:

[1] Korth and Schilberschatz, Database System Concepts, 6th ed., Tata McGraw Hill, 2011.

[2] C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CA 19. 204 **Computer Networks** **Total Lectures: 40**
Credits: 3-1-0-4

Prerequisite(s): Nill

Objective(s):

- To become familiar with layered communication architectures (OSI and TCP/IP).
- To understand the client/server model and key application layer protocols.
- To understand fundamentals of computer networks and major routing protocols.

1	**Basic concepts of networks and Layered Architecture:** Computer networks introduction, network topologies, protocols and standards, Client-Server transactions, Network devices: repeaters, bridges, gateway, Routers; categories of networks- LAN, WAN and MAN. Layers and their function, OSI reference model, TCP/IP model, Comparison of models.	**[9]**
2	**Physical layer:** Transmission Media, guided and unguided; Attenuation, Distortion, Noise, Switching.	**[7]**
3	**Data Link Layer:** Functionality, Framing, Encoding Techniques, Design Issue, Error Detection & Correction Codes, MAC.	**[7]**
4	**Network & Transport Layer:** Routing Algorithms (Distance Vector & Link State), IPv4 and IPv6, Connection Oriented and Connection Less services, Sliding Window Protocols.	**[8]**
5	**Application Layer :** Network Security & Privacy, Data Compression & Cryptography, Electronic Mail (SMTP, POP3, IMAP), DNS, FTP, HTTP, telnet etc.	**[9]**

Outcome(s): On successful completion of this course, students will be able to

- Analyze computer network component and devices.
- Synthesize how communication works in a network and internet.
- Formulate the concept of topologies and their applications.
- Analyze protocol at different layers and how they play important role in network implementation.
- Enumerate the layers of OSI and TCP/IP models.

Text Book: [1]. B. A. Forouzan, Data Communications and Networking, 5th ed., Tata McGraw Hill, 2013.

Reference Book: [1]. A. S. Tanenbaum, Computer Networks, 4th ed., Prentice-Hall of India, 2002.

CA 19. 206 **Computer Graphics** **Total Lectures: 40**
3-1-0-4

Prerequisite(s): CS-19.103 (C Programming)

Objective(s):

- To introduce the students with the graphics mode, with the help of basic algorithms and methodologies.
- The objective of the course is to equip students with fundamental knowledge and basic technical competence in the field of computer graphics.
- Provide an understanding of how a computer draws the fundamental graphics primitives.
- To learn Computer Graphics methodologies/Algorithms and techniques.

1	**Basic Concepts:** Application Areas of Computer Graphics, Graphical User Interface, RGB Color model, CMY color models, Advantages of Computer Graphics.	**[8]**
2	**Graphics Hardware:** Random Scan Displays, Raster Scan Display (with Introduction to Flickering, Interlacing, American Standard Video), Color CRT Monitors, Flat Panel Display (Plasma Panel, Liquid Crystal Display, Electroluminescent Display).	**[7]**
3	**Raster Graphics Algorithms:** Line Drawing Algorithms-DDA, Bresenham's Algorithm, Circle and Ellipse Drawing Algorithms, Filling (Scan-Converting Polygon Filling, Inside Outside Tests Boundary Fill and Area Fill Algorithm). Cohen- Sutherland Algorithm of clipping.	**[12]**
4	**Transformations:** 2-D Transformations (Rotation, Reflection,Shearing, Scaling), Homogeneous Coordinate Representation, and Translation.	**[8]**
5	**Animation Introduction:** Conventional and Computer-Assisted Animation, Animation languages, methods of controlling Animation, basic rules of Animation.	**[5]**

Outcome(s): On successful completion of this course, students will be able to

- Understand basic concepts of computer graphics.
- Acquire knowledge about drawing basic shapes such as lines, circle ellipse, polygon.
- Perform processing of basic shapes by various processing algorithms /techniques.
- Implement two dimensional transformations.

Text Books:

[1]. D. D. Hearn and M. P. Baker, Computer Graphics, 3rd ed., Prentice Hall India, 2011.
[2]. A. Kalbag, Computer graphics & animation, 1st ed., Usborne, 1999.

Reference Books:

[1]. J. D. Foley, A. V. Dam, S. K. Feiner, J. F. Hughes, Computer Graphics Principles and Practice, 2nd ed., Addison Wesley, 1995.
[2]. D. F. Rogers, Procedural Elements for Computer Graphics, 2nd ed., Tata McGraw Hill Publications, 2001.

CA 19. 207 **C++ Programming** **Total Lectures: 40**
Credits: 3-0-0-3

Prerequisite(s): CS-19.103 (C Programming)

Objective(s):

- To get a basic knowledge of object-oriented concepts.
- To master in programming related to classes inheritance using C++.

1	**Introduction to Object Oriented Programming and C++:** Basic concepts of object–oriented programming, Structured versus object- oriented programming, merits and demerits of object oriented methodology. C++ Preprocessor directives, Variables, data types, constants, operators, scope resolution operator, memory management operators, decision and loop control structures, arrays, strings, functions.	**[8]**
2	**Classes and Objects:** Class definition, Structure versus class, accessing member functions within a class, data hiding, arrays within a class, static data and member functions, objects, friend functions and friend classes, constant member functions, pointers to members, constructors and destructor.	**[9]**
3	**Overloading and Exception Handling:** Definition, unary operator overloading, binary operators overloading, overloading of new and delete operators, manipulation of string using operators, type conversion, overloading with friend functions, function overloading, error and exception handling.	**[9]**
4	**Inheritance and Overriding:** Derived and base classes, type of inheritance, derived class constructors and destructor, overriding member functions, public and private inheritance, virtual base classes, abstract classes, this pointer, virtual functions and pure virtual functions, static and dynamic bindings.	**[8]**
5	**Introduction of I/O Streams and the Standard Library:** Header files, I/O stream library, stream I/O for objects, file I/O.	**[6]**

Outcome(s): On the successful completion of the course, the student will be able to:

- To gain the basic knowledge on object oriented concepts.
- To understand the role of inheritance, polymorphism, dynamic binding and generic structures in building reusable code.

Text Books:

[1]. R. Lafore, Object-Oriented Programming in C++, 4th ed.,Pearson Education, 1997.
[2]. Balagurusamy E., Object Oriented Programming With C++, 6th ed., Tata McGraw Hill Publishing Co. Ltd., 2013.

Reference Books:

[1]. Stroustrup Bjarne,Programming -Principles and Practice Using C++, 4th ed.Addison-Wesley, 2013
[2]. Schildt Herbert, “C++: The Complete Reference”, 4th ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2003.

CA 19. 208 **Electronic Commerce** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Computer Fundamental

Objective(s): A comprehensive overview of how firms compete in today's environment with a focus on strategic choices and the infrastructures affecting e-commerce including technology, capital, media, and public policy.

1	**Electronic Commerce**: Overview and Scope, Traditional Commerce vs.ElectronicCommerce,ImpactofE-Commerce,Electronic Markets,InternetCommerce,e-commerceinperspective,ApplicationofE Commerce inDirect Marketingand Selling,advantagesand disadvantages,and futureof E-commerce	**[6]**
2	**BusinessstrategyinanElectronicAge:**ValueChains,Supplychain,Porter's value chain Model, Inter Organizational value chains, Strategic Business unit chains and industryvalue chains.	**[8]**
3	**Business toBusiness E-Commerce**: Inter-organizational Transitions, Credit TransactionTradeCycle,avariety oftransactions.Electronic DataInterchange (EDI):Introduction,BenefitsofEDI,EDITechnology,EDI standards,EDI Communication, EDI Implementation, EDIagreement, EDIsecurity.	**[8]**
4	**Electronic Payment System:** Introduction, Online Payment System, Prepaid Electronic Payment System, Post Paid Electronic System, E-Cheques, Credit Cards, Smart Cards, E-Purses, DebitCards,LegalRisk of E-Payment System.	**[9]**
5	**Securing NetworkTransaction:** Security Policy, Procedures and Practices, Transaction Security, Cryptography Algorithm, Public Key Algorithm,AuthenticationProtocol,Digital Signature, E-Mail Security. Different case studies of E commerce	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Illustrate management's role in the networked economy.
- Identify strategies involved in running an e-commerce company.
- Identify factors of successful implementation of an online strategy.
- Compare metrics used to evaluate progress of an e-commerce strategy.
- Summarize the effect of laws and regulations on e-commerce and Internet business.

Text Books:

[1]. Whitely David, "E-commerce Strategy, Technology and application", Tata McGraw Hill Publications, New Delhi,2005.

Reference Books:

[1]. Kalakota ,R. and Whinston, A. B. "Readings in Electronic Commerce", Addison Wesley.2006
[2]. Schneider, Gary P. and Perry ,Jame, "Electronic Commerce" Thomson Publication.2003
[3]. P.T. Joseph, S.J., "E-Commerce :An Indian Perspective", PHI.

CA 19. 209 **Discrete Mathematics** **Total Lectures: 40**
3-1-0-4

Prerequisite(s): Nill

Objective(s):
- To Introduce fundamental concepts and applications of discrete structure in the field of computer science

1	**Set Theory:** Definition of Sets, Subsets, Cardinality of Sets, types of sets: Equal Sets, Universal Sets, Finite and Infinite Sets, proper set, power sets, Operations on Sets: Union, Intersection, Complement of Sets, set difference, Cartesian Product, Venn Diagrams, and Algebra of sets, duality, counting principle.	**[10]**
2	**Relations and Functions:** Definition, types of relation, Ordered Pairs, properties of relation, equivalence relations, partial ordering relation. Function: Domain and Range, Onto, Into, and One to One Function, Composite and Inverse Functions.	**[8]**
3	**Algebraic Structures:** Definition of a group, properties of group, different types of group, subgroup, finite, infinitely, countable and Cyclic Groups.	**[8]**
4	**Prepositional Calculus:** Propositions, Logical Connectives: conjunction, disjunction and negation, Truth Tables, Tautologies and Contradictions, Conditional and Bi-conditional statements.	**[8]**
5	**Counting:** Basic principles, permutations, combinations, summations, principle of inclusion and exclusion, pigeon-hole principle.	**[6]**

Outcome(s): On the successful completion of the course, the student will be able to:
- Understand the theory and techniques of logic, graphs and trees, and algebraic systems.
- Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.

Text Book:
[1]. B. Kolman, C. Robert , S. Busb, C. Ross, Discrete Mathematical Structures, 6th ed., PHI, 2009.
[2]. H. R. Kenneth, Discrete Mathematics and Its Applications, 7th ed., TMH, 2011.

Reference Book:
[1]. Swapan Kumar Chakraborty, BikashKanti Sarkar, Discrete Mathematics, Oxford Higher Education, 2011
[2]. C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, Tata Mcgraw-Hill, 3rd Edition, 2008.

CA 19. 210 **Java Programming** **Total Lectures: 40**
3-1-0-4

Prerequisite(s): Nill

Objective(s): The objective of this course is to:

- Cover issues related to the definition, creation and usage of classes, objects and methods.
- Discuss the principles of inheritance and polymorphism.
- Provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.

1	**Basics of Java Programming:** Importance of Java, Java Byte code, Java and HTML, the Java buzzwords, using blocks of code, lexical issues, Java Class Libraries. Constants, Variables, Data Types, Operators, Type Conversion in Expression, Mathematical Functions, Decision Control Structure, Loop Control Structure, Arrays.	**[10]**
2	**Class and Inheritance:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, the this keyword, garbage collection, the finalize () method, overloading methods, using objects as parameters, returning objects, recursion, introducing access control, understanding static, introducing final, arrays revisited, introducing nested and inner classes, Wrapper Classes. Inheritance: Multilevel hierarchy, method overriding, Abstract classes, Final classes, String Class.	**[10]**
3	**I/O and String Handling:** I/O basics, reading console input, writing console output, the PrintWriter class, reading and writing files, String and StringBuffer class, Various Types of string operations related to both the classes.	**[6]**
4	**Package, Interfaces and Exception Handling:** Packages, importing packages, interfaces, exception-handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, creating your own exception subclasses, using exceptions.	**[7]**
5	**Applet Programming:** Applet life cycle, creating executable application, Designing a web page, Applet Tag, Parameter passing in applets, Graphic Class, lines, rectangles, circle and ellipse, polygons.	**[7]**

Outcome(s): Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifies, automatic documentation through comments, error exception handling).

Text Book:
[1]. H. Schildt, Java The Complete Reference, 8th ed., Herbert Schildt, 2011.
[2]. J. Jukowski, Mastering Java J2SE 1.4, SYBEX, 2002.

Reference Book:
[1]. A. B. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
[2]. P. Deitel, H. Deitel , Java How To Program, 10th ed., Deitel publication, 2014.

CA 19. 231 **Management Information System** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Computer Fundamental

Objective(s): To understand how to leverage information systems to effectively operate and grow an enterprise. The course provides a foundation in the theory and practical application of information systems within an organization. Managing, analyzing, designing, and implementing an MIS will be the focus of the course

1	**Introduction:** Elements, characteristics, objectives and importance, relationshipbetween MIS and Computer, role of MIS in the functions of management.	**[6]**
2	**Information:** Classification of information, levels of information,techniques of data collection, quality aspect of information, value of Information	**[8]**
3	**Decision Making:** Decision making concepts, rationality in decision making,decision support system, MIS as a technique for programmed decisions, structured v/s Un-structured decisions, formal vs. informal systems, model of decision making, methods, MIS and role of decision making.	**[8]**
4	**Manager and Computers:** Database concept, database models, database design,RDBMS, MIS and RDBMS, network topology, LAN, MAN, WAN and data communication.	**[9]**
5	**Development and Application of MIS:** Strategic and project planning for MIS, conceptual systemdesign, detailed design, implementation, evaluation and maintenance of the MIS, pitfalls of MIS. MIS for marketing, financial, production management,human resource management.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- understand and articulate fundamental concepts of information technology management.
- assess and apply IT to solve common business problems.
- suggest and defend effective solutions to business problems, and design a database application to solve a business problem.
- discuss the ethical aspects of information technology use in the organization and its governance issues.

Text Books:

[1]. Jawadekar,W. S. “Management Information System”, Tata McGraw- Hill Publishing Co. Ltd., New Delhi, 2004

Reference Books:

[1]. Murdick, R, G, Ross J E and Clagget, J,R, “Information Systems for Modern Management”, PHI, New Delhi.,2003
[2]. Sadagopan, “Management Information System”, PHI, New Delhi.2010.
[3]. Parker, Case Thomas, “Management Information System: Strategies and Action”, Tata McGraw- Hill Publishing Co. Ltd., New Delhi

CA 19.232 **Enterprise Resource Planning** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Computer Fundamental and Networking

Objective(s): This course will enable student understanding of issues and decisions that must be made when embarking upon a ERP selection and implementation journey. It will also lead to an understanding the challenges associated with managing extant ERP systems.

1	**Overview:** Definition, ERP & Business, Evolution of ERP, Need of ERP, Features of ERP, Motivation behind ERP, Technologies & Infrastructure required for ERP, Demerits of ERP, benefits & application, BPR & ERP,ERP Market.	**[6]**
2	**Data Mining & Data Warehousing:** Foundation of Data Mining, scope of Data Mining, Mechanism, Data Mining methods & Algorithms, Relevance of Data Mining to BPR, Database marketing by Data mining. Data warehouse Management System, Business Intelligent system architecture, features, Application, Necessity of Data warehousing, critical factors for the failure of Data warehouse.	**[8]**
3	**Implementation Issues:** Implementation Methodologies, Post Implementation Issue, Hidden Costs of ERP (Training, Testing, Dirty Data), Role of consultant	**[8]**
4	**ERP Module :** BAAN, SAP, ORACLE, People soft, Comparison of major ERP packages	**[9]**
5	**ERP & E-commerce:** Electronic Data Interchange, Advantage of EDI with respect to business, ERP fitness with E-commerce, Post ERP work with E-commerce, ERP & Internet.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Understand and gain insight into process views of organizations and tools and techniquesused to model both as-is and to-be models.
- Apply the process modeling techniques in one or more modeling environments.
- Know and be able to apply key technical terminology in enterprise information systems asthey apply in different ERP products and development methods
- Understand key differences between the major ERP applications (such as SAP R/3, andOracle/PeopleSoft/Sibel) and issues specific to these applications their configuration andmanagement.
- Analyze a current architecture and perform an effective gap analysis before an ERP implementation
- Be able to map enterprise architectural resources to a contemporary Enterprise Architecturemapping tool.

Text Books:

[1]. Luvai F. Motiwalla, Jeff Thompson, Enterprise Systems For Management, Pearson Education., 2nd Ed., 2011
[2]. Ravi Shankar, S.Jaiswal, Enterprise Resource Planning, Galgotia Publication Pvt. Ltd., 2nd Ed., 2005.

Reference Books:

[1]. Monk, E. F., Wagner, B. J., Concepts in Enterprise Resource Planning, Course Technology CengageLearning,3rd Ed. 2009.
[2]. Chuck Munson, Supply Chain Management Casebook : The Comprehensive Coverage and Best Practices in SCM, Pearson FT Press 2013.
[3]. Ferran, C., and Salim, R., Enterprise Resource Planning for Global Economics: Managerial Issues and Challenges, Information Science References, 2008.

CA 19.237 **Software Project Management** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): (System Analysis and Design)

Objective(s):

- To introduce the concepts of Software Project Management to the students.
- To make the students understand the requirement for project evaluation.
- To make the students understand the requirement for Software quality assurance and project management along with its tools.

1	**Introduction to Software Project Management (SPM) : S**oftware Engineering problem and software product, software product attributes, definition of a Software Project (SP), SP vs. other types of projects activities covered by SPM, categorizing SPs, Project Management cycle, SPM framework, types of project plan	**[10]**
2	**Project Evaluation:** Strategic assessment, technical assessment, cost benefit analysis, cash flow forecasting, cost benefit evaluation techniques, risk evaluation	**[8]**
3	**Activity Planning**: Objectives, project schedule, sequencing and scheduling activities, network planning models, forward pass, backward pass, activity float, shortening project duration, activity on arrow networks.	**[8]**
4	**Managing people and Organizing teams:** Introduction, understanding behaviour, organizational behavior, working in groups, becoming a team, decision making leadership, organizational structures.	[7]
5	**Software Quality Assurance and Testing:** Testing principles and objectives, test plan, types and levels of testing, test strategies, program verification and validation, software quality, SEI-CMM,SQA activities, QA organization structure, SQA plan	**[7]**

Outcome(s): After completion of the course, students would be able to:

- Identifying the essential skills required to be an excellent project manager
- Analyzing the main factors influencing project management outcome

Text Books:

[1]. Bob Hughes, Mikecotterell, "Software Project Management", Fourth Edition, Tata McGraw Hill, 2009.

[2]. AshfaqueAhmed,"Software Project Management: A Process-Driven Approach",CRC Press, 2016.

Reference Books:

[1]. Ramesh, Gopalaswamy, "Managing Global Projects", Tata McGraw Hill,2nded. 2005.

[2]. Royce, "Software Project Management", Pearson Education, 1999

[3]. Walker Royce Software Project Management,, Addison Wesley, 1998.

CA 19. 263 **System Software** **Total Lectures: 40**

3-0-0-3

Prerequisite(s): Basic concepts of Unix-like systems. Shells and scripting. System-level programming in the C language. Software development tools and techniques.

Objective(s): This course provides an introduction to computer systems and explores the design and implementation issues of System programs that play an important role in program development.

1	**Overview:** Language processors, data structures for language processors, assemblers,macrosandmacroprocessors,compilers,interpreters, linkers and loaders.	**[6]**
2	**Operating System:** Functions of Operating System, Kernel, Shell, Process, Process state diagram, System Calls	**[8]**
3	**Assemblers:** Design of an assembler ,one pass and two pass Assembler, Databases of Assemblers,tableprocessing	**[8]**
4	**MacroProcessors:**Importance of Macro, MacroDefinition,Macro call,Macro Expansion,ConditionalMacroexpansion,Nesting ofMacros,FunctionsofMacro Processor .	**[9]**
5	**Loaders, Linkers and Compilers:**FunctionofLoaders, loaderschemes-compileandgo, general,absolute,subroutinelinkages,relocating loaders,directlinkingloaders, binders, linkingloaders,overlays, dynamicbinders,TypesofCompilers,Phases of compilerdesign,recursion,calland return statements.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Apply knowledge of mathematics, science, and engineering
- Design a system, component, or process to meet desired needs within realistic constraints.
- Identify, formulate, and solve engineering problems Understand the concept of input/output devices of Computers and how it works.

Text Books:

[1]. Donovan J.J., “Systems Programming”, New York, Mc-Graw Hill, 3rd Ed 1993.

Reference Books:

[1]. Leland L Beck,”System Software, An Introduction to System Programming”, Pearson Education, 13th Indian Reprint, New Delhi,2003

[2]. Dhamdhere, D.M., “Introduction to Systems Software”, Tata Mc-Graw Hill 1996.

CA 19. 265 **Internet Technologies** **Total Lectures: 40**
Credits 3-0-0-3

Prerequisite(s): Computer Fundamental

Objective(s): Internet Technologies presents the student with an introduction to the Internet and its services, applications and tools

1	**Introduction:** Layering, TCP/IP Layering, Internet Addresses, The Domain Name System,Client ServerModel, PortNumbers,Implementations andApplication, Programminginterfaces.	**[6]**
2	**IP**:TheLinkLayerEthernetandIEEE802EncapsulationTrailerEncapsulation,**SLIP:**SerialLineIP, Compressed SLIP,**PPP**: Point-to-Point Protocol. TheInternetProtocolIPHeader,IPRouting,SubnetAddressing,SubnetMask, Special CaseIPAddresses.	**[8]**
3	**Introduction toARP**: Address Resolution Protocol and RARP: Reverse Address Resolution Protocol, ARP Packet Format, ProxyARP, RARPPacketFormat.	**[8]**
4	**ICMP**:InternetControlMessageProtocolIntroduction,ICMP,MessageTypes,ICMP Address, Mask Request and Reply , IP Routing RoutingPrinciples, Introduction to Dynamic Routing; . UDP: User Datagram Protocol UDP Header, UDP Checksum; DNS: The Domain Name System DNS Basics, DNS Message Format, security	**[9]**
5	**TCP**: Transmission Control Protocol TCP Services, TCP Header TCP Connection, Establishment and Termination, TCP Timeout and Retransmission, Repacketization; Telnet and Rlogin Remote Login Rlogin Protocol, SMTP Protocol; FTP: File Transfer Protocol and SMTP: Simple Mail Transfer Protocol.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Understand different types of networks, various topologies and application of networks.
- Understand types of addresses, data communication.
- Understand the concept of networking models, protocols, functionality of each layer.
- Learn basic networking hardware and tools.

Text Books:

[1]. Tannenbaum A. S., “Computer Networks”, Prentice-Hall India., New Delhi
[2]. ForouzanBehrouz A, “Data Communication and Networking”, TMH, New Delhi

Reference Books:

[1]. Sybex ,“Networking Complete”, BPB Publication, New Delhi
[2]. Stallings Willam, “Data and Computer Communication”, Pearson Education, New Delhi

CA 19.267 **Network Security** **Total Lectures: 40**
Credits 3-0-0-3

Prerequisite(s): Computer Fundamental and Networking,
Basic Mathematics.

Objective(s): Students will learn the basic concepts in computer security including software vulnerability analysis and defense, networking and wireless security, applied cryptography, as well as ethical, legal, social and economic facets of security.

1	**Introduction:** Attacks, Services and Mechanisms, Security Attacks, Security Services, Integrity check, digital Signature, authentication, has algorithms	**[6]**
2	**Secret Key Cryptography:** Block Encryption, DES rounds, S-Boxes IDEA: Overview comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB CBC, OFB, CFB, Multiple encryptions DES, Hash Functions and Message Digests: Length of hash, uses, algorithms (MD2, MD4, MD5, SHS) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages,digest computation.) SHS: Overview, padding, stages	**[8]**
3	**Public key Cryptography:** Algorithms, examples, Modular arithmetic (addition,multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption.Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures	**[8]**
4	**Authentication:** Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs offline guessing, storing. Cryptographic Authentication:passwords as keys, protocols, KDC's Certification Revocation, Interdomain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution, smart cards, biometrics, Kerberos: purpose, authentication, serer and ticket granting server, keys and tickets, use of AS and TGS, replicated servers. Kerberos V4: names, inter-realm authentication,Key version numbers. Kerberos V5: names, realms, delegation, forwarding and proxies, ticket lifetimes, revoking tickets, multiple Realms	**[9]**
5	**Network Security:** Electronic mail security, IP security, Network management security.Security for electronic commerce: SSL, SET. System Security: Intruders and Viruses, Firewalls, Intrusion Detection	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Identify the security goals of an information system, point out contradictory goals and suggest compromises.
- Understand of the principles underlying cryptography and cryptanalysis and have a technical understanding of the main cryptographic concepts and technologies.
- Understand the purpose of security protocols and be witness to the difficulties of their verification.

Text Books:

[1]. AtulKahate," Cryptography and Network Security", TMH, New Delhi
[2]. Kaufman, C., Perlman, R., and Speciner, M., "Network Security, Private Communication in a public world" , PHI

Reference Books:

[1]. Stallings, W., "Cryptography and Network Security: Principles and Practice", Prentice Hall.
[2]. BehrouzAForouzan, "Cryptography and Network Security"; McGraw Hill.

CA 19. 373 **Software and CASE Tools** **Total Lectures: 40**

3-0-0-3

Prerequisite(s): Computer Fundamental, Computer programming

Objective(s):

- To introduce the concept of software crisis, managing complexity, requirements specification, architectural and detailed design, testing and analysis, software process, and tools and environments.
- Explores concepts and techniques for design and construction of reliable and maintainable software systems in modern high-level languages; program structure and design; program-correctness approaches, including testing; and event-driven programming

1	**Software Engineering Fundamentals :** Definition of software product and process, Software Characteristics, Components, Applications, Layered Technologies, Processes and Product, Methods and Tools, Generic View of Software Engineering, Software Crisis and Software development paradigms	**[6]**
2	**Software Requirements Analysis & Specification:** System specification, Software requirements specification (SRS) standards, Analysis Modeling: Difference between Data and Information, ER Diagram, Dataflow Model, Control Flow Model, Control and Process Specification, Data Dictionary	**[8]**
3	**Software Design:** Software architecture, Modular design - cohesion and coupling, Process-oriented design, Data-oriented design, User-interface design, Real-time software design, introduction to Object Oriented Design	**[8]**
4	**CASE Tools, Coding and Testing:** Computer-aided software engineering, Introduction to CASE, Building Blocks of CASE, Integrated Case Environment, Characteristics of good Programming languages, Introduction to Testing Process, Testing Activities like Unit, Integration & System Testing.	**[9]**
5	**Reengineering, Quality and Metrics:** Business Process Reengineering, Reverse Engineering, Software re-engineerin. SQA-Software Quality Assurance, Software Reliability, Software quality metrics, SQA plan, ISO 9000 and 9001 Quality Standards.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Make independent and critical assessments,
- Identify, formulate and solve problems autonomously, and
- Deal with changes in working life.
- Stay abreast of the development of knowledge, and
- Communicate their knowledge to others, including those who lack specialist knowledge in the field.

Text Books:

[1]. Pressman R.S. , "Software Engineering", TMH 7th Ed 2014.

[2]. PankajJalote,"An Integrated Approach to Software Engineering", NAROSA, 2005.

Reference Books:

[1]. Designing Flexible Object Oriented systems with UML - Charles Ritcher

[2]. Fairely, R.E., "Software Engineering Concepts", McGraw-Hill

[3]. Object-Oriented Analysis and Design: using UML Mike O'Docherty Wiley Publication

ET 19.362 **Mobile Apps Development** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CA 19.210 (Java Programming)

Objective(s):
- To learn how mobile apps are different from others traditional apps by learning those aspects of mobile programming that make it unique from other platforms
- Program mobile applications for the Android operating system that use basic and advanced phone features
- Deploy applications to the Android marketplace for distribution.

1	**Getting started with Mobility:** Mobility landscape, mobile platform, mobile apps development, overview of android platform, setting up the mobile app development environment along with an emulator, a case study on mobile app development.	[8]
2	**Building blocks of mobile apps: Apps user:** Interface designing-mobile UI resources (Layout,UI elements, Draw-able,Menu), activity-states and life-cycle, interaction amongst activities. app-functionality beyond user interface- threads, async task, service –state and life cycle, notification, broad cast receivers, telephony and smsapis native data handling-on device file I/O, shared preferences, mobile database such as SQLite, and enterprise data access(via Internet/Intranet)	[15]
3	**Sprucing up mobile apps:** Graphics and animation- custom views, canvas, animation APIs, multimedia-audio/video playback and record, location awareness, and native hardware access (sensor such as accelerometer and gyroscope).	[8]
4	**Testing mobile apps:** Debugging mobile apps, whiteboxtesting,blackbox testing, and test automation of mobile app, JUnit for Android, Robotium, Monkey Talk.	[6]
5	**Taking apps to market:** Versioning signing and packaging mobileapps, distributing apps on mobile market place.	[3]

Outcome(s): On successful completion of this course, students will be able to
- Understand the android operating system in details
- Create mobile application for various screens
- Deploy on play store market
- Use various sensors available in mobile

Text Books:
[1]. Barry Burd, Android Application Development All in One for Dummies, Johen Wiley & Sons Inc., Edition I , 2011.
[2]. AnubhavPradhan ,Anil V Deshpandy, Mobile App Development, Edition

Reference Books:
[1]. Lauren Darcey, Shane Conder,"Teach Yourself Android Application Development in 24 Hours",Sams Publishing, 2012, 2nd Edition , 2012.

ET 19.471 **Cloud Computing (Infosys)** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Computer Fundamental and Networking
Object Oriented Design and Programming

Objective(s): This course covers a series of current cloud computing technologies, including technologies for Infrastructure as a Service, Platform as a Service, Software as a Service, and Physical Systems as a Service.

1	**Overview of Cloud Computing:** Brief history and evolution - History of Cloud Computing, Evolution of Cloud Computing, Traditional vs. Cloud Computing. Why Cloud Computing, Cloud service models (IaaS, PaaS&SaaS). Cloud deployment models (Public, Private, Hybrid and Community Cloud), Benefits and Challenges of Cloud Computing. Introduction to AWS Public Cloud Vendor. Cost optimization in AWS.	**[6]**
2	**Virtualization**: Basics of virtualization, Virtualization technologies, Server virtualization, VM migration techniques, Role of virtualization in Cloud Computing. Introduction to EC2 service of AWS.	**[8]**
3	**WWoWorking with Private Cloud**: Private Cloud Definition, Characteristics of rivate Cloud, Private Cloud deployment models, Private Cloud Vendors - CloudStack, OpenStack, Eucalyptus Microsoft, Private Cloud – Benefits and Challenges. Private Cloud implementation in Amazon EC2 service.	**[8]**
4	**Working with Public Clouds:** What is Public Cloud, Why Public Cloud, When to opt for Public Cloud, Public Cloud Service Models, and Public Cloud Players. Infrastructure as a Service Offerings, IaaS Vendors, PaaS offerings, PaaS vendors, Software as a Service. Demonstrating public cloud with AWS – Storage and Database services. Private vs. Public Cloud – When to choose.	**[9]**
5	**Overview of Cloud Security:** Explain the security concerns in Traditional IT, Introduce challenges in Cloud Computing in terms of Application Security, Server Security, and Network Security. Security reference model, Abuse and Nefarious Use of Cloud Computing, Insecure Interfaces and APIs, Malicious Insiders, Shared Technology Issues, Data Loss or Leakage, Account or Service Hijacking, Unknown Risk Profile, Shared security model between vendor and customer in IAAS/PAAS/SAAS, Implementing security in AWS. Migration paths for cloud, Selection criteria for cloud deployment, Issues/risks in cloud computing, Future technology trends in Cloud Computing.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Understand the concepts of cloud computing
- Understand the advantages and limitations of different cloud architectures.
- Understand the enabling technologies for building cloud systems.
- Understand the concept of security in cloud computing.

Text Books:

[1]. Cloud Computing: Principles and paradigms By Raj Kumar Buyya, James Broberg, AndrezeiM. Goscinski, 2011
[2]. Cloud Computing, By Michael Miller, 2008.
[3]. Cloud Computing for dummies, By Judith Hurwitz, Robin Bllor, Marcia Kaufman, Fern Halper, 2009.

Reference Books:

[1]. Rittinghouse, John, W. Cloud computing: Implementation, management and security
[2]. Rhoton, John, Cloud Computing Architected: Solution Design Handbook.
[3]. Krutz, Ronald L.; Vines, Russell DeanKalakota ,R. and Whinston, A. B.,"Cloud Security: A comprehensive Guide to Secure Cloud Computing", Addison Wesley.

UC 19.101 **Social and Professional Ethics** **Total Lectures: 26**
2-0-0-2

Objective: To create an awareness on professional ethics and human values, To instill moral and social values and loyalty and to appreciate the rights of others.

Pre-requisite:

1.	**Basic Human Values:** Morals, Values and Ethics – Truth, Rights Conduct (Righteousness), Love, non-violence and peace, Humility and character. Core areas of ethics: Social ethics, Personal ethics Integrity and Trustworthiness, Honesty, Loyalty, Courage, Prudence, Confidence, Confidentiality.	**[5]**
2.	**Theories of Ethics:** Kohlberg and Gilligan's analysis of moral development, - Deontology, Utilitarianism, Virtue Theory Rights Theory, Casuist Theory of Consequentialism – Robert Nozick's Theory of Entitlement and Property Rights.	**[4]**
3.	**Professional Ethics:** Introduction, meaning of work ethics, professional ethics for Journalists, Physicians, Lawyers, Engineers and Accountants. Intellectual property Rights, scope of ethics, code of conduct, business values and inner consciousness, Ethics at the workplace cybercrime, plagiarism, misconduct, fraudulent use of institutional resources, etc.	**[7]**
4.	**Corporate Social Responsibility:** Evolution of Corporate Social Responsibility (CSR) in India, CSR models, CSR to different stakeholders, Corporate Social Responsibility Initiatives of Major Companies of India, Promoting value based governance in organization. Whistle blower policy.	**[6]**
5.	**Ethics and Environment:** Introduction to environmental Issues- Industry and Environmental Pollution, Ethics of Controlling environmental pollution – Impact of environmental pollution on human health – Rights, Duties and care in environmental protection - Sustainable development.	**[4]**

Outcome: The students will understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories.

Text Books:

1. B.N Ghosh "Business Ethics and Corporate Governance", McGraw Hill Education, Chennai, 2016
2. John R Boatright, "Ethics And The Conduct Of Business", Pearson Education, New Delhi, 2013.

Reference Books:

1. Raju Ramachandran, "Professional Ethics: Changing Profession and Changing Ethics", LexisNexis, Butterworths, 2nd Edition 2014.
2. Andrew Crane and Dirk Matten, "Business Ethics", Oxford University Press, 2nd Edition, 2015.
3. S.K Mandal "Ethics in Business and Corporate Governance" McGraw Hill Education, New Delhi, 2013.
4. R. Subramanian "Professional Ethics", Oxford University Press, 2015.

UC 19.102 Communication Skills **Total Lectures: 26**

2-0-0-2

Objective: This Course aims to develop and enhance the linguistic and communicative competence of the students. The students will be exposed to various forms of personal and professional communication. The self-learning tasks designed will facilitate to enhance effective communication skills.

Pre-requisite:

1.	**Introduction to Communication:** Need for Effective Communication, The Process of Communication, Use of language in communication; Barriers to Communication: Types of barriers (Semantic, Intrapersonal, Interpersonal, And Organizational); Miscommunication; Noise; Overcoming measures. **Technology-based Communication:** Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software.	[5]
2.	**Listening and Reading Skills :** Listening as an active skill; Types of Listeners; Listening for general content; Listening to fill up information; Intensive Listening; Listening for specific information; Developing effective listening skills; Barriers to effective listening skills. **Reading Skills**: Previewing techniques; Skimming; Scanning; Understanding the gist of an argument; Identifying the topic sentence; recognizing coherence and sequencing of sentences; Improving comprehension skills.	[6]
3.	**Writing Skills**: Sentence formation; Use of appropriate diction; Paragraph and Essay Writing; Coherence and Cohesion. Common Errors. **Letter Writing:** Formal, informal and demi-official letters; **Job Application:** Cover letter, Differences between bio-data, CV and Resume. **Report Writing**: Basics of Report Writing; Structure of a report; Types of reports.	[6]
4.	**Non-verbal Communication and Body Language:** Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language.	[3]
5.	**Interview Skills:** Types of Interviews; Ensuring success in job interviews; Appropriate use of non-verbal communication. **Group Discussion:** Differences between group discussion and debate; Ensuring success in group discussions. **Presentation Skills:** Oral presentation and public speaking skills.	[6]

Outcome: The students would hone the skills of reading, writing, listening, and speaking and become adept at communicating in the current modern context.

Text Books:

3. Raman, M., & Singh, P. (2017). Business Communication (2nd edition.). New Delhi: Oxford University Press.
4. Lesikar, Raymond V and Marie E. Flatley. Basic Business Communication: Skills for Empowering the Internet Generation: Ninth Edition. New Delhi: Tata McGraw-Hill,

Reference Books:

1. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Publishing Company Limited
2. Bonet, Diana. The Business of Listening: Third Edition. New Delhi: Viva Books, 2004.

UC 19.201 **Introduction to Management and Leadership** **Total Lectures: 26**
2-0-0-2

Objective: This Course, Management and leadership focus on understanding seminal and contemporary leadership theories and principles. To provide a basis of understanding to the students with reference to the working of the business organization through the process of management.

Pre-requisite:

1.	**Introduction to Management :** Nature of Management, Meaning, Definition, it's nature purpose, importance & Functions, Management as Art, Science & Profession- Management as social System Concepts of management-Administration-Organization	**[4]**
2.	**Evolution of Management Thought:** Contribution of F.W.Taylor, Henri Fayol ,Elton Mayo , Chester Barhard & Peter Drucker to the management thought. Various approaches to management (i.e. Schools of management thought)Indian Management Thought.	**[5]**
3.	**Functions of Management:** Planning - Meaning - Need & Importance, types levels - advantages & limitations. Organizing - Elements of organizing & processes, Delegation of authority - difficulties in delegation – Decentralization, Staffing - Meaning & Importance, Controlling - Process & Techniques, Coordination - Need – Importance.	**[6]**
4.	**Introduction to Leadership**: Leadership styles, qualities of a good leader, role of a leader, trait approach to leadership, behaviour approaches to leadership; Situational theories; Transformational Leadership transactional leadership, Neutralizers and substitutes to leadership.	**[6]**
5.	**Emerging Challenges to Leadership**: Leadership in changing workplace, Leader's role in fostering teamwork, Overcoming traditional thinking Methods to enhance creative problem solving, Climate for creative thinking, Leadership practices for innovation, Ethical leadership development, Cultural sensitivity, intelligence, and global leadership skills.	**[5]**

Outcome: On successful completion of the course, students will be able to Work effectively and collaboratively with others in diverse management contexts.

Text Books:

1. Dr. L.M.Parasad, "Principles & practice of management", Sultan Chand & Sons - New Delhi, 2015
2. Stephen P.Robbins "Organizational Behavior" Pearson Publisher,16th Edition, 2014

Reference Books:

1. Principles of Management, By Tripathi, Reddy Tata McGraw Hill, 2012
2. Essential of Business Administration - K.Aswathapa Himalaya Publishing House, 2014
3. Hughes, R., Ginnett, R., & Curphy, G. Leadership: Enhancing the lessons of experience, McGraw Hill, 7th Edition, 2017
4. Northouse, P. G. "Leadership: Theory and Practice" Sage Publications, New Delhi, 7th Edition 2015.

UC 19.202 **Business Environment** **Total Lectures: 26**
2-0-0-2

Objective: To familiarize the students about the background of the spectrum of business and its environment (internal and external).

Pre-requisite: Good General knowledge.

1.	**Dimensions of Business Environment**: Nature and characteristics of contemporary business; Types of business environment - general and task environment, Internal (Value system, Organization structure, Human Resource, Company image and brand value, Physical assets) and external Environment (micro and macro), Environmental analysis and strategic Management.	[5]
2.	**Social Environment**: Concept and salient features of Indian culture and values, Impact of culture on business, Cultural resources, Ethics and social responsibility of business, Consumerism.	[5]
3.	**Political and legal Environment*:*** Impact of competing political ideologies and role of government, Political Stability and Instability on Business Activities, Legal framework for establishing a business unit in India, Competitive Conditions, Foreign Direct Investment in India.	[5]
4.	**Economic Environment**: Economic systems – Market, Planned and Mixed economy; Indian economy – overview; Economic reforms in India; Economic policies – Determinants of National Income, Privatization, Fiscal policy and Monetary policy.	[6]
5.	**Technological Environment:** Features of technology; Impact of technology; Management of technology; status of technology in India; Policy for research and development in India.	[5]

Outcome: Understanding real life situations vis-à-vis economic, social, legal, political and technological systems in the country and analyzing the impact of changes on different industries and trends in different sectors of the economy and society.

Text Books:

3. Business Environment, Francis Cherunilam, 1st Edition, 2018.
4. Essentials of Business Environment, K Aswathappa, HPH, 12th Edition, 2014.

Reference Books:

5. Business Environment, BN Ghosh, OUP, 2015
6. Business Environment: Text & Cases (3rd Edition), Justin Paul, McGraw Hill, 2016.
7. Business Environment, AC Fernando, Pearson, 2016

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech CS

CS 19.506 **Distributed Operating Systems** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite: Operating System

Objective(s):

- To learn the operating system and distributed computing environment
- To learn remote procedure call and Remote method invocation.
- To learn the principles of distributed shared memory
- To learn distributed file system..

1	**Introduction and distributed computing environment**: Definition, Evolution of distributed computing system, Distributed computing system models- Minicomputer model, workstation model, workstation –server model, processor –pool model, hybrid model. Advantages of distributed operating system. Design issues of distributed operating system- Transparency, Reliability, concurrency, scalability, heterogeneity, openness, security.	[8]
2	**Message Passing:** Introduction, issues in IPC by message passing, Synchronization, buffering –null buffer, single message buffer, unbounded capacity buffer, finite bound buffer. Multi datagram message, encoding and decoding of message data. Process addressing, failure handling, group communication.	[6]
3	**Remote Procedure call and Remote Method Invocation:** RPC model, Transparency of RPC, Implementing RPC mechanism, Stub generation, RPC Messages, Parameter passing, semantics, call semantics. Communication protocols for RPC-request protocol, request/reply protocol, request/reply/acknowledge protocol, RPC heterogeneous environment, Light weight RPC. Remote Method Invocation(RMI) : Introduction, communication between distributed objects, design issues for RMI implementation of RMI , clock synchronization, logical clock- Lamport time stamps, deadlock, election algorithms- Bully algorithm, Ring algorithm , distributed transactions.	[15]
4	**Distributed shared memory:** Introduction, message passing vs DSM, implementation approaches to DSM, design and implementation issues- Structure and synchronization model. Granularity, Structure of shared memory space, consistency model, replacement strategy, thrashing.	[8]
5	**Distributed File System:** Design, implementation, trends in distributed file system.	[7]

Outcome(s): On successful completion of this course, students will be able to

- Understand the primary functionalities of operating system.
- Understand Message passing efficiently in an operating system environment
- Develop new operating systems as well as work on existing ones to develop them further

Text Books:

[1] Pradeep K. Sinha, "Distributed Operating Systems: Concepts and Design", Prentice-Hall of India, 3rd Printing, October 2001 .

[2] Andrew S. Tanenbaum and Maarten van Steen, " Distributed Systems", PHI, second Printing, July 2003.

Reference Books:

[1] G. Coulorius, J. Dollimore and T. Kinderberg, "Distributed Systems: Concepts and Design", fourth edition, Addison Wesley, May 2005.

CS 19.508 **Soft Computing Paradigms** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite: Artificial Intelligence

Objective(s):

- To familiarize with soft computing concepts
- To introduce the idea of artificial neural networks, fuzzy logic and use of heuristics based on human experience
- To introduce the concept of genetic algorithm and its applications to soft computing using some applications

1. **Artificial Neural Networks:** Definition, benefits of Artificial Neural Networks, terminology, neuron models, activation function, network architectures, learning process, types of learning: Hebbian, competitive, error-correction, Boltzmann learning. [8]

2. **Types of Neural Networks:** Feed forward neural network: Single layer perceptron, limitations, multi layer perceptron, back propagation algorithm, practical considerations, radial basis function network. Recurrent networks: Hopfield network, NARX model, state space model, recurrent multi layer, perceptron, second order networks. Self-organizing map, and principal component analysis. [12]

3. **Fuzzy Logic and applications :** Basic concepts of fuzzy logic, crisp sets and fuzzy sets, operations and properties of crisp sets and fuzzy sets, crisp and fuzzy relations, fuzzy rules, fuzzification and defuzzification. Pattern recognition, control engineering, image processing, neuro fuzzy application. [10]

4. **Genetic Algorithms:** Basic concepts, working principles, genetic operators, genetic programming, parsing trees and mathematical foundation of genetic algorithm. . Other optimization methods: Swarm Intelligence, ant colony optimization. [6]

5. **Hybrid Systems:** Neuro genetic systems, fuzzy genetic systems and neuro fuzzy genetic systems, applications. [4]

Outcome(s): On successful completion the students will be able to:

- Identify and describe soft computing techniques and their roles in building intelligent machines
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
- Apply genetic algorithms to combinatorial optimization problems
- Apply neural networks to pattern classification and regression problems
- Evaluate and compare solutions by various soft computing approaches for a given problem

Text Books:

[1] Li Min Fu, "Neural Networks in Computer Intelligence", Tata McGraw Hill Edition, 2008.

[2] S.N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", Wiley India, 2008.

Reference Books:

[1] S. Rajsekaran, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Application", Prentice Hall, 2010.

[2] Simon S. Haykin , "Neural Networks- A Comprehensive Foundation", Prentice Hall, 2009

[3] D.E. GoldBerg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2009.

[4] S. Rajsekaran, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Application", Prentice Hall, 2010

CS 19.510 **Digital Image Processing and Analysis** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite: Computer Programming, Computer Graphics

Objective(s):

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the image segmentation and representation techniques
- To study the image representation in form of features and descriptors

1. **Image Representation:** Sampling, Quantization, Image Basis Function, Image Types, Fourier Transform, Discrete Cosine Transform, Walsh- Hadamard Transform, Wavelet Transform, Principal Component Analysis [6]

2. **Image Enhancement and Restoration:** Contrast Stretching, Histogram Specification, Histogram Equalization, Enhancement Using Arithmetic/Logic Operations, Smoothing Sharpening, Low-Pass Filters, High-Pass Filters, Bandpass Filters, Homomorphic Filtering, Restoration Process Model, Noise Models, Inverse Filtering , Minimum Mean-Square Error Restoration. [8]

3. **Image Morphology**: Introduction, Logic Operations Involving Binary Images, Dilation and Erosion, Opening And Closing, Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening. [5]

4. **Image Segmentation:** Region Extraction, Pixel-Based Approach, Thresholding, Edge And Line Detection, Pattern Fitting Approach, Hough Transform, Radon Transform, Edge Linking And Edge Following, Edge, Corner Detection**.** [6]

5. **Pattern Recognition , Compression and Feature Extraction** [15]
Recognition: Deterministic Methods, Clustering, Neural Network, Template Matching, Statistical Classification, Syntactic Recognition, Tree Search, Graph Matching.Image Compression: Information Content of an Image, Lossless and Lossy Compression Algorithms, Compression Standards. Feature Extraction: Representation, Topological Attributes, Geometric Attributes, spatial Moments, Texture, Boundary Based Description, Region Based Description, Intensity Based and Relational Description.

Outcome(s): On successful completion of this course, students will be able to

- Discuss digital image fundamentals.
- Apply image enhancement and restoration techniques.
- Use image compression, segmentation and features extraction Techniques.

Text Books:

[1] Gonzaloz R. C. and Woods R.E., “Digital Image Processing”, Prentice Hall 2002.

[2] Jain A.K., “Fundamentals of Digital Image Processing”, Prentice Hall 1989.

Reference Books:

[1] William K. Pratt, “Digital Image Processing”, John Wiley, 2001.
[2] B. Chanda and D. Dutta Majumder ,” Digital Image Processing and Analysis”,PHI, 2002

CS 19.511 **Ad hoc Sensor Networks** **Total Lectures: 40**

Prerequisite: Computer Networks **Credit: 3-1-0-4**

Objective(s):

- To learn the Ad hoc networks and related protocols
- To learn QoS parameters of Ad hoc network
- To learn the basic principles of sensor networks
- To understand the functionality of wireless sensor network and respective securities issues

1	**Ad hoc Networks:** Introduction and Definitions, Ad hoc Network Applications, Design Challenges. Routing in Mobile Ad hoc Networks: Introduction, Flooding, Proactive Routing, On Demand Routing, Proactive Versus on demand Debate, Location based Routing.	[7]
2	**Multicasting and Transport layer Protocols in Ad hoc Networks:** Introduction, Classifications of Protocols, Multicasting Protocols, Broadcasting. Protocol Comparisons, Overarching Issues. Transport layer Protocols in Ad hoc Networks: Introduction, TCP and Ad hoc Networks, Transport Layer for Ad hoc Networks: Overview, Modified TCP, TCP-aware Cross-layered Solutions. Ad hoc Transport Protocol.	[9]
3	**QoS Issue in Ad hoc Networks:** Introduction, Definition of QoS, Medium Access Layer, QoS Routing, Inter- Layer Design Approaches. Security in Mobile Ad hoc Networks: Vulnerabilities of Mobile Ad hoc Networks, Potential Attacks, Attack Prevention Techniques. Intrusion Detection Techniques.	[8]
4	**Overview of Wireless Sensor Networks (WSNs)**: Introduction, Constraints and Challenges, Advantages of Sensor Networks, Sensor Network Applications' Routing Protocols: Geographic, Energy-Aware Routing – Unicast Geographic Routing, Routing on a Curve, Energy-Minimizing Broadcast, Energy-Aware Routing to a Region; Attribute-Based Routing – Directed Diffusion, Rumor Routing.	[10]
5	**Security in WSNs:** Introduction: IEEE 802.11b Security Mechanisms, WEP Security Issues, WEP Improvements, Wireless Security Threats and Risks: Types of Security Threats, Physical Security of Wireless Devices, WLAN Attacks. Risk Mitigation and Countermeasures: Basic Countermeasures, AAA Infrastructure Solutions, Additional Enhancements.	[6]

Outcome(s): On successful completion of this course, students will be able to
Understand the basic working of sensor networks
Understand security aspects of WSN

Text Books:

[1] Prasant Mohapatra and Srihanamurthy, "Ad Hoc Networks Technologies and Protocols", Springer, Springer International Edition, 2009.

[2] Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks", John Wiley & Sons, Inc., Pub!ication, 2007.

Reference Books:

[1] A.Boukereche, "Handbook of Algorithms for Wireless Networking and Mobile Computing", Chapman and Hall/CRC Computer and Information Science Series, 2007.
[2] Zhao, Guibas, "Wireless Sensor Networks" , Elsevier, 2004.

CS 19.512 **Advances in Database Management Systems** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite: Database Management System

Objective(s): The objectives of this Course are :

- To learn object relational databases
- To learn query processing and optimization
- To learn database recovery and database security
- To learn distributed databases

1. **Object and Object-Relational Databases:** Introduction, Object relational features, Object database extensions to SQL, ODMG object model and the object definition language (ODL) [8]

2. **Query Processing and Optimization:** Translating SQL queries into relational algebra. Algorithms for external sorting, select, join, project and set operations. Implementing aggregate operations and outer joins. Combining operations using pipelining, heuristic query optimization, selectivity and cost estimates in query optimization, semantic query optimization. [8]

3. **Database Recovery:** Recovery concepts, no-undo/redo recovery based on deferred update, recovery techniques based on immediate update, shadow paging, ARIES algorithm, recovery in multi database systems, database backup and recovery from catastrophic failures. [8]

4. **Database Security:** Security issues, granting and revoking privileges, role based access control for multilevel security, SQL injection, statistical database security, flow control, encryption and public key infrastructures, privacy issues and preservation, challenges of database security**.** [8]

5. **Distributed Databases:** Distributed database architecture, fragmentation, and query processing and optimization management in distributed databases. Database concepts, types, distributed distribution and allocation techniques, in distributed databases, transaction [8]

Outcome(s): After completion of the course, students will be able to:

- Understand object and object relational databases.
- Understand Structured Query Language (SQL) with query optimization.
- Understand issues in database recovery and database security

Text Books:

[1] Elmasri, Navathe, "Fundamentals of Database systems", Addison Wesley, sixth ed, 2010.

[2] Raghu Ramakrishnan, Gehrke, "Database Management systems", McGraw Hill, third ed, 2009.

Reference Books:

[1] Thomas m. Connolly, Carolyn E. Begg, "Database Systems", Pearson education, fifth ed, 2009.

CS 19.515 **Machine Learning** **Total Lectures: 40**

Credit:3-1-0-4

Prerequisite: Artificial Intelligence

Objective(s):

- To learn the Machine learning concepts.
- To learn different models of Machine learning.

1. **Foundations of Learning:** Components of learning, learning models, geometric models, probabilistic models, logic models, grouping and grading, learning versus design, supervised learning, unsupervised learning, reinforcement learning , theory of learning, feasibility of learning, error and noise, training versus testing, theory of generalization, generalization bound, approximation generalization trade off, bias and variance, learning curve. [8]

2. **Linear Models:** Linear classification, univariate linear regression, multivariate linear regression, regularized regression, logistic regression, perceptron, multilayer neural networks, learning neural networks structures, support vector machines, soft margin SVM, going beyond linearity, generalization and overfitting, regularization, validation. [8]

3. **Distance-based Models:** Nearest neighbour models, K-means clustering, hierarchical clustering, k-d trees, locality sensitive hashing, non-parametric regression, ensemble learning, bagging and random forests, boosting, meta learning. [8]

4. **Tree and Rule Models:** Decision trees, learning decision trees, ranking and probability estimation trees, regression trees, clustering trees, learning ordered rule lists, learning unordered rule lists, descriptive rule learning, association rule mining, first-order rule learning. [8]

5. **Reinforcement Learning:** Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal-difference learning, active reinforcement learning, exploration, learning an action utility function, generalization in reinforcement learning, policy search, applications in game playing, applications in robot control. [8]

Outcome(s): Students will be able to

- Compare and apply Machine learning models for different problems.
- Carry out research in the area of Machine learning.

Text Books:

[1] T. M. Mitchell, Machine Learning, McGraw Hill, 1997.
[2] P. Flach, Machine Learning: The art and science of algorithms that make sense of data, Cambridge University Press, 2012.

Reference Books:

[1] M. Mohri, A. Rostamizadeh, and A. Talwalkar, Foundations of Machine Learning, MIT Press, 2012.

[2] S. Russel and P. Norvig, Artificial Intelligence: A Modern Approach, Third Edition, Prentice Hall, 2009.

CS 19.521 **Big Data Analytics** **Total Lectures: 40**

Credit:3-1-0-4

Prerequisite: Data Mining, Database Management Systems

Objective(s):

- To learn Big Data characteristics
- To learn Hadoop architecture and functioning of Map-Reduce.
- To learn other Big data tools like HIVE, HIVEQL and HBASE.

1. **INTRODUCTION: D**istributed file system – Big Data and its importance, four Vs, drivers for Big data, Big data analytics, Big data applications, algorithms using map reduce, matrix-vector multiplication by Map Reduce. [8]

2. **Introduction to HADOOP:** Apache HADOOP & HADOOP ecosystem , moving data in and out of Hadoop , understanding inputs and outputs of MapReduce , data serialization [8]

3. **HADOOP Architecture:** HADOOP architecture, HADOOP storage: HDFS, common HADOOP shell commands , anatomy of file write and read., namenode, secondary namenode, and datanode, HADOOP MapReduce paradigm, map and reduce tasks, job, task trackers ,cluster setup, SSH & HADOOP configuration, HDFS administering, monitoring & maintenance. [8]

4. **HADOOP Ecosystem and YARN**: HADOOP ecosystem components, schedulers, fair and capacity, HADOOP 2.0 new features, namenode, high availability, HDFS federation, mrv2, YARN, running mrv1 in YARN. [8]

5. **HIVE and HIVEQL, HBASE**: HIVE architecture and installation, comparison with traditional database, hiveql, querying data, sorting and aggregating, map reduce scripts, joins & subqueries, Hbase concepts, advanced usage, schema design, advance indexing - Pig, Zookeeper - how it helps in monitoring a cluster, Hbase uses Zookeeper and how to build applications with Zookeeper. [8]

Outcome(s): The students will be able to carry out research in Big Data using the latest tools.

Text Books:

[1] Chris Eaton, Dirk deroos et al., Understanding Big data , McGraw Hill, 2012.

[2] Tom White, HADOOP: The definitive Guide , O Reilly 2012.

Reference Books:

[1] Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, Professional Hadoop Solutions, Wiley, 2015.

[2] Jy Liebowitz, Big Data and Business analytics, CRC press, 2013.

CS 19.523 **Operations Research** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite: Engineering Mathematics
Objective(s): To learn major Operations research techniques.

1. **Introduction to Operation Research:** Origins of or, nature, impact and phases of OR, solving the OR Model , operation research as tool for decision support system, productivity improvement, overview of OR research techniques. [6]

2. **Linear Programming Extensions:** Formulation of linear programming problem, linear programming models, assumptions of linear programming, graphical method of solving LP problem, Simplex method for solving LP problem, special cases in Simplex method application. Formulation of transportation problem, types of transportation problems, methods of initial feasible solution, methods of optimum solution, unbalanced transportation problem, assignment problem, transshipment model. [14]

3. **Decision, Game & Queueing Theory:** Formulation of two person, zero-sum games, solving simple games, mixed strategies, non-zero sum games, basic structure & components of decision, decision criteria, decision trees, basic characteristics of queueing system, terminologies & notation, Poisson process of queueing, M/M/1 system queueing model. queueing decision models. [8]

4. **Hybrid OR Models, Project Management PERT & CPM:** Assumption and comparison PERT & CPM, algorithms of PERT CPM techniques, fundamentals of network model, guidelines for network construction, critical path analysis, methods based on time estimates to find critical paths, concept of slack & oats in network analysis, Project Evaluation & Review Techniques (PERT) [6]

5. **Dynamic Programming:** Terminologies, multi decision process, Bellman's principles of optimality, characteristics of dynamic programming problems, dynamic programming algorithms, solving LPP using dynamic programming, recent applications of dynamic programming in OR. [6]

Outcome(s): Students will be able to apply Operation Research techniques relevant to their area of research.

Text Books:
[1] Hamdy A Taha, Operations Research: An Introduction, Pearson education India, 8th Edition, 2011.
[2] Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research, 8th edition McGraw-Hill, 2001.

Reference Books:
[1] Richard Bronson , Govindasami Naadimuthu, Schaum's Outline of Operations Research, 2nd edition, McGraw-Hill Education, 1997.
[2] Wayne L. Winston, Operations Research: Applications and Algorithms, Cengage Learning, 2003.

CS 19.562 **Mobile Cloud Computing** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Computer Networks, Cloud Computing

Objective(s):

- To learn the cloud services and requirements of cloud
- To become familiar with different cloud models and solutions
- To learn mobile computing architectures

1. **Introduction:** Cloud, Business and IT Perspective, Virtualization, Cloud Services Requirements, Cloud And Dynamic Infrastructure, Cloud Computing Characteristics, Cloud Adoption. [8]
2. **Cloud at a Service:** Internet Software Evolution, Web Services Deliver from the Cloud, Communication-as-a-Service, Infrastructure-as-a-Service, Monitoring-as-a-Service, Platform-as-a-Service, Software-as-a-Service, Building Cloud Network. [8]
3. **Cloud Models and Solutions:** Cloud Models, Cloud Characteristics, Measured Service, Security in a Public Cloud, Public Verses Private Clouds, Cloud Infrastructure Self Service. Cloud Solutions: Cloud Ecosystem, Cloud Business Process Management, Cloud Service Management, Cloud Stack, Computing On Demand, Cloud Sourcing. [16]
4. **Cloud Offerings and Virtualization technology:** Virtual Desktop Infrastructure, Storage Cloud. Cloud Virtualization technology: Virtualization, Virtualization Benefits, Server Virtualization, Hypervisor Management Software, Virtualized Data Center. [12]
5. **Mobile Computing:** Motivation, Applications, Architectures, Platforms For Mobile Cloud Computing, Windows Phone, Android, IPhone, Popular Mobile Apps, 3G, 4G, Bluetooth, Wi-Fi. [8]

Outcomes(s): On the successful completion of the course, the student will be able to:

- To understand the cloud infrastructure
- To understand the different services provided by cloud.
- To understand mobile computing

Text Books:

[1] Kumar Saurabh, "Cloud Computing", Wiley India, 2011.
[2] Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley: February 2011.

Reference Books:

[1] Haley Beard, "Cloud Computing Best Practices for Managing and Measuring Processes for On Demand computing applications and data Centers in the Cloud with SLAs" , Emereo Pty Limited, July 2008.
[2] Asoke Talkukder, Roopa R Yavagal, "Mobile Computing – Technology, Applications and Service Creation", Tata McGraw Hill, 2007
[3 Raj Kamal, "Mobile Computing", Oxford University Press, 2007.
[4] Michael Miller, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", 1st Edition, Publisher: Pearson, 2008.

CS 19.563 **Advances in Distributed Computing** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Computer network, Computer Architecture, Distributed System

Objective(s): The objectives of this Course are :

- To learn distributed systems and distributed computing
- To learn synchronous and asynchronous system
- To learn fault tolerant and non-fault tolerant systems.
- To learn synchronous shared memory systems.

1. **Introduction:** Distributed Systems, Cluster Computing, Supercomputing, Cloud Computing. [6]
2. **Synchronous networks and Fault-tolerant Systems:** Leader election in synchronous ring networks. Leader election in rings. Basic computational tasks in general synchronous networks: leader election. Fault-tolerant Systems: Consensus, Link failures: the two generals problem. Process failures (stopping, Byzantine). Algorithms for agreement with stopping and Byzantine failures. Exponential information gathering. [12]
3. **Asynchronous distributed computing and Non-fault-tolerant Systems:** Formal modeling of asynchronous systems using interacting state machines (I/O automata). Proving correctness of distributed algorithms. Non-fault-tolerant Systems: Algorithms for asynchronous networks. Leader election. [10]
4. **Time, clocks, and the ordering of events:** State-machine simulation. Vector timestamps. Stable property detection. Distributed termination. Global snapshots. Deadlock detection, Synchronizers: Synchronizer applications. Synchronous vs. Asynchronous distributed systems. [12]
5. **Asynchronous shared-memory systems and Locking:** The mutual exclusion problem. Mutual exclusion algorithms. Bounds on shared memory for mutual exclusion. Resource allocation. The Dining Philosophers problem. Locking: Locking algorithms, optimistic algorithms, lock-free algorithms, lazy algorithms, Load scheduling and balancing techniques. [12]

Outcome(s): On successful completion the students will be able to:

- Understand distributed algorithms for synchronous and asynchronous distributed computing
- Understand various synchronizer applications with synchronous and asynchronous systems..

Text Books:

[1] Lynch, Nancy, “Distributed Algorithms”, Burlington, MA: Morgan Kaufmann, 1996. ISBN: 9781558603486.

[2] George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems, Concept and Design”, 3rd Edition, Pearson Education, 2005.

Reference Books:

[1] Pradeep K. Sinha, “Distributed Operating Systems: Concepts and Design”, PHI, 2007.

[2] Randy Chow, Theodore Johnson, “Distributed Operating Systems and Algorithm Analysis”, Pearson, 2009.

[3] Mukesh Singhal, Niranjan G. Shivaratri, Niranjan Shivaratri, “Advanced Concepts in Operating Systems”, TMH, 1994.

[4] Sunita Mahajan, Seema Shah, “Distributed Computing”, Oxford University Press,2010

CS 19.564 **Machine Intelligence and Robotics** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Artificial Intelligence

Objective(s):

- To learn artificial intelligence and knowledge representation
- To become familiar with knowledge organization and control strategies
- To learn robotics and robot programming

1. **Introduction:** Importance of AI, Knowledge Based System, Knowledge organization & manipulation, Conceptual Introduction to LISP and other AI programming Languages. [10]

2. **Knowledge Representation:** Syntax, Semantics, Inference Rules, Non-deductive Inference methods, and representations using rules. Forward chaining and backward chaining. Fuzzy Logic & Natural languages computations. Probabilistic Reasoning. Object Oriented Representation. [10]

3. **Knowledge Organization & Manipulation:** Search & control strategies, matching techniques, knowledge organization & management, Genetic Algorithms based search techniques. [10]

4. **Robotics:** Types of Robots, spatial transformation and kinematics of open chain linkages. Mobile robots, Actuators, sensors, programming and control. Applications - motion planning, grasping and industrial automation. [12]

5. **Robot Programming:** Languages, characteristics of Languages, Position Specification, Motion Specification. Robot Program synthesis, Programming solution using VAL Robot programming Language, Artificial Intelligence, search strategies, Heuristic search, Rule based problem solving, Knowledge Representation, Robot programming using LEGO robots. [10]

Outcomes(s): On the successful completion of the course, the student will be able to:

- To understand robot programming using LEGO NXT EV3
- To understand VAL robot programming language
- • To understand knowledge representation and AI Programming Languages.

Text Books:

[1] R.D. Klafter, Chemieleskio, T.A. and Negin M., "Robotics Engineering an Integrated approach", Prentice Hall , 1989.

[2] M. Nagenevtsky, "Artificial Intelligence –A guide to intelligent systems", Addison – Wesley , 2005.

Reference Books:

[1] K.S.FU, R.C. Gonzalez, and C.S.G.Lee., "Robotics control , Sensing, Vision ,and Intelligence" , Prentice Hall , 1987.

[2] J.J. Craig, "Introduction to Robotics", Addison Wesley Publishers, 2005.

[3] G. Bekey, "Autonomous Robots", MIT Press, 2005.

CS 19.565 **Advanced Compiler Construction** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Compiler design, Theory of automata

Objective(s):

- To learn the major conceptual areas of language translation and compiler design.
- To learn the knowledge in code optimization and register allocation techniques
- To extend the knowledge of different parsers.
- To provide practical programming skills necessary for construction of a compiler.

1. **Advanced Issues in Elementary topics:** Compiler, phases and passes, finite state machines, regular expressions and their applications to lexical analysis, implementation of lexical analyzer using FLEX, CFG, bottom-up and top-down parsers, implementation of parsers using YACC. [10]

2. **Symbol Table Structure and Intermediate Representations:** Storage classes, visibility and lifetime. Symbol attributes and symbol table entries, local symbol table management, and global symbol table structure, storage binding and symbolic registers. Intermediate Representations: Issues in designing intermediate languages, High level, medium level, low level and multi-level intermediate languages. Representing all intermediate languages in informal compiler algorithm notation (ICAN). [14]

3. **Code Optimization:** Introduction, early optimization, redundancy elimination. Loop optimization: Induction variable optimizations, bounds checking elimination. Procedure optimization: Tail-call optimization and Tail-recursion optimization, procedure integration, In-line expansion, leaf routine optimization and shrink wrapping. [8]

4. **Register Allocation**: Register allocation and assignment, local methods, graph coloring, priority based graph coloring. Code Scheduling: Instruction Scheduling, Speculative loads and boosting, speculative scheduling, trace scheduling, percolation scheduling. [12]

5. **Inter procedural Analysis and Optimization** Call graph, inter procedural data flow analysis, constant propagation, alias analysis, optimizations and register allocation. [8]

Outcome(s): On successful completion of this course, the students will be able to

- Use lexical analyzer and parser generator tools.
- Generate intermediate code.
- Be familiar with register allocation. and compiler code optimization

Text Books:

[1] Steven S. Muchnik, “Advanced Compiler Design Implementation”, Morgan Kauffman publishers, 2005.

[2] Alfred Aho, Monica Lam, Ravi Sethi, Jeffrey Ullman, “Compilers: Principles, Techniques, and Tools”, Second edition, Addison-Wesley, 2006.

Reference Books:

[1] Louden, Compiler Construction: Principles and Practice, Cengage Learning, 1st edition, 1997

[2] Fisher, Faraboschi, Young, “Embedded Computing - A VLIW Approach to Architecture, Compilers, and Tools”, Morgan Kaufmann, 2005.

CS 19.566 **Natural Language Processing** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Artificial Intelligence

Objective(s):

- To learn language modeling, syntactic analysis and parsing
- To learn semantic analysis and parsing
- To learn robotics and robot programming

1. **Language Modelling and Syntactic Analysis :** Definition, Origin of NLP, Language and Knowledge, The challenges of NLP, Language and Grammar, NLP application, Successful early NLP systems, Information retrieval. Various grammar-based language models, statistical language models. [16]

   Word Level Analysis and Syntactic Analysis: Introduction, Regular Expressions, Finite State Automata, Morphological Parsing, Spelling Error Detection and correction, words and words classes, Part-of-speech tagging . Context Free grammar, Constituency, Parsing, Probability Parsing.

2. **Semantic Analysis and Discourse Processing:** Introduction, Meaning Representation, Lexical Semantics, Ambiguity, word sense Disambiguation. Cohesion, Reference Resolution, Discourse Coherence and Structure. [8]

3. **Natural Language generation and Machine Translation:** Introduction, Architecture of NLG systems, Generation task and representation, Problems in Machine Translations, Machine Translation approaches, Direct Machine Translation, Rule based machine translation, corpus-based MT, Semantic or knowledge based MT systems. [10]

4. **Application and Lexical Resources:** Speech Recognition and Synthesis, Information Retrieval Systems, Information Extraction, Automatic Text Summarization, Question-Answering; Resources**:** WordNet, FrameNet, Stemmers, Part-of Speech Tagger. [10]

5. **NLP with Python:** Introduction, Processing Raw Text, Writing Structured Program, Categorizing and Tagging words, learning to Classify Text, Analyzing Sentence Structure. [8]

Outcome(s): On the successful completion of the course, the student will be able to:

- To understand Implementation of Natural language processing using Python
- To understand VAL robot programming language
- To understand knowledge representation and AI Programming Languages.

Text Books:

[1] Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", O" Reilly Media , 2009.

Reference Books:

[1] U. S. Tiwary and Tanveer Siddiqui, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
[2] Christopher D. Manning and Hinrich Schutze," Foundation of Statistical Natural Language Processing", ISBN 026213360

CS 19.567 **Bioinformatics** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Computer Programming, DBMS

Objective(s):

- To learn the basics of bioinformatics
- To learn the bioinformatics databases and web techniques
- To extend the knowledge bioinformatics and distributed computing

1. **Introduction to Bioinformatics:** Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics Problems and Applications of Bioinformatics. [6]

2. **Bioinformatics Databases:** Introduction, Nucleotide sequence database - Protein sequence databases, Sequence motif databases, Protein structure databases, other relevant databases. Data storage and retrieval and Interoperability: Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search. The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON. [19]

3. **Sequence Alignments and Visualization:** Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example),Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization. [16]

4. **Bioinformatics and Web Techniques:** Clustal V, Clustal W 1.7, RasMol, Oligo, Molscript, Tree view, Alscript, Genetic Analysis Software, Phylip. Semantic Web Techniques: Bridging databases, browsing space of information, life sciences identifiers, RDF data representation. [10]

5. **Bioinformatics and Distributed Computing:** Java Distributed computing platform, DPRml, DSEARCH. [5]

Outcome(s): On successful completion of the course, the students will be able to

- Use different bioinformatics databases and web techniques
- Understand sequence alignment algorithms

Text Books:

[1] Dan E. Krane ,"Fundamental Concepts of Bioinformatics", third edition, Pearson Education, 2009.

[2] Claverie, J.M. and Notredame C. ," Bioinformatics for Dummies", Wiley Editor , January 2003.

Reference Books:

[1] Shalini Suri, "Bioinformatics", APH Publishing Corporation, 2006.

CS 19.568 **Advanced Software Engineering** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Software Engineering

Objective(s):

- To understand the software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To acquire knowledge on implementation issues in software design..
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study object oriented system analysis, design and testing.

1. **Introduction:** Software life cycle models, Waterfall, Prototype, Evolutionary and Spiral Models, Overview of Quality Standards like ISO 9001, SEI – CMM, Software Requirements analysis & specifications, Software Project Management. [10]
2. **Fundamental issues in software design:** Goodness of design, cohesions, coupling, Classification of Cohesiveness & Coupling, Function-oriented design: structured analysis and design. [8]
3. **Software Testing:** Testing process, Design of test cases, functional testing: Boundary value analysis, Equivalence class testing, Decision table testing, Cause effect graphing, Structural testing, Path Testing, Data flow and mutation testing, Unit Testing, Integration and System Testing, Debugging, Alpha & Beta Testing, Regression Testing, Testing Tools & Standards. [8]
4. **Object Oriented System Analysis. Design and Testing:** Object oriented and object basics, object oriented system development cycle, process framework of OOSAD, unified approach UML, UML Diagrams: class diagram, use-case diagram, behavior diagram, OOAP, OOD and OODBMS. [16]
   Object-Oriented Testing: Testing Object Oriented Systems overview. Broadening the View of Testing, Testing OOA and OOD Models, Object-Oriented Testing Strategies, Test Case Design for OO Software , Testing Methods Applicable at the Class Level.
5. **Advanced Topics in Software Engineering:** Overview of Formal Methods, Cleanroom Software Engineering, Component-Based Software Engineering, Client-Server Software Engineering, Web Engineering, Reengineering, Computer-Aided Software Engineering, and the Road Ahead. [10]

Outcome(s): On successful completion of this course, students will be able to

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.
- Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

[1] R. S. Pressman, “Software Engineering – A practitioner‟s approach”, 5th Ed., McGraw Hill Int. Ed., 2001.
[2] Ian Sommerville, “Software Engineering”, Addison. Wesley, 1999.

Reference Books:

[1] K. K. Aggarwal & Yogesh Singh, “Software Engineering”, New Age International, 2001.
[2] Stephen R. Schach, “Classical & Object Oriented Software Engineering”, IRWIN, 1996.
[3] P. Jalote, “An Integrated approach to Software Engineering”, Narosa, 1991.
[4] Booch, Rumbaugh and Jacobson “The Unified Modeling Language User Guide”, Addison-Wesley 2005.

CS 19.569 **Advanced Computer Graphics** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Computer Graphics

Objective(s):

- To introduce the students with the principles of animation
- The objective of the course is to equip students with fundamental knowledge and technical competence in the field of computer graphics.
- Provide an understanding of rendering and 3D modeling.
- To learn three dimensional object representation.

1. **3D Transformation and Viewing**: 3D transformation, composite transformation, viewing pipeline, parallel and perspective projection, visible surface detection: classification of visible surface detection algorithms, back face detection, depth buffer method, A-buffer method, scan-line method, depth sorting method. [7]

2. **Animation:** Introduction of computer Animation, Principles of Animation, Keyframing, Kino-dynamics Planning- motion blending, skinning-skeleton animation, rigid skinning ,linear skinning, dual skinning, physics modeling-Physics-based animation, rigid body systems, articulated rigid bodies, forward and inverse dynamics. [7]

3. **Rendering:** Basic concepts of graphics models-illumination& reflection models Shading-Scanning polygons, Gourad and Phong shading , texture mapping- bump & environmental maps , mipmaps , shading languages-vertex shedders and fragment shedders. [12]

4. **Modeling:** Representation, Using homogeneous Coordinate systems, Modeling process, terrain-representation, methods , fault formation & weather, plants modeling , animals modeling. [12]

5. **Surface Representation:** Three dimensional object representation –polygon representations, implicit representation , Beziers ,B-splines-basis function, knot insertion, conversion , rational B-splines (NURBS)-properties and examples , evaluators, subdivision surfaces-coarse mesh and subdivision rule, types of subdivisions , Voxels . [14]

Outcome(s): On successful completion of this course, students will be able to.

- Perform 3D transformation and viewing techniques.
- Understand various styles of animation.
- Acquire knowledge about illumination models, color models and surface rendering.

Text Books:

[1] Peter Shirley, Stephen Robert Marschner, “Fundamentals of Computer Graphics” , A K Peters Limited, 2009.

[2] David F. Rogers, Procedural Elements for Computer Graphics, Tata McGraw Hill Publications, 2nd edition, 2001.

Reference Books:

[1] Shreiner Dave, “Opengl Programming Guide: The Official Guide To Learning Opengl”, Version 2.1, 6/E , Pearson Education India, 2008.

[2] Francis S. Hill, Jr., Stephen M. Kelley , “Computer Graphics: Using OpenGL”, Pearson Prentice Hall, 2008

[3] James D.Foley, Andries van Dam, Steven K. Feiner, John F. Hughes , “Computer Graphics , Principles & Practice”, 3rd Edition, Pearson Prentice Hall, 2013

CS 19.570 **Mathematical Modeling** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Engineering Mathematics

Objective(s):

- To acquire knowledge about basics of various mathematical models
- To learn methods of model fitting
- To study modeling with differential equations

1. **Introduction :** Basics of modeling, mathematical models, Modeling change with difference equations, Approximate change with difference equations, solutions to dynamical systems, systems of difference equations. Modeling using proportionality, modeling using geometric similarity. [12]

2. **Model fitting and Experimental modeling** : Fitting models to data graphically, analytic method of model fitting, applying the least square criterion, choosing a best model, one term models , high order polynomial models, smoothing of low order polynomial models, cubic spline models. [10]

3. **Simulation modeling:** Introduction, simulating deterministic behavior: area under a curve, generating random numbers, simulates probabilistic behavior, queuing models. Introduction to some simulators. [10]

4. **Discrete modeling:** Probability modeling with discrete systems, linear regression, an overview of discrete optimization modeling, linear programming: geometric and algebraic solutions, simplex method. [10]

5. **Modeling with differential equations:** Introduction, population growth, graphical solutions of autonomous differential equations, numerical approximation methods, graphical solutions of autonomous systems of First order differential equations. [10]

Outcome(s): On successful completion of this course, students will be able to

- Understand simulation modeling and discrete optimization modeling
- Understand queueing models and low order polynomial models

Text Books:

[1] Giordano, Weir, and Fox, “A First Course in Mathematical Modeling”, 4th edition, Brooks/Cole Thomson Learning, 2009.

[2] Randall James Swift, “A Course in Mathematical Modeling”, Cambridge University Press, 1999.

Reference Books:

[1] Edward A. Bender, “An Introduction to Mathematical Modeling”, Courier Dover Publications, 2000.

[2] Neville D. Fowkes, John J. Mahony, “An introduction to mathematical modeling”, Wiley, 1994.

[3] Jerry Banks, John S. Carson II Barry L. Nelson David M. Nicol,” discrete event system simulation ”, Prentice Hall, fourth edition , 2004

CS 19.571 **Advances in Algorithm Design** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Data Structures, Design and Analysis of Algorithm

Objective(s):

- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms complexity

1. **Pattern matching algorithms:** Finite automata and regular expression, recognition of regular expression patterns, recognition of substrings, Two – way deterministic pushdown automata, position trees and substring identifiers. [11]

2. **Computability theory:** Turing machines, variants of Turing machines, Hilbert‟s problem, decidable languages, the halting problem, Un-decidable problems from language theory, mapping reducibility, the recursion theorem, decidability of logical theories, Turing reducibility, definition of information. [11]

3. **Fast Fourier Transform and Polynomials:** Representation of polynomials, the DFT and FFT algorithms, efficient FFT implementation, the FFT using bit operations, products of polynomials, the Schonhage – Strassen integer multiplication algorithm. [11]

4. **Randomized Algorithm and Parallel Algorithm:** Monte-Carlo algorithm, Las-Vegas algorithm, Game tree evaluation, De-randomization. Models for parallel computation basic techniques; Parallel matrix algorithms: matrix-vector multiplication, matrix multiplication, triangular system solution, sorting networks-parallel merging networks, zero –one principle. [8]

5. **Complexity theory:** Time complexity, the classes P,NP,NP complete and NP hard, Hierarchy theorems, Relativization, Circuit Complexity, approximation algorithms, probabilistic algorithms, circuit complexity, alteration, interactive proof systems, parallel computation, cryptography. [11]

Outcome(s): On the successful completion of the course, the student will be able to:

- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.

Text Books:

[1] Aho Alfred V., Hopcraft John E., Ullman Jefferey D. “The design and analysis of computer algorithms” Pearson education, tenth impression 2012.

[2] Cormen Thomas H. “Introduction to algorithms” PHI, Third edition – 2012.

Reference Books:

[1] MICHAEL SIPSER Sipser Michael, “Introduction to the theory of computation” Thomson press, Third edition 2012.

[2] Brassard G.,Fundamental of Algorithmcs, Prentice-Hall of India, 2003. 4.Horowitz E.,Computer Algorithms, Galgotia Publications, 2002.

RM 19.101 **Research Methodology** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): Communication Skills

Objective(s):

- To understand a general definition of research design.
- To identify the overall process of designing a research study from its inception to its report.
- To be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- To understand the primary characteristics of quantitative research and qualitative research.
- To identify a research problem stated in a study

1. **Introduction**: Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research. [6]
2. **Problem Formulation**: Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature, Research Gaps. [10]
3. **Research Design**: Research Framework, Meaning &Significance of Research Designs, Features of a good Research Design, Types of Research Design. [10]
4. **Data Analysis and Simulation Tool**: Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis, SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [12]
5. **Report Writing**: Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [2]

Outcome(s): On successful completion of this course, the students will be able to

- Assess critically the following methods: literature study, case study, structured surveys, interviews, focus groups, participatory approaches, narrative analysis, cost-benefit analysis, scenario methodology and technology foresight.

Text Books:

1. R.Pannershelvam, "ResearchMethodology" PrenticeHall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"ResearchMethodology: MethodsandTechniques",New Age International (p) Limited,Publishers New Delhi, 4ndedition,2018.

Reference Books:

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013

UC 19.101 **Social and Professional Ethics** **Total Lectures: 26**

2-0-0-2

Objective: To create an awareness on professional ethics and human values, To instill moral and social values and loyalty and to appreciate the rights of others.

Pre-requisite:

1. **Basic Human Values:** Morals, Values and Ethics – Truth, Rights Conduct (Righteousness), Love, non-violence and peace, Humility and character. Core areas of ethics: Social ethics, Personal ethics Integrity and Trustworthiness, Honesty, Loyalty, Courage, Prudence, Confidence, Confidentiality. **[5]**

2. **Theories of Ethics:** Kohlberg and Gilligan's analysis of moral development, - Deontology, Utilitarianism, Virtue Theory Rights Theory, Casuist Theory of Consequentialism – Robert Nozick's Theory of Entitlement and Property Rights. **[4]**

3. **Professional Ethics:** Introduction, meaning of work ethics, professional ethics for Journalists, Physicians, Lawyers, Engineers and Accountants. Intellectual property Rights, scope of ethics, code of conduct, business values and inner consciousness, Ethics at the workplace cybercrime, plagiarism, misconduct, fraudulent use of institutional resources, etc. **[7]**

4. **Corporate Social Responsibility:** Evolution of Corporate Social Responsibility (CSR) in India, CSR models, CSR to different stakeholders, Corporate Social Responsibility Initiatives of Major Companies of India, Promoting value based governance in organization. Whistle blower policy. **[6]**

5. **Ethics and Environment:** Introduction to environmental Issues- Industry and Environmental Pollution, Ethics of Controlling environmental pollution – Impact of environmental pollution on human health – Rights, Duties and care in environmental protection - Sustainable development. **[4]**

Outcome: The students will understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories.

Text Books:

1. B.N Ghosh "Business Ethics and Corporate Governance", McGraw Hill Education, Chennai, 2016
2. John R Boatright, "Ethics And The Conduct Of Business", Pearson Education, New Delhi, 2013.

Reference Books:

1. Raju Ramachandran, "Professional Ethics: Changing Profession and Changing Ethics", LexisNexis, Butterworths, 2nd Edition 2014.
2. Andrew Crane and Dirk Matten, "Business Ethics", Oxford University Press, 2nd Edition, 2015.
3. S.K Mandal "Ethics in Business and Corporate Governance" McGraw Hill Education, New Delhi, 2013.
4. R. Subramanian "Professional Ethics", Oxford University Press, 2015.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech VLSI

EC 19.541	Semiconductor Device Models for Circuit Simulation	3-1-0-4
	Total Lectures:	**40**

Objectives: To provide foundation in various semiconductor device models.

Pre-requisite: **Semiconductor Devices and Circuits**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to Diode Models:** Principle of circuit simulation and its objectives. Introductions to SPICE- DC, small signal, large signal, high frequency, noise models of diodes and measurement of diode model parameters.	**[10]**
2.	**Bipolar Junction Transistor Models:** DC, small signal, high frequency and noise models of bipolar junction transistors, extraction of bipolar junction transistor model parameters.	**[8]**
3.	**MOSFET Models:** DC, small signal, high frequency and noise model of MOSFETs. MOSFET channel mobility model, level-1 and level-2 large signal MOSFET Models.	**[10]**
4.	**MOSFET Scaling and other Effects:** Devices scaling, short and narrow channel MOSFETs. Extraction of MOSFET model parameters.	**[6]**
5.	**Devices Models:** JFET, Heterojunction FET, Heterojunction bipolar transistor and MESFETs, JFET and MESFET model parameters.	**[6]**

Course Outcomes: At the end of the course student will be able

1. Explain the equations, approximations and techniques available for deriving a model with specified properties, for a general device characteristic with known qualitative theory.
2. Apply suitable approximations and techniques to derive the model referred to above starting from drift-diffusion transport equations.
3. Simulate characteristics of a simple device using MATLAB, SPICE.
4. Explain how the equations get lengthy and parameters increase in number while developing a compact model

Text Books:

1. Dasgupta, Nandita, and Amitava Dasgupta. *Semiconductor devices: modelling and technology*. PHI Learning Pvt. Ltd., 2004.
2. Streetman, Ben G., and Sanjay Kumar Banerjee. *Solid State Electronic Devices: Global Edition*. Pearson education, 2016.

Reference Books:

1. Adir Bar-Lev. *Semiconductors and electronic devices*. Prentice-Hall International.

EC 19.542	Analog VLSI Design	3-1-0-4
	Total Lectures:	**40**

Objectives:

- To develop the ability design and analyze MOS based Analog VLSI circuits to draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
- To develop the skills to design analog VLSI circuits for a given specification.

Pre-requisite: **Electronics Devices and Circuits, Network Theory**

Unit No.	Course Contents	Lecture Hours
1.	**Basic consideration in analog VLSI design**: Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.	**[8]**
2.	**Differential Amplifiers**: Single Ended and Differential Operation, Basic Differential Pair, Common-Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors – Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.	**[8]**
3.	**Frequency Response of Amplifiers**: General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs. CMOS comparators.	**[8]**
4.	**Feedback Amplifiers**: General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation. Mixed signal circuits.	**[8]**
5.	**MOS circuit components:** Switched capacitor filters realization by MOS technology.	**[8]**

Course Outcomes: At the end of the course student will be able

1. Draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
2. Design analog VLSI circuits for a given specification.
3. Analyse the frequency response of the different configurations of an amplifier.
4. Understand the feedback topologies involved in the amplifier design.
5. Appreciate the design features of the differential amplifiers.

Text Books:

1. Razavi, Behzad. *Design of Analog CMOS Integrated Circuits*. McGraw-Hill Higher Education, 2001.
2. Johns, David A., and Ken Martin. *Analog integrated circuit design*. John Wiley & Sons, 2008.

Reference Books:

1. Gray, Paul R., et al. *Analysis and design of analog integrated circuits*. Wiley, 2001.

EC 19.543	VLSI Fabrication Technology	3-1-0-4
	Total Lectures:	**40**

Objectives: To provide rigorous foundation in MOS and CMOS fabrication process.

Pre-requisite: **Semiconductor Physics**

Unit No.	Course Contents	Lecture Hours
1.	**Crystal Growth and Oxidation:** Electron grade silicon. Crystal growth. Wafer preparation. Vapour phase and molecular beam epitaxy. SOI. Epitaxial evaluation. Oxidation techniques, systems and properties. Oxidation defects.	**[8]**
2.	**Lithography:** Optical, electron, X-ray and ion lithography methods. Plasma properties, size, control, etch mechanism, etch techniques and equipment's.	**[8]**
3.	**Deposition:** Deposition process and methods. Diffusion in solids. Diffusion equation and diffusion mechanisms.	**[8]**
4.	**Process Simulation:** Ion implantation and metallization. Process simulation of ion implementation, diffusion, oxidation, epitaxy, lithography, etching and deposition. NMOS, CMOS, MOS memory and bipolar IC technologies. IC fabrication.	**[8]**
5.	**Packaging**: Analytical and assembly techniques. Packaging of VLSI devices.	**[8]**

Course Outcomes: At the end of the course student will be able

1. Appreciate the various techniques involved in the VLSI fabrication process.
2. Understand the different lithography methods and etching process.
3. Appreciate the deposition and diffusion mechanisms.
4. Analyze the fabrication of NMOS, CMOS memory and bipolar devices
5. Understand the nuances of assembly and packaging of VLSI devices.

Text Books:

1. S. M. Sze. *VLSI Technology*. Second Edition, McGraw-Hill 2017.
2. Gandhi, Sorab K. *VLSI fabrication principles: silicon and gallium arsenide*. Vol. 117. John Wiley, 2003.

Reference Books:

1. Wolf, Wayne. *Modern VLSI design: systems on silicon*. Prentice-Hall, Inc., 2002.
2. A.I.C.T.E, Design and Fabrication Technology, A.I.C.T.E, Bangalore, 2001.

EC 19.544 **VLSI Systems and Subsystems** **3-1-0-4**

Total Lectures: 40

Objectives:

- To prepare the student to understand the HDL language feature to realize the complex digital systems.
- To design and simulate sequential and concurrent techniques in HDL
- To explain modeling of digital systems using HDL and design methodology
- Understand the concepts of Memories and Programmable logic
- Understand the concepts of Physical Design Process such as partitioning, Floorplanning, Placement and Routing.

Pre-requisite: **Digital VLSI Design**

Unit No.	Course Contents	Lecture Hours
1.	**System specification using HDL:** Basic Concepts, Structural Gate-Level Modeling, Switch-Level Modeling, Behavioral and RTL Modeling.	**[8]**
2.	**General VLSI Components:** Multiplexers, Binary Decoders, Equality Detectors and Comparators, Priority Encoder, Shift and Rotation Operations, Latches and Flip-flops, Registers.	**[8]**
3.	**Arithmetic circuits in CMOS VLSI:** Bit Adder Circuits, Ripple carry adders, Carry-Look Ahead Adders, High speed adders, Multipliers.	**[8]**
4.	**Memories and Programmable logic:** SRAM, SRAM arrays DRAM, ROM arrays, Logic arrays.	**[8]**
5.	**System level physical design:** Interconnect Delay Modeling, Interconnect Scaling, Floorplaning and Routing, Input and Output Circuits, VLSI clocking and system design. Reliability and testing of VLSI circuits	**[8]**

Course Outcomes:

At the end of the course student will be able

1. Model, simulate, verify, and synthesize with hardware description languages.
2. Understand and use major syntactic elements of HDL - entities, architectures, processes, functions, common concurrent statements, and common sequential statements
3. Design digital logic circuits in different types of modeling
4. Demonstrate timing and resource usage associated with modeling approach.
5. Use computer-aided design tools for design of complex digital logic circuits.

Text Books:

1. Uyemura, John P. *Introduction to VLSI circuits and systems*. John Wiley, 2002.
2. Wolf, Wayne. *Modern VLSI design: system-on-chip design*. Pearson Education, 2002.

Reference Books:

1. Hill, Frederick J., Gerald R. Peterson, and Fredrick J. Hill. *Computer aided logical design with emphasis on VLSI*. Vol. 4. New York: Wiley, 1993.

EC 19.545 **Elements of Digital VLSI Design** **3-1-0-4**

Total Lectures: 40

Objectives:

- To provide rigorous foundation in MOS and CMOS digital circuits
- To train the students in transistor budgets, clock speeds and the growing challenges of power consumption and productivity

Pre-requisite: **Electronics Devices and Circuits**

Unit No.	Course Contents	Lecture Hours
1.	**CMOS Technology:** CMOS Technology & Device Scaling, Stick Diagram, Layout and Full Custom Mask Design, CMOS process enhancement, Technology related CAD issues.	**[8]**
2.	**Introduction to CMOS circuits:** MOS inverters : Static and Dynamic Characteristics, Inverter Delay and Power Dissipation, Interconnect delay	**[8]**
3.	**MOS Logic Circuits:** Combinational MOS Logic Circuits, Sequential MOS Logic Circuits, Circuit characterization and performance estimation: Delay estimation, Logical effort and transistor sizing, Power dissipation, Interconnect design margin, Reliability.	**[10]**
4.	**VLSI Circuits:** Dynamic Logic Circuits, Low power VLSI Circuits	**[8]**
5.	**Advance VLSI Circuits:** Introduction to BiCMOS Circuits, Introduction to FPGA and ASICS.	**[6]**

Course Outcomes: At the end of the course student will be able

1. Implement the logic circuits using MOS and CMOS technology.
2. Analyze various circuit configurations and their applications
3. Analyze the merits of circuits according to the technology and applications change.
4. Design low power CMOS VLSI circuits.
5. understand the rapid advances in CMOS Technology

Text Books:

1. Kang, Sung-Mo, Yusuf Leblebici, and Chulwoo Kim. *CMOS digital integrated circuits: analysis & design*. McGraw-Hill Higher Education, 2014.
2. Weste, Neil HE, and Kainran Eshraghian. *Principles of CMOS VLSI design: A systems perspective*. Pearson Education Asia, 2001.

Reference Books:

1. Baker, Jacob R., Harry W. Li, and David E. Boyce. *CMOS Circuit Design, Layout and Simulation*, Prentice-Hall of India, 2000.

EC 19.546	Embedded System Design	3-1-0-4
	Total Lectures:	**40**

Objectives:

- To learn basics of embedded hardware and software
- To understand the basics of the Embedded Processor Architecture and Microcontrollers
- To Understand the issues related to Embedded software Architecture & Development

Pre-requisite: **Microcontroller and Interfacing**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to Embedded System & Design Concepts:** Introduction & examples of embedded system, Concept of embedded system design , design challenges, processor technology & IC technology, Embedded processor & general purpose processor, trades-offs, development phase of embedded system & use of software tools for development of embedded system.	**[4]**
2.	**Embedded Processor Architecture/Microcontrollers:** Role of processor selection in embedded system, overviews of 8-bits/16-bits/32-bits microcontrollers, 8051 microcontroller: Architecture, basic assembly language programming concepts, instruction sets, addressing modes, logical operations, arithmetic operations, branching instructions, Boolean instructions, subroutines, timing subroutine, serial data communication & interrupt process, assembly language programming examples	**[12]**
3.	**Interfacing, programming & real-time applications:** Memory & I/O interfacing, Timer & counter operation & Programming, Serial communication, & interrupt handling, LCD & keyboard interfacing, DS 12887 RTC interfacing, interfacing ADC/DAC, real world interfacing & applications.	**[12]**
4.	**Embedded software Architecture & Development:** Challenges & issues in an embedded software development, real-time programming language & embedded OS, Embedded software architecture: Round-Robin, Round-Robin with interrupt, RTOS architecture, tasks & tasks states, priority based scheduling, Semaphore & shared data, timer function, memory management, encapsulating semaphore & queue, hard real-time scheduling consideration, saving memory space & power. Embedded software development process & tools.	**[6]**
5.	**Networks for Embedded system:** 12C two wire busses, the can bus, SHARC link ports, Ethernet, Myrinet, IEEE 1451.1 & IEEE 1451.2 plugs & play standards, embedded TCP/IP	**[6]**

Course Outcomes: At the end of the course student will be able Understand the embedded systems and embedded software architecture

Text Books:

1. Simon, David E. *An embedded software primer*. Vol. 1. Addison-Wesley Professional, 1999.
2. Ali, Mazidi Muhammad. *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*. Pearson Education India, 2007.
3. Vahid, Frank, and Tony Givargis. *Embedded system design: a unified hardware/software introduction*. Vol. 52. New York: Wiley, 2002.

Reference Books:

1. Shibu K V. *Introduction to Embedded Systems*. Tata McGraw Hill Education Private Limited, 2009

EC 19.551	**Design of Digital Systems (Elective I)**	**3-1-0-4**
	Total Lectures:	**40**

Objectives:

- To get an idea about designing complex, high speed digital systems and how to

Pre-requisite: **Digital Electronics**

Unit No.	Course Contents	Lecture Hours
1.	**Mapping algorithms into Architectures:** Data path synthesis, control structures, critical path and worst case timing analysis. FSM and Hazards.	**[8]**
2.	**Combinational network delay:** Power and energy optimization in combinational logic circuit. Sequential machine design styles. Rules for clocking. Performance analysis.	**[8]**
3.	**Sequencing static circuits:** Circuit design of latches and flip-flops. Static sequencing element methodology. Sequencing dynamic circuits. Synchronizers.	**[8]**
4.	**Data path and array subsystems:** Addition / Subtraction, Comparators, counters, coding, multiplication and division. SRAM, DRAM, ROM, serial access memory, context addressable memory.	**[8]**
5.	**Reconfigurable Computing:** Fine grain and Coarse grain architectures, Configuration architectures-Single context, Multi context, partially reconfigurable, Pipeline reconfigurable, Block Configurable, Parallel processing.	**[8]**

Course Outcomes:

At the end of the course student will be able

1. Identify mapping algorithms into architectures.
2. Summarize various delays in combinational circuit and its optimization methods.
3. Summarize circuit design of latches and flip-flops.
4. Construct combinational and sequential circuits of medium complexity that is based on VLSIs, and programmable logic devices.
5. Summarize the advanced topics such as reconfigurable computing, partially reconfigurable, Pipeline reconfigurable architectures and block configurable.

Text Books:

1. Weste, Neil HE, and David Harris. *CMOS VLSI design: a circuits and systems perspective*. Pearson Education India, 2015.
2. Wolf, Wayne. *FPGA-based system design*. Pearson education, 2004.

Reference Books:

1. John F. Wakerly. *Digital Design: Principles and Practices*. Prentice Hall.

EC 19.552	VLSI Physical Design and Design Automation (Elective II)	3-1-0-4

Total Lectures: 40

Objectives:

- To learn basics of embedded hardware and software
- To understand the basics of the Embedded Processor Architecture and Microcontrollers
- To Understand the issues related to Embedded software Architecture & Development

Pre-requisite: **Elements of VLSI Design**

Unit No.	Course Contents	Lecture Hours
1.	**VLSI design automation tools-** algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.	**[6]**
2.	**Placement and Routing:** Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.	**[10]**
3.	**Floor planning and routing-** floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.	**[8]**
4.	**Simulation and logic synthesis-** gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis.	**[8]**
5.	**High-level synthesis-** hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.	**[8]**

Course Outcomes: At the end of the course student will be able

1. Students are able to know how to place the blocks and how to partition the blocks while for designing the layout for IC.
2. Students are able to solve the performance issues in circuit layout.
3. Students are able to analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning, placement and routing

Text Books:

1. S.H. Gerez. *Algorithms for VLSI Design Automation*. John Wiley, 1998.
2. N.A.Sherwani. *Algorithms for VLSI Physical Design Automation*. Kluwer, 1999.

Reference Books:

1. R. Geiger, P. Allen, and N. R Strader. *VLSI Design Techniques for Analog and Digital Circuits*. McGraw-Hill, New York, 1990.

EC 19.553	ASIC Design (Elective I)	3-1-0-4
	Total Lectures:	**40**

Objectives:

- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
- To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
- To give the student an understanding of basics of System on Chip and Platform based design.
- To give the student an understanding of High performance algorithms

Pre-requisite: **Digital Electronics**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to Technology**: Types of ASICs, VLSI Design flow, Design and Layout Rules, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells and I/O cells. Programmable interconnects. Advanced FPGAs and CPLDs and Soft-core processors.	**[8]**
2.	**ASIC physical design issues**: System Partitioning, Floorplanning and Placement. Algorithms: K-L, FM, Simulated annealing algorithms. Full Custom Design: Basics, Needs & Applications. Schematic and layout basics, Full Custom Design Flow.	**[8]**
3.	**Semicustom Approach:** Synthesis (RTL to GATE netlist) - Introduction to Constraints (SDC), Introduction to Static Timing Analysis (STA). Place and Route (Logical to Physical Implementation): Floorplan and Power-Plan, Placement, Clock Tree Synthesis (clock planning), Routing, Timing Optimization, GDS generation.	**[8]**
4.	**Extraction**: Logical equivalence and STA: Parasitic Extraction Flow, STA: Timing Flow, LEC: Introduction, flow and Tools used. Physical Verification: Introduction, DRC, LVS and basics of DFM.	**[8]**
5.	**System-On-Chip Design** - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.	**[8]**

Course Outcomes: At the end of the course student will be able

1. Demonstrate VLSI tool-flow and appreciate FPGA and CPLD architectures
2. Understand the issues involved in ASIC design, including technology choice, design management and tool-flow.
3. Understand the algorithms used for ASIC construction.
4. understand Semicustom Design Flow and Tool used - from RTL to GDS and Logical to Physical Implementation
5. understand the basics of System on Chip and on chip communication architectures appreciate high performance algorithms for ASICs

Text Books:

1. Smith, Michael John Sebastian. *Application-specific integrated circuits*. Vol. 7. Reading, MA: Addison-Wesley, 2003.
2. Pasricha, Sudeep, and Nikil Dutt. *On-chip communication architectures: system on chip interconnect*. Morgan Kaufmann, 2010.

Reference Books:

Gerez, Sabih H. *Algorithms for VLSI design automation*. John Wiley & Sons, Inc., 1999.

EC 19.554 **MEMS and Microsystems (Elective II)** **3-1-0-4**

Total Lectures: 40

Objectives:
- To learn basics of MEMS and Microsystems

Pre-requisite: **Electronic Devices**

Unit No.	Course Contents	Lecture Hours
1.	**Overview of Mems and Microsystems:** Mems And Microsystems, Evolution of micro fabrication, Microsystems and miniaturization, Application of Microsystems, Markets for Microsystems	**[8]**
2.	**Working Principles of Microsystems:** Introduction, MEMS and Micro actuators, Microfluidics, Micro actuators with Mechanical inertia	**[8]**
3.	**Engineering Science for Microsystems Design:** Introduction, Molecular theory of matter and intermolecular forces, Doping of semiconductor, Plasma physics, Electrochemistry	**[8]**
4.	**Thermo-fluid Engineering and Microsystems Design:** Introduction, Clock Skew and Sequential Circuit Performance, Clock Generation and Synchronization	**[8]**
5.	**Designing Arithmetic Building Blocks:** Introduction, Basic equation in continuum fluid dynamics, Laminar fluid flow in circular conduits, Computational fluid dynamics, incompressible fluid flow in micro-conduits	**[8]**

Course Outcomes:

At the end of the course student will be able

1. Understand the products and materials used in MEMS and Micro sensors.
2. Use the reconfigurable design implementation in MEMS.
3. Apply different bio medical applications

Text Books:

1. Tai-Ran Hsu, *MEMS and Microsystems*, 2nd Edition, Wiley, 2008.
2. Mohamad Gad El Hak, *MEMS Design and Fabrication*, 2nd Edition, CRC Press, 2006.

Reference Books:

1. Vijay. K. Varadan, K.J. Vinoy, and K.A. Jose, *RF MEMS and their Applications*, Wiley-India, 2011.

EC 19.555	Advanced Digital Communication (Elective I)	3-1-0-4
	Total Lectures:	**40**

Objectives:

- To give the student an understanding of issues related to Channel models and Modulation Schemes.
- To give the student an understanding of issues related to Digital Communications through Fading Channels.

Pre-requisite: **Digital Communication**

Unit No.	Course Contents	Lecture Hours
1.	**Channel models and Modulation Schemes:** Digital communication system model, communication channels and their characteristics, mathematical models for communication channels, AWGN channel, Probability and Stochastic Processes. Selected modulation schemes, digital PAM, PSK, QAM and FSK modulations, geometric (signal space) representation of modulated signals, Spectral Characteristics of Digitally Modulated Signals.	**[12]**
2.	**Receivers for AWGN channel**: Demodulation by correlation and matched filter receiver, detection by maximum likelihood detectors, performance analysis of optimum receiver for selected modulation schemes over AWGN channel.	**[6]**
3.	**Channel Capacity and Coding:** Channel capacity, Channel capacity with Orthogonal Signals, Random Selection of Codes – probabilistic approach and algebraic approach, Linear Block Codes, Cyclic Codes, Convolutional Codes, Soft-Decision Decoding and Hard-Decision Decoding	**[8]**
4.	**Channels and Mutual Information:** Channel capacity theorem (without proof), uncoded performance and Shannon limit, Information channels, probability relations in a channel, *a priori* and *a posteriori* entropies, generalization of Shannon's first theorem, mutual information, conditional mutual information, noiseless and deterministic channels, cascaded channels.	**[8]**
5.	**Digital Communications through Fading Channels:** Characterization of multipath fading channels, channel correlation and power spectra, statistical models of fading channels, frequency-nonselective, slowly fading, fast fading models, diversity techniques, digital signaling over fading channel, coded waveforms for fading channels, multiple antenna systems.	**[8]**

Course Outcomes: At the end of the course student will be able understand different digital modulation techniques, fading effects and information theory

Text Books:

1. John G. Proakis, *Digital Communications*, McGraw-Hill International Edition (4th Edition)
2. Bernard Sklar, Pabitra Kumar Ray, *Digital Communications – Fundamentals and Applications*, Pearson (2nd Edition)

Reference Books:

1. B. P. Lathi, Zhi Ding, *Modern Digital and Analog Communication Systems*, Oxford (International 4th Edition)

EC 19.556	**Advanced Wireless Communication (Elective II)**	**3-1-0-4**
	Total Lectures:	**40**

Objectives:

- To give the student an understanding of issues related to Wireless Channel Characteristics and Fading Channel Capacity and Diversity Techniques.
- To give the student an understanding of issues related to Modulation, Detection and Multiple access for wireless communication.

Pre-requisite: **Digital Communication**

Unit No.	**Course Contents**	**Lecture Hours**
1.	**Introduction:** Recent wireless systems and applications, cellular system concept and design fundamentals, dynamic resource allocation, frequency re-use concepts in time, frequency and code-division systems, improving coverage and capacity in cellular system-cell-splitting, microcell &picocell zone concept.	**[8]**
2.	**Wireless Channel Characteristics:** Concept of wireless channels- time varying channel impulse function. Basic propagation mechanisms- path loss and shadowing, outdoor and indoor propagation model- Okumura, Hata models, partition loss, log-distance loss, large-scale and small-scale propagation, multipath fading, outage probability, correlation, power-spectral density, average fade duration, channel coherency-coherence time and coherence bandwidth, Doppler shift.	**[8]**
3.	**Fading Channel Capacity And Diversity Techniques:** Capacity of AWGN and fading channels, MIMO-channel capacity, error probability over fading channels, diversity techniques to remove fading effects- space, time, frequency, polarization and transmit diversity techniques.	**[8]**
4.	**Channel coding for wireless communication:** coding as a means of time diversity, multiple- antennas coding, Alamouti codes, space- time block codes, design principle, coded modulation in MIMO frequency-selective channels, OFDM-MIMO system.	**[8]**
5.	**Modulation, Detection and Multiple access for wireless communication:** signal-space analysis, PSK, FSK, MSK, QAM modulation and signal constellation , multi-dimensional signals, orthogonal expansion of signals, spread spectrum modulation techniques-DS-SS & FH-SS in AWGN channels, multiple access techniques- FDMA, TDMA, spread – spectra multiple access, CDMA, space- division multiple access.	**[8]**

Course Outcomes:

At the end of the course student will be able

Understand different digital Wireless Channel Characteristics, Fading Channel Capacity And Diversity Techniques, Channel coding for wireless communication, Detection and Multiple access for wireless communication.

Text Books:

1. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2007.
2. Theodore S Rappaport, *Wireless Communication*, Pearson Education, Asia, New Delhi, 2002.

EC 19.557	RF and Microwave Engineering (Elective I)	3-1-0-4
	Total Lectures :	**40**

Objective 1. To Understand the basics of RF passive components and circuits.
2. To Analyze and evaluate the RF circuits using various RF circuit tools.

Pre-requisite Basic understanding of Electromagnetic field theory and Low frequency Electronics

Unit No.	Course Contents	
1.	**Two Port Network Theory:** Review of Low frequency parameters: Impedance, Admittance, ABCD parameters, High Frequency parameters, Formulation of S parameters, Properties of S parameters, Reciprocal and lossless Network, Transmission matrix, RF behavior of Resistors, Capacitors and Inductors.	**[8]**
2.	**Passive Microwave Devices:** Terminations, Attenuators, Phase shifters, Directional couplers, Hybrid Junctions, Power dividers, Circulator, Isolator, Impedance matching devices: Tuning screw, Stub and quarter wave transformers.	**[8]**
3.	**Microwave Generation:** Review of conventional vacuum Triodes, Tetrodes and Pentodes, High frequency effects in vacuum Tubes, Gunn diode oscillator, Varactor diode. Theory and application of Two cavity Klystron Amplifier, Reflex Klystron oscillator, Traveling wave tube amplifier, Magnetron oscillator using Cylindrical, Linear, Coaxial Voltage tunable Magnetrons, Backward wave Crossed field amplifier and oscillator.	**[10]**
4.	**Filters:** Analysis of periodic structures, filter design by insertion loss method, maximally flat and Chebyshev designs.	**[6]**
5.	**Microwave Measurements:** Measuring Instruments : Principle of operation and application of VSWR meter, Power meter, Spectrum analyzer, Network analyzer, Measurement of Impedance, Frequency, Power, VSWR, Q-factor, Dielectric constant, Scattering coefficients, Attenuation, S-parameters.	**[8]**

Outcome Student will be able to understand the fundamentals of RF and Microwave Engineering. They are also able to design and analyze the RF passive circuit using various RF circuit tools.

Text Books:

1. Collin, R.E., "*Foundations for Microwave Engineering*", 2nd Ed., John Wiley & Sons, 2000.
2. Pozar, D.M., "*Microwave Engineering*", 3rd Ed., John Wiley & Sons, 2004.

Reference Books:

1. Edwards, T.C. and Steer M.B., "*Foundations for Interconnects and Microstrip Design*", 3rd Ed., John Wiley & Sons, 2001.
2. Ludwig, R. and Bretchko, P., "*RF Circuit Design*", 2nd Ed., Pearson Education, 2000.
3. Hunter, I., "*Theory and Design of Microwave Filters*", 3rd Ed., IEE Press., 2001.

EC 19.558	**Advanced Antenna & Wave Propagation**	**(Elective II)**	**3-1-0-4**
		Total Lectures :	**40**

Objective 1. To Understand the basics of advanced antenna systems.
2. To Analyze different wave propagations.

Pre-requisite Basic understanding of Electromagnetic field theory

Unit No.	**Course Contents**	
1.	**Introduction of Antenna & its Parameters:** Reciprocity theorem, Review of microwave antennas-Parabolic Reflector, Cassegrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication.	**[9]**
2.	**Frequency-independent antennas:** Scattering and diffraction. Internal-equation methods, current distribution: Self and mutual impedances, arrays: design and synthesis.	**[7]**
3.	**Different Antennas and their Characterization:** Full wave analysis of Microstrip Antenna (MSA),Active Integrated MSA, Compact MSA with enhanced gain, Broadband Antenna(MSA), Dual frequency & Dual polarized MSA. Antenna Measurements, Standardization and characterization of antennas, Anechoic Chamber, Open-air test range.	**[10]**
4.	**Review of Modes of Propagation:** Surface wave, Ground wave, Sky wave, Space wave, Troposphere propagation.	**[6]**
5.	**Propagation**: Propagation over plane-Earth, Spherical Earth, Refraction, Anomalous Propagation, Diffraction, Modified refractive index- Its effects on wave propagation, Duct and other nonstandard propagation. Environmental noise, Radiation Hazards.	**[8]**

Outcome Student will be able to understand the fundamentals of advanced antennas. They are also able to analyze different wave propagations.

Text Books:

1. R.E Collin, *Antennas & Radio Wave Propagation*, Mc-Graw Hill
2. R. Garg, P. Bhartia , InduBhal& A. Ittipibom, Microstrip, *Antenna Design Handbook*, Artech house
3. Jordan &Balmain, *Electromagnetic Waves and Radiating Systems*, PHI

Reference Books:

1. M. Dolukhanov, *Propagation of Radio Waves*, Mir Publication
2. Girish Kumar & K.P.Roy, *Broad band Microstrip Antenna*, Artech House
3. Kin. Lu. Wong, *Compact and Broadband Microstrip Antenna*, John Wiley & Sons

EC 19.560 **Low Power VLSI Technology (Elective III)** **3-1-0-4**

Total Lectures: 40

Objectives:

- To expose the students to the low voltage device modeling, low voltage, low power VLSI CMOS circuit design.

Pre-requisite: **Elements of VLSI Design**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to low power VLSI technology**: Voltage scaling and power-delay tradeoff, Sources of Power Dissipation, Static Power Dissipation, Active Power Dissipation Designing for Low Power, Circuit Techniques For Leakage Power Reduction	**[8]**
2.	**Threshold Voltage Scaling:** Multi-threshold CMOS, Standard Adder Cells, CMOS Adders Architectures, Low Voltage Low Power Design Techniques, Current Mode Adders	**[8]**
3.	**Dynamic Logic Circuits:** Variable threshold CMOS. Estimation and optimization of switching activity. Various problems associated with dynamic logic circuits. Differential, BiCMOS and low voltage dynamic logic circuits	**[8]**
4.	**Switched Capacitance:** Reduction of switched capacitance. Adiabatic logic circuits. Basic background on testing, Unsuitable design techniques for safety-critical applications, Low power and safely operating circuits, Case study – A Low power subsystem design	**[8]**
5.	**Low-Power Memories:** Sources of power dissipation in SRAMs, Low power SRAM circuit techniques, Sources of power dissipation in DRAMs, Low power DRAM circuit techniques, DC-DC converters. Low-power architecture.	**[8]**

Course Outcomes:

At the end of the course student will be able

1. Identify clearly the sources of power consumption in a given VLSI Circuit
2. Analyze and estimate dynamic and leakage power components in a DSM VLSI circuit
3. Choose different types of SRAMs/ DRAMs for Low power applications
4. Design low power arithmetic circuits and systems
5. Decide at which level of abstraction it is advantageous to implement low power techniques in a VLSI system design

Text Books:

1. Yeo K., Rofail S. S., and Goh W. *CMOS/BiCMOS ULSI Low Voltage, Low Power*. Pearsons Education Asia, 2003.
2. Weste N. H. *Principles of CMOS VLSI Design* Pearsons Education Asia, 2001.

Reference Books:

1. Geiger R. L. *VLSI Design Techniques for Analog and Digital Circuits*. McGraw-Hill, New York, 1990.

EC 19.562 **Mixed-Signal Systems (Elective III)** **3-1-0-4**

Total Lectures: 40

Objectives:

- To make the students to understand the design and performance measures concept of mixed signal circuit.

Pre-requisite: **Analog VLSI Design**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to Mixed-Signal Systems:** Concepts of Mixed-Signal Design and Performance Measures. Fundamentals of Data Converters. Nyquist Rate Converters and Over sampling Converters.	**[4]**
2.	**Design methodology** for mixed signal IC design using gm/Id concept.	**[8]**
3.	**Static and dynamic logic**, OTA-C circuits. Silicon compilers.	**[8]**
4.	**CMOS Digital Circuits Design:** Design of MOSFET Switches and Switched-Capacitor Circuits, Layout Considerations.	**[10]**
5.	**Filter design strategies.** Design of frequency and Q tunable continuous time filters, Image processing.	**[10]**

Course Outcomes:

At the end of the course student will be able

1. Appreciate the fundamentals of data converters and also optimized their performances.
2. Understand the design methodology for mixed signal IC design using gm/Id concept.
3. Analyze the design of current mirrors and operational amplifiers
4. Design the CMOS digital circuits and implement its layout.
5. Design the frequency and Q tunable time domain filters.

Text Books:

1. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS, Circuit Design, Layout, and Simulation, Wiley-IEEE Press, 1998
2. David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley and Sons, 1997.

Reference Books:

1. Christoph G. *Languages for System Specification - Selected Contributions on UML, SystemC*. System Verilog, Mixed-Signal Systems, and Property Specifications from FDL'03, Springer Publisher, 1996.
2. Nishath K. V. *Simulation Techniques and Solutions for Mixed-signal Coupling in Integrated Circuits*. Springer Publisher, 1994.

EC 19.564 **Advanced Digital Signal Processing (Elective III)** **3-1-0-4**

Total Lectures: 40

Objectives:

- To give the student an understanding of issues related to Filter Structure and Design and Finite Word-length Effects.
- To give the student an understanding of Multi-rate DSP and Wavelets

Pre-requisite: **Digital Signal Processing**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction:** Analog versus digital signal processing, Sampling and sampling theorem, Quantization, AD- and DA-conversion, AD- and DA hardware realizations, Digital signal processors.	**[4]**
2.	**Filter Structure and Design:** Short review of DFT and FFT, DCT, IIR and FIR, block diagram representation of filters, IIR and FIR structures, design aspects of digital filters, IIR filter design methods - Impulse Invariance method, Bilinear transformation, Butterworth and Chebyshev approximation, FIR filter design – Rectangular window, Kaiser window, comparison between IIR and FIR filters.	**[8]**
3.	**Finite Word-length Effects:** quantization of fixed-point and floating-point numbers, analysis of coefficient quantization effects, noise analysis in A/D conversion, analysis of round-off errors, dynamic range scaling, SNR in low-order IIR filters, low-sensitivity digital filters, limit cycles, limit-cycle free structures.	**[10]**
4.	**Multi-rate DSP:** Up-sampler and down-sampler, filters in sampling rate alternation systems; multi-stage design of decimator and interpolator, polyphase decomposition; arbitrary sampling rate converter, Lagrange interpolation, digital filter banks, uniform DFT filter banks, Nyquist filters, quadrature-mirror filter banks, perfect reconstruction two-channel FIR filter banks, multi-level filter banks.	**[10]**
5.	**Wavelets:** Wavelet Analysis, The Continuous Wavelet Transform, scaling, shifting scale and frequency, The Discrete Wavelet Transform, One Stage filtering, Approximation and Details, Filter bank analysis, Multilevel Decomposition, Number of levels, Wavelet reconstruction, Reconstruction filter- Reconstructing Approximations and details, Multilevel Reconstruction, Wavelet packet synthesis, Typical Applications.	**[8]**

Course Outcomes:

At the end of the course student will be able

Understand different filter Structure and Design and Finite Word-length Effects, Multi-rate DSP and Wavelets.

Text Books:

1. S. K. Mitra, *Digital Signal Processing*, McGraw Hill
2. Martin Vetterli & Jelena Kovacevic, *Wavelets and Subband Coding*, PHI
3. Oppenheim, Wilsky & Nawab, *Signals and Systems*, PHI

Reference Books:

1. Simon Haykin & Bary Van Veen, *Signals and Systems*, Wiley Eastern
2. Lathi, Bhagwandas Pannalal. *Signal processing and linear systems*. New York: Oxford University Press, 1998.

EC 19.566 **Wireless Sensor Networks (Elective III)** **3-1-0-4**

Total Lectures: 40

Objectives:

- To give the student an understanding of issues related to Wireless Sensor Networks.
- To give the student an understanding of Sensor Tasking and Control and Operating Systems for WSNs.

Pre-requisite: **Digital Communication**

Unit No.	Course Contents	Lecture Hours
1.	**Overview of Wireless Sensor Networks (WSNs):** Introduction, Constraints and Challenges, Advantages of Sensor Networks, Sensor Network Applications, Key definitions of Sensor Networks. Wireless Sensor Technological Background: Wireless Communication Technology, Hardware and Software Platforms.	**[8]**
2.	**Networking Sensors:** Medium Access Control – The S-MAC Protocol, The IEEE 802.15.4 Standard, Zigbee Standard; Geographic, Energy-Aware Routing – Unicast Geographic Routing, Routing on a Curve, Energy-Minimizing Broadcast, Energy-Aware Routing to a Region; Attribute-Based Routing – Directed Diffusion, Rumor Routing.	**[10]**
3.	**Infrastructure Establishment:** Topology Control, Clustering, Time Synchronization, Localization and Localization Services.	**[8]**
4.	**Sensor Tasking and Control:** Task-Driven Sensing, Roles of Sensor Nodes and Utilities, Information-Based Sensor Tasking, Joint Routing and Information Aggregation.	**[6]**
5.	**Operating Systems for WSNs:** Introduction, Operating System Design Issues, Examples of Operating Systems – TinyOS, Mate, MagnetOS, EYES OS, Node-Level Simulators – ns-2, TOSSIM.	**[8]**

Course Outcomes:

At the end of the course student will be able

Understand the Networking Sensors, Infrastructure Establishment, Sensor Tasking and Control.

Text Books:

1. Sohraby, Kazem, Daniel Minoli, and Taieb Znati. *Wireless sensor networks: technology, protocols, and applications*. John Wiley & Sons, 2007.
2. Zhao, Feng, Leonidas J. Guibas, and Leonidas Guibas. *Wireless sensor networks: an information processing approach*. Morgan Kaufmann, 2004.

Reference Books:

1. Zaman, Noor, ed. *Wireless Sensor Networks and Energy Efficiency: Protocols, Routing and Management: Protocols, Routing and Management*. IGI Global, 2012.
2. Raghavendra, Cauligi S., Krishna M. Sivalingam, and Taieb Znati, eds. Wireless sensor networks. Springer, 2006.

MA 19.509	Advanced Mathematics	3-1-0-4
	Total Lectures:	**40**

Objectives: To acquire fundamental knowledge computational numerical techniques and fundamentals of statistics and probability and apply in inter-disciplinary engineering disciplines.

Prerequisite: **Engineering Mathematics**

Unit No.	Course Contents	Lecture Hours
1.	**Computer based numerical methods:** Methods for numerical solution of algebraic and transcendental equations: Direct methods e.g. Bisection method, Regula-Falsi method; Iterative method e.g. Newton-Raphson method. Methods for the solution of simultaneous linear equations: Direct methods e.g. Gauss elimination method; Iterative method e.g. Gauss-Seidel method, Jacobi method.	**[8]**
2.	**Finite difference** table for equal and unequal intervals in the independent variable values. Newton's forward and backward interpolation formula; Newton's interpolation formula for divided differences. Numerical differentiation.	**[8]**
3.	**Numerical Integration methods:** Simpson's rules, Trapezoidal rule and Romberg's method. Numerical solution of ordinary differential equations: Euler method, Modified Euler method and Runge-Kutta methods. Numerical solution of elliptic and parabolic differential equations using finite difference approach.	**[8]**
4.	**Statistics and Probability:**Concept of random variable, total and conditional probability, Bayes' theorem, probability distributions and probability density functions, moments and moment generating functions. Some theoretical probability distributions such as binomial, Poisson, normal, uniform, exponential, rectangular, χ^2, t, F.	**[8]**
5.	**Sampling theory:** sampling distributions and sampling techniques. Estimation theory, Point and Interval estimation of mean and variance of data. Testing of hypotheses. Simple and Composite hypothesis. Correlation and Regression. Multiple and Partial correlation and regression. Concepts of stochastic processes with special reference to Monte Carlo methods.	**[8]**

Course Outcomes: After completion of the course, students would be able to apply the knowledge of computational numerical techniques with statistics and probability theory in inter-disciplinary engineering and solve curriculum problems.

Text Books:

1. Shastri S.S., *Introductory Method of Numerical Analysis, Prentice-Hall of India*, 3rd Ed., 2002.
2. Trivedi K.S., *Probability and Statistics with Reliability Queuing and Computer Science Application*, Prentice-Hall of India, 2002.

Reference Books:

1. Papoulis, Probability, *Random Variables and Stochastic Processes*, TMH, 2018.
2. Gupta & Kapoor, *Fundamental of Mathematical Statistics, SCS Publisher*, 2002.
3. Dass and Verma, *Higher Engineering Mathematics*, S.Chand, 2019.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

MCA

CA 20.500 **Computer Information System*** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): None.
Objective(s): To give essential knowledge about computer information system and its components.

1. **Introduction:** Evolution of Computers, Generation of Computers, Classification of Computers, Block Diagram of Digital Computers, Memory Unit, ALU,CPU, I/O Devices, Basic Bus Architecture. Software Classification, Machine Language, Assembly Languages And High Level Languages, Assembler, Compilers And Interpreters, Process of Compilation, Programming Language Generations, Introduction to Operating Systems and Role of the Operating System. **[8]**
2. **Digital Logic:** Introduction to Boolean Algebra and Logic Gates, K-map Representation and Boolean Function Simplification, Number Systems: Conversion from One Number System to Another, Binary Operations, Complement Representation of Numbers , Alphanumeric Codes, Floating Point Representation of Numbers, Floating Point Arithmetic Operations. **[6]**
3. **Digital Circuit Building Blocks:** Adders, Subtractors, Comparators, Encoders, Decoders, Multiplexers, De-Multiplexers, Latches, Flip-Flops, Master Slave Flip Flops, Shift Registers and Counters. **[10]**
4. **Internet Technologies**: Introduction to Computer Networks, Internet, WWW and E Mail, Web Browsers, Introduction to LAN,MAN, WAN, An Introduction to the Design of Web Pages, HTML tags and CSS, Web Servers, Server Scripting, XML. **[8]**
5. **Software Development:** A Systematic Approach to Program Design, Coding, Testing, and Debugging. Application of these Skills to the Construction of Robust Programs. Use of Programming Environments and Tools to Aid in the Software Development Process. **[8]**

Outcome(s): On successful completion of this course, students will be able totake specialized courses with strong fundamentals of Computer Information Systems.

Text Books:

1. P.K. Sinha, Computer Fundamentals, BPB Publications, latest Ed.
2. M. Morris Mano, Digital Logic & Computer Design, Pearson,latest Ed.
3. Roger S. Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill Higher Education, latest Ed.
4. Thomas Powell, HTML and CSS: The Complete Reference, Tata McGraw-Hill,5thEdition, 2010.

Reference Books:

1. Andrew S.Tanenbaum, Computer Networks, Pearson Education, 5thEdition, 2013.
2. V. Rajaraman, Fundamentals of Computers, PHI, 6th Edition, 2014.

CA 20.501 **Programming Concepts** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s):
- To learn the basics of programming skills through C-Programming language.
- To understand the fundamentals concepts like syntax, and statements with essentials of efficient compiling, running and debugging processes.

1.	**Introduction:**Brief History, Library& Linking, Compilation & Execution, Data Types, Operator and Expression Identifier, Keyword and Token, Constant, Data Declaration and Definition, Operators and Expression, Precedence& Associability of Operators.	[7]
2.	**Control and Loop Statement:** Introduction, Selection Statements, If, TheConditional Expression, switch, Iteration Statements: for loop, while loop, do-While loop, Jump, Go to label, break and continue, exit () function.	[7]
3.	**Array, Function and String:** Definition, declaration and Types of Array, Operation and application of array, Brief introduction on string header files and applications of strings. Function, argument passing, scope of variable, call by reference and call by value, recursion, passing array to function.	[5]
4.	**Structure, Union and Pointer:** Definition, Declaration and Initialization, Accessing Structure members, Arrays of Structure, Passing Structure to function, Structure to Pointer, Union. Definition, declaration, Pointer to Pointer, NULL Pointer, De-referencing Pointer, array to pointer (1-D array ,2-D array) pointer array, function to pointer.	[12]
5.	**File handling and Storage Classes:** Introduction, Defining and Opening a File in read and writes mode, Closing a file and ending of file, Enumerated data types, Error Handling During I/O Operation Random Access to Files, Command Line Arguments. Storage Classes, Preprocessor Directive.	[9]

Outcome(s): At the end of the course student will be able to:
- Describe the process of problem solving through C.
- Write a justifiable C program for a given algorithm.
- Trace the certain C program manually.

Text Books:
1. Scheldt Herbert, “C The Complete Reference” Tata McGraw hill Latest Ed.
2. Kernighan & Ritchie, “C Programming Language” Prentice Hall Second Edition, latest Ed

Reference Books:
1. Kanetkar Y.P., “Let us C Solutions” 10th edition, BPB publication, latest Ed.
2. Balaguruswamy E., “Programming in ANSI C “5th Edition Tata McGraw-Hill Education, latest Ed.

CA 20.502 **Operating System** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- Understand the fundamental operating system abstractions like processes, threads, files, semaphores, IPC and deadlocks.
- Understand operating system from user's perspective as well as from system's perspective.
- Understand the principles of concurrency and synchronization.
- Understand basic resource management techniques.

1.	**Introduction:** Overview, Evolution,Types, operating system functions andcharacteristics.	[3]
2.	**Process Management and Memory Management:** The process concept, operating system services for process management, scheduling algorithms and multiple processor scheduling. Storage allocation methods, paging, segmentation, virtual memory concept, demand paging, page replacement algorithms and trashing.	[10]
3.	**Input /Output and File Systems:** Hardware organization, device scheduling policies, Functions of file systems, file access and allocation methods, directory systems, structured organizations, directory and file protection mechanisms and implementation issues. Device dependent and device independent software.	[7]
4.	**Deadlocks and Process Synchronization:** Characterization, prevention and avoidance, deadlock detection and recovery and practical consideration. Critical section problem, semaphores, classical process co-ordination problems and their solutions, inter process communication and message-passing mechanisms. Client-server modeling, RPC, threads.	[10]
5.	**Protection & Security:** Goals of Protection, Principles of Protection. Domain of protection Access Matrix, Implementation of Access Matrix. Access control, Revocation of Access Rights. Capability- Based systems, Language - Based Protection, Security problem, program threats, system and network threats cryptography as a security tool, user authentication, implementing security defenses, fire walling to protect systems.	[9]

Outcome(s): By learning the course, the students will be able to,
describe, contrast and compare differing structures for operating systems
understand and analyse theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files

Text Books:

1. Silberschatz A., and Galvin P.B., Operating System Concepts, John Wiley &Sons, latest Edition.
2. Tanenbaum A.S., Modern Operating Systems, Pearson Education Asia, latest Edition.

Reference Books:

1. Stallings W., Operating Systems, Pearson Education Asia, latest Edition.
2. Tanenbaum A.S. and Woodhull A. S., Operating Systems- Design and Implementation, Pearson Education Asia, latest Edition.

CA 20.503 **Management Information Systems**

Total Lectures:40
3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To introduce the concept of system analysis for managing the projects
- To analyze and document systems, design new systems and implement their plans.
- Understanding paradigm shift to E-enterprise
- Applications of IS and IT to management functions of the industry

1.	**MIS and Enterprise:** Management Information System (MIS) concepts, definition, role, impact, And management as a control system, MIS: A support to the management, goals, objectives and target, MIS for a digital firm, E-Business Enterprise: A digital firm-organization of business in digital firm, E-business, E-commerce, real time enterprise.	[8]
2.	**Strategic management of business performance:** Concept of corporate planning, essentiality of strategic planning, development of business strategies, types of strategies, short range planning, tools of planning,MIS: Strategic business planning.	[6]
3.	**Information and Knowledge:** Information Concepts, Classification of information, System Engineering: Analysis and Design- System concepts, system control, types of system, handling system complexity, system development model, Relationship between Information and Knowledge.	[8]
4.	**Development and implementation of MIS:** Determining the information requirement, Development and implementation of the MIS,Management of information, Quality of MIS, Business process reengineering.	[8]
5.	**Application of Management Information Systems:** Applications in manufacturing sector-personnel management, financial management, production management, raw material management, marketing management, applications in service sector, Decision support system.	[10]

Outcome(s):

By learning the course, the students will be able to

- Learn MIS and enterprise and strategic management of business performance.
- Learn management information system and its application
- Develop and implementation of MIS

Text Books:

[1] W. S.Jawadekar, Management Information Systems, New York, Latest Ed.

Reference Books:

[1] J. A.O' Brien, Management Information Systems, McGraw-Hill, Latest Ed.
[2] Davis G. B., and Olson M. H., Management Information Systems, Tata McGraw-Hill, Latest Ed.

CA 20.504 **Object Oriented Programming through Java** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): (C-Programming)

Objective(s):

- Cover issues related to the definition, creation and usage of classes, objects and methods.
- Discuss the principles of inheritance and polymorphism.
- Provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- Cover the basics of API and to explore the java abstract programming interface.

1.	**Overview:**IntroductiontoJava,importanceofJava, interactiveDevelopmentEnvironments: Eclipse/Net Beans, basics of OOP. DataTypes,Variable, andArrays:Primitivedatatypes,typecasting,arrays,operatorsand control structures, identifiers, constants and literals	[10]
2.	**Classes and Objects:** Class fundamentals, declaringobjects, assigning object reference variables, introducing methods, constructors, this keyword, garbage collection, the finalize()method, overloading methods, using objects as parameters and return type, introducing accesscontrol,understanding static, introducing final,introducing nestedandinnerclasses, exploringthe stringclass, usingcommand-linearguments.	[10]
3.	**Inheritance:** Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final in inheritance, the object class.	[4]
4.	**Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, JAVA's built-in exceptions, user defined exception.	[8]
5.	**Multi threaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managingthreads, thread class built-in functions.I/O and String Handling: I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer.	[8]

Outcome(s): Upon completion ofthis course, studentsareableto:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identifyclasses, objects,membersofaclassandthe relationships amongthem needed for aspecificproblem.
- Develop programs using the in-built JavaAPIandtheJavastandardclass library.
- CreateJavaapplicationprogramsusingsoundOOPpractices(e.g.,interfacesandAPIs) andproperprogramstructuring(e.g.,byusingaccesscontrolidentifies,automatic documentation throughcomments, error exception handling).
- Useof development environment like Eclipse forcollaborativeprogramming

Text Books:
[1] H. Schildt, Java The Complete Reference, Herbert Schildt, 10th Edition, 2017.
[2] John Jukowski, Mastering Java J2SE 1.4,SYBEX,Latest Ed.

Reference Books:
[1] A.B. Downey, Think Java: How to Think Like a Computer Scientist, Latest Ed.
[2] P.Deitel and H.Deitel, Java How To Program (Early Objects), 10thEdition, 2015.

CA 20.505 **Database Management Systems** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS, RDBMS& ODBMS in the organization

1.	**Introduction**: Databases and database users, database system concepts and architecture, data modeling using the Entity-Relationship (ER) model, Enhanced Entity Relationship model.	[6]
2.	**Relational Data Model**: Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model. Structured Query Language (SQL): SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views	[12]
3.	**Database Design**: Functional dependencies and normalization of relational databases, First Normal Form (1NF), 2NF, 3NF, Boyce-Codd normal form (BCNF), multivalued dependency, 4NF.	[6]
4.	**Transaction Processing**: Introduction, properties, recoverability, serializability. Concurrency control techniques: Two phase locking protocol, database recovery techniques: Recovery concepts, recovery techniques based on deferred and immediate update	[8]
5.	**Object and Object-Relational Databases**: Concepts for object databases, object database standards and design, object relational systems, object relational features, object database extensions to SQL, ODMG object model and the object definition language (ODL)	[8]

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.

Understand Object Oriented databases

Text Books:

[1]R.Elmasri & S.B.Navathe, Fundamentals of Database Management Systems, 7thEdition, Pearson Education, 2016.
[2] R. Ramakrishnan, DatabaseManagementSystems, Latest Edition, Tata McGraw Hill, latest Ed.

Reference Books:

[1] Korth and Schilberschatz, Database System Concepts, 6th Edition, Tata McGraw Hill, 2011.
[2] C.J. Date, Database Systems, Tata McGraw Hill, Latest Edition.

CA 20.506 **Software Engineering** **Total Lectures:40**

Credit:3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To understand the basic software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To know about software requirements specification, requirement elicitation, structured system analysis and introduction of object-oriented analysis and design, design techniques.
- To acquire knowledge on implementation issues such as modularity and coding standards.
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study web based-system and application, software re-use, software re-engineering, agile software engineering, software engineering and testing tools.
- To develop teamwork and have project based experience.

1.	**Introduction:** Software crisis, Software engineering Approach and Challenges, Software development process models with comparison: Waterfall, Rapid Prototyping, Spiral, Iterative, V-shape and Evolutionary Model, SEI-CMM.	[6]
2.	**Software Processes and Requirement Analysis:** Software engineering: a layered technology requirement elicitation, requirement analysis, software requirement and specifications, data flow diagrams, data dictionaries, entity-relationship diagrams. Software Measurement, planning schedule, Risk management, Quality Assurance.	[10]
3.	**Software Design and Estimation Techniques:** Introduction to object-oriented design, Function and Object Oriented Design concepts, Verification and Validations, Software size and cost estimation Techniques: Size oriented Metrix, FPA and COCOMO.	[8]
4.	**Testing:** Software testing fundamentals, test case design, white box testing:-basis path testing, control structure testing, black box testing: boundary value analysis, equivalence class testing, decision table testing, cause effect graphing, debugging, testing tools & standards, testing for client/server architecture,	[9]
5.	**Special Topics:**Brief of software re-use, reverse engineering, software re-engineering, agile software engineering, CASE Tools.	[7]

Outcome(s):

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Author a software requirements document and understanding of the proper contents of a software requirements document.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.

  Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

[1] R. S. Pressman, Software Engineering – A practitioner's approach, Tata-McGraw-Hill Int. Ed., 8th edition, 2014.

[2] K. K. Aggarwal, Yogesh Singh, Software Engineering, New Age International, latest edition.

Reference Books:

[1] Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publisher, Latest edition.

[2] Rajib Mall, Fundamentals of Software Engineering, Prentice-Hall, Latest edition

CA 20.507 **Mathematical Foundation** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Elementary Mathematics

Objective(s): To acquire fundamental knowledge of higher Mathematics and apply in Science and engineering disciplines.

1.	**Matrix Theory:** Introduction to the matrix theory, types of matrices, inverse of matrices, rank of matrices, solving system of linear equations.	[10]
2.	**Eigen Values:** Eigen values and Eigen vectors, Sparse matrix, diagonalization and triangulization of matrices.	[6]
3.	**Three-dimensional geometry and Vector calculus:** Basic concepts of three-dimensional geometry (viz. direction cosines and direction ratios), equation of aplane and of a straight line. Basic concepts of vectors, gradient, divergence and curl of a vector.	[8]
4.	**Calculus:** Introduction of differential and integral calculus, derivatives of various types of functions, basic idea of differential equations, solutions of ordinary differential equations with constant coefficients.	[10]
5.	**Complex Algebra:** Introduction to the complex algebra, complex numbers, geometrical representation of complex numbers, Argand diagram, De-Moirvre'stheorem.	[6]

Outcome(s): After completion of the course, students would be able to apply fundamentals of higher mathematical knowledge in science and engineering and also solve curriculum problems.

Text Books:

1. Ramana B. V. , " Higher Engineering Mathematics", Tata McGraw – Hill PublishingCompany Ltd., P 1390, Latest edition.
2. Babu Ram, "Engineering Mathematics", Pearson, New Delhi, 2010.
3. Narayan Shanti, "Analytical Solid Geometry", S Chand & Company, New Delhi, Latestedition.

Reference Books:

1. Grewal B. S. and Grewal J. S. , "Higher Engineering Mathematics" , Khanna Publishers,New Delhi, P. 1390, 40th edition,20014
2. KreyszigErrwin, "Engineering Mathematics", John Wiley& Sons, New York, , p. 1639, Latestedition.

CA 20.508 **Data Structure Concepts** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): C Programming

Objective(s):

- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems,
- To promote an analytical and empirical appreciation of the behavior of algorithms using data structures.

1.	**Introduction:** Data Structure definition, Requirement of different Data Structures, Abstract Data Type, Analysis of Algorithm	[3]
2.	**Linear Data Structure:** One and Two-dimensional Arrays, Array Representation, Selection Sort, Bubble Sort, Quick Sort, Heap Sort and Merge Sort, Sequential Search, Binary Search. Linked List and its representations, Operations on Linked List, Types of Linked List, Stack and its representation, Operations on Stack, Queue and its representation, Operations on Queue, Applications of these data structures.	[15]
3.	**Tree :** Binary Tree and its travesals (Breadth-First, Depth-First), Expression Trees (Infix, Prefix, Postfix Traversals), Binary Search Trees, Heaps,AVL Tree	[12]
4.	**Graph:** Matrix Representation, List representation and applications, Minimum Spanning Tree finding algorithms, Shortest Path finding algorithms.	[5]
5.	**Hashing Techniques:** Hash Function, Address Calculation Techniques, Common Hashing Functions, Collision Resolution, Linear Probing, Double Hashing, Bucket Hashing, Deletion and Rehashing.	[5]

Outcome(s): On the successful completion of the course, the student will be able to:

- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:

1. Horowitz and Sahani, “Fundamental of data structures”,Galgotia Publication, Latest Ed.
2. Lipschutz, “Data Structures Schaum’s Outline Series”, Tata Mcgraw Hills, Latest Ed.

Reference Books:

1. TenenbaumAaron M., YedidyahLangsam and Moshe J. Augenstein “DataStructures through C, Tata Mcgraw Hills, Latest Ed.
2. Kruse R. etal, “Data Structures and Program Design in C”, Pearson Education,Latest Ed.

CA 20.510 **R Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Concepts (CA 20.501)

Objective(s):

- To understand and learn programming concepts of R
- To Apply R programming to solve various statistical, graphics and modeling problems

1.	**Fundamentals of R**: Evolution of R, Features of R, R environmental Setup, R Script file. Data types- Vectors, Lists, Matrices, Arrays, Factors, Data Frames, Variables, finding and deleting variables, Operators in R.	[6]
2.	**Control Statements in R**: if-else statement, switch statement, Repeat loop, while loop, for loop, break statement, next statement	[8]
3.	**Functions, Strings and Vectors :** Function Definition , Function Components Built-in Function, User-defined Function, Calling a Function, Lazy Evaluation of Function, Strings and Strings Manipulation, Vector creation, accessing vector elements, vector manipulation,	[10]
4.	**Lists, Matrices and Arrays: List** Creation, Naming list elements, Accessing list elements, Manipulating list elements, Merging list, Converting list to Vector, Accessing elements of matrix, matrix computations, Naming row and column of array, accessing array elements, manipulating array elements, calculation across array elements.	[10]
5.	**Data frames, factors and packages:** Extract data from data frame, expand data frames, factors in data frames, changing the order of levels, generating factor levels, packages.	[6]

Outcome(s): After completing the course the student is expected to

- be able to use and program in the R programming language
- be able to use R programming to solve statistical problems
- be able to apply R Programming concept to solve real world problems

Text Books:

1. Hadley Wickham, Garrett Grolemund, R for Data Science, O'Reilly, January 2017.
2. John Maindonald and John Braun, Data Analysis and Graphics Using R, Cambridge University Press, Cambridge, Latest Ed.

Reference Books:

1. Peter Dalgaard, Introductory Statistics with R, Springer Verlag, Latest Ed.
2. Phil Spector. Data Manipulation with R. Springer, New York, 2008.

CA 19.603 **Design and Analysis of Algorithms** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): CA19.516(Data Structures)

Objective(s):
- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms power.

1. **Introduction:** Fundamentals of algorithms and problem solving, asymptotic notations, time complexity and analysis of algorithms, solutions of recurrence relations, master theorem and summations techniques. [8]
2. **Analysis of Sorting and Searching Algorithms:** Linear, binary and interpolation search, insertion, selection, merge, quick and heap sort, stability and other issues, hashing. [8]
3. **Algorithm Design Approaches:** Greedy method (knapsack problem, job sequencing problem), dynamic programming (assembly line scheduling, matrix chain multiplication), backtracking (8 queens problem, sum of subsets), branch and bound (0/1 knapsack problem), divide and conquer algorithms (Strassen matrix multiplication), problems based on these design paradigms. [8]
4. **Tree and Graph algorithms:** Spanning trees, Prim and Kruskal's algorithm, Huffman coding, BFS and DFS, disjoint set operations, connected components, shortest path algorithms in a graph such as Dijkstra, Bellman Ford, Warshall's etc. [8]
5. **Complexity Classes:** P,NP,NP hard and NP complete problems, reducibility, decision and optimization problems, examples of NP complete problems such as 3 CNF, clique, vertex cover and traveling salesman problem, basic introduction of approximation algorithms. [8]

Outcome(s): On the successful completion of the course, the student will be able to:
- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.
- Modify existing algorithms to improve efficiency.

Text Books:

1. T. H.Cormen, C. E.Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, PHI Learning Private Limited, 3rd edition, 2016.
2. E. Horowitz, S.Sahni, S.Rajasekaran, Computer Algorithms, Silicon Press, 2nd edition, 2008.

Reference Books:

1. A. Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 3rd edition, 2012.
2. A. V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, 1st edition, 2006.
3. D. E. Knuth, The Art of Computer Programming, Volumes 1& 3, Pearson Education, 2009.
4. S. S. Skiena, The Algorithm Design Manual, Springer, 2nd edition, 2008.

CA 19.605 **Computer Communications Networks** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CA 19.204 (Computer Networks)

Objective(s):

- To become familiar with layered communication architectures (OSI and TCP/IP).
- To understand the client/server model and key application layer protocols.
- To construct large-scale computer networks
- To understand fundamentals of computer networks and major protocols.
- To analyze and evaluate major Internet protocols.
- To program simple network applications using socket API
- To learn and adopt newly introduced computer network technologies by themselves.

1. **Introduction to Network Model:** History and development of computer networks, categories of networks, layering and protocols. [8]
   Physical Layer: Different types of transmission media, transmission impairments, encoding schemes (NRZ, NRZI, Manchester, 4B/5B, Manchester etc.)
2. **Data Link Layer:** Framing concept, Aloha, CSMA/CA, CSMA/CD protocols, performance evaluation and characteristics, error detection (parity, CRC), sliding window, stop and wait protocols,stop performance and efficiency,packet and circuit switching. [8]
3. **Local Area Network and Network Layer:** IEEE 802.3, 802.4, 802.5, 802.11, performance evaluation.IPv4, IP address classes, classless addressing, IPv6, ARP, RARP, DHCP, ICMP, routing algorithms: distance vector, metrics, RIP, OSPF, BGP, congestion control algorithms, leaky bucket, token bucket. [10]
4. **Transport Layer:** Duties of the transport layer, connection, TCP, TCP services, TCP header, UDP, evaluating protocol such as TCP/UDP using simulator like NS2. [6]
5. **Application Layer:** DNS, FTP, HTTP, SMTP, POP, basics of network security (cryptography, digital signature and firewall). [8]

Outcome(s): On successful completion of this course, students will be able to

- Analyze computer network component and devices.
- Synthesize how communication works in a network and internet.
- Formulate the concept of topologies and their applications.
- Analyze protocol at different layers and how they play important role in network implementation.
- Identify and analyze the latest technology with existing one.
- Enumerate the layers of OSI and TCP/IP models.
- Configure network and wireless technology including client/server programming.

Text Books:

[1]Forouzan B. A., Data Communications and Networking, Tata McGraw-Hill, 5th edition, 2013
[2] Stallings W., Data and Computer Communications, Prentice-Hall of India, 10th edition, 2013.

Reference Books:

[1] Tanenbaum A. S., Computer Networks, Prentice-Hall of India, 5th edition, 2010.
[2]Hayes J. F., Modeling and Analysis of Computer Communication Networks, Plenum Press, 1st edition, 1987.

CA 19.606 **Cryptography & Network Security** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CA 19.204(Computer Networks)

Objective(s):

- To understand the classical encryption and decryption algorithms, their techniques as well cryptanalysis.
- To acquire basic knowledge of finite fields and number theory.
- To understand the various block ciphers, stream cipher models, principles of public key cryptosystems, hash functions and digital signatures.
- To understand the different authentication techniques.

1. **General Overview and Classical Cryptography:** General overview of threats, risks and consequences, sources of threats, attacks, classification and preventive measures, introduction to some simple ciphers such as shift cipher, substitution cipher, affine cipher, Vigener cipher, hill cipher, permutation cipher and stream ciphers. [8]

2. **Symmetric/Secret Key Cryptography:** Block ciphers and their principles- boxes, P-boxes, DES, 3 DES, AES. [6]

3. **Key Exchange/Distribution Schemes:** Diffie - Hellman key exchange, man- in- the-middle attack, Fiat-Naor key distribution, Needham – Schroeder scheme and attack possible on it, Kerberos. [7]

4. **Asymmetric Key/Public Key Cryptosystems:** RSA description, different attacks on RSA and remedies, other public keycryptosystems such as ElGamal and Rabin cryptosystems and possible attacks on them. [7]

5. **Digital Signature Schemes:**Security requirements for digital signatures, ElGamal digital signature scheme and its security analysis, the digital signature algorithm (DSA), Schnorr digital signature scheme, provably secure signature schemes and undeniable signatures. Network Security: Electronic mail security, IP security, Network management security.SSL, SET Indruders and Viruses, Firewalls, Intrusion Detection. [12]

Outcome(s): On successful completion of this course, students will be able to :

- Analyze the security threats.
- Design robust cryptographic algorithms.

Text Books:

[1] A. Kahate, Cryptography and Network Security, Tata McGraw Hill,2nd Edition, 2008

[2] William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, 7th edition 2017

Reference Books:

[1] Jonathan Katz , Yehuda Lindell, Introduction to Modern Cryptography, (Cryptography and Network Security Series), Chapman and Hall/CRC; 2nd edition, 2014.

[2]Wenbo Mao, Modern Cryptography Theory & Practice, 1st edition, 2004.

CA19.607 **Database Management Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): NIL

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS, RDBMS& ODBMS in the organization

1. **Introduction**: Databases and database users, database system concepts and architecture, data modeling using the Entity-Relationship (ER) model, Enhanced Entity Relationship model. [6]
2. **Relational Data Model**: Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model.
   Structured Query Language (SQL): SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views [12]
3. **Database Design**: Functional dependencies and normalization of relational databases, First Normal Form (1NF), 2NF, 3NF, Boyce-Codd normal form (BCNF), multivalued dependency, 4NF. [6]
4. **TransactionProcessing**:Introduction,properties,recoverability,serializability. Concurrency control techniques: Two phase locking protocol, database recovery techniques: Recovery concepts, recovery techniques based on deferred and immediate update [8]
5. **Object and Object-Relational Databases**: Concepts for object databases, object database standards and design, object relational systems, object relational features, object database extensions to SQL, ODMG object model and the object definition language (ODL) [8]

Outcome(s): After completion ofthecourse, students willbe able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.
- Understand Object Oriented databases

Text Books:

[1] R.Elmasri&S.B.Navathe,FundamentalsofDatabaseManagementSystems,7th Edition, Pearson Education, 2016.

[2] R. Ramakrishnan, DatabaseManagementSystems, 3rd Edition, Tata McGraw Hill, 2008.

Reference Books:

[1] Korth and Schilberschatz, Database System Concepts, 6th Edition, Tata McGraw Hill, 2011.

[2] C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CA 19.608 **Management Information Systems** **3-0-0-3**
Total Lectures:40

Prerequisite(s): CA 19.106 (System Analysis and Design)

Objective(s):

- To introduce the concept of system analysis for managing the projects
- To analyze and document systems, design new systems and implement their plans.
- Understanding paradigm shift to E-enterprise
- Applications of IS and IT to management functions of the industry

1.	**MIS and Enterprise:**Management Information System(MIS) concepts, definition, role, impact, management as a control system, MIS: A support to the management, goals, objectives and target, MIS for a digital firm, E-Business Enterprise: A digital firm-organization of business in digital firm, E-business, E-commerce, real time enterprise.	[8]
2.	**Strategic management of business performance:** Concept of corporate planning, essentiality of strategic planning, development of business strategies, types of strategies, short range planning, tools of planning,MIS: Strategic business planning.	[6]
3.	**Information andKnowledge:** Information Concepts, Classification of information,System Engineering: Analysis and Design- System concepts, system control, types of system, handling system complexity, system development model, Relationship between Information and Knowledge.	[8]
4.	**Development and implementation of MIS:** Determining the information requirement, Development and implementation of the MIS,Management of information, Quality of MIS, Business process reengineering.	[8]
5.	**Application of Management Information Systems:** Applications in manufacturing sector-personnel management, financial management, production management, raw material management, marketing management, applications in service sector, Decision support system.	[10]

Outcome(s): By learning the course, the students will be able to

- Learn MIS and enterprise and strategic management of business performance.
- Learn management information system and its application
- Develop and implementation of MIS

Text Books:

[1] W. S.Jawadekar, Management Information Systems, , New York, 4th ed, 2009..

Reference Books:

[1] J. A.O' Brien, Management Information Systems, McGraw-Hill, 2004.
[2] Davis G. B., and Olson M. H., Management Information Systems, Tata McGraw-Hill,1985.

CA 19.609 **Java Programming** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CA 19.509 (C-Programming)

Objective(s):

- Cover issues related to the definition, creation and usage of classes, objects and methods.
- Discuss the principles of inheritance and polymorphism.
- Provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- Cover the basics of API and to explore the java abstract programming interface.

1. **Overview:**IntroductiontoJava,importanceofJava, interactiveDevelopmentEnvironments: Eclipse/Net Beans, basics of OOP. DataTypes,Variable, andArrays:Primitivedatatypes,typecasting,arrays,operatorsand control structures, identifiers, constants and literals [10]
2. **Classes and Objects:** Class fundamentals, declaringobjects, assigning object reference variables, introducing methods, constructors,this keyword,garbagecollection,the finalize()method, overloading methods, using objects as parameters and return type, introducing accesscontrol,understanding static, introducing final,introducing nestedandinnerclasses, exploringthe stringclass, usingcommand-linearguments. [10]
3. **Inheritance:**Inheritancebasics,usingsuper,multilevelhierarchy,constructorinhierarchy, methodoverriding,dynamicmethoddispatch,usingabstractclasses,usingfinalin inheritance, the objectclass. [4]
4. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages,interfaces,exception-handlingfundamentals,exceptiontypes,usingtry andcatch, multiplecatchclauses,nestedtrystatements,throw,throws,finally,JAVA'sbuilt-in exceptions, userdefinedexception. [8]
5. **MultithreadedProgramming:**TheJavathreadmodel,themainthread,creatingmultiple threads, threads priorities, managingthreads, thread class built-in functions. I/O and String Handling: I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer. [8]

Outcome(s): Upon completion ofthis course, studentsareableto:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identifyclasses, objects,membersofaclassandthe relationships amongthem needed for aspecificproblem.
- Develop programs using the in-built JavaAPIandtheJavastandardclass library.
- CreateJavaapplicationprogramsusingsoundOOPpractices(e.g.,interfacesandAPIs) andproperprogramstructuring(e.g.,byusingaccesscontrolidentifies,automatic documentation throughcomments, error exception handling).
- Useof development environment like Eclipse forcollaborativeprogramming

Text Books:

[1] H.Schildt, Java The Complete Reference, Herbert Schildt, 10th Edition, 2017.
[2] John Jukowski, Mastering Java J2SE 1.4,SYBEX, 2002.

Reference Books:

[1] A.B. Downey, ThinkJava:HowtoThinkLikeaComputer Scientist, 2011.
[2] P.Deitel andH.Deitel,JavaHowTo Program (EarlyObjects),10th Edition, 2015.

CA 19. 610 **Mobile Computing** **3-0-0-3**

Total Lectures:40

Prerequisite(s):
- To learn GSM , HLR-VLR CDMA, GPRS
- To learn database management issues

Objective(s):
- To learn how mobile computing are different from others traditional computing by learning thoseaspects of mobile programming that make it unique from other platforms
- Program mobile applications for the Android operating system that use basic and advanced phone features.

1.	**Introduction:** Issues in mobile computing, overview of wireless telephony: cellular concept, GSM: air-interface, channel structure, location management: HLR-VLR, hierarchical, handoffs, channel allocation in cellular systems, CDMA, GPRS	[8]
2.	**Wireless Networking:** Wireless LAN Overview: MAC issues, IEEE 802.11, Blue Tooth,Wireless multiple access protocols, TCP over wireless, Wireless applications, data broadcasting, Mobile IP, WAP: Architecture, protocol stack, application environment, applications.	[8]
3.	**Data Management Issues**: Data replication for mobile computers, adaptive clustering for mobile wireless networks, File system, Disconnected operations.	[8]
4.	**Mobile Agents computing**: Security and fault tolerance, transaction processing in mobile computing environment.	[8]
5.	**Ad Hoc Networks**: Localization, MAC issues, Routing protocols, global state routing (GSR), Destination sequenced distance vector routing (DSDV), Dynamic source routing (DSR), Ad Hoc on demand distance vector routing (AODV), Temporary ordered routing algorithm (TORA),QoS in Ad Hoc Networks, applications.	[8]

Outcome(s):
- Understanding of Ad Hoc Networks and wireless networking and its applications
- Understanding of CDMA, GPRS

Text Books:
[1] J. Schiller, “Mobile Communications”, Addison Wesley, 2003.
[2] S. T. Rappaport, Wireless communications: principles and practice. Vol. 2. New Jersey: prentice hall PTR, 1996.

Reference Books:
[1] Perkins Charles, “Mobile IP”, Addison Wesley,1994
[2] Perkins Charles, “Ad hoc Networks”, Addison Wesley,2001.

CA 19.629 **Computer Organization and Architecture** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): CA19.511 (Digital Electronics)

Objective(s):

- To have a thorough understandingofthebasicstructure and operation ofamodern digitalcomputer.
- To discuss in detail the operation of the arithmetic unit including the algorithms &implementation of fixed-point and floating-point representation
- TostudythedifferentwaysofcommunicatingwithI/OdevicesandstandardI/Ointerfaces.
- Tostudythehierarchicalmemorysystemincludingcachememoriesandvirtualmemory.

1. **Principles of Computer Organization:** Introduction to computer architecture, central processing unit, machine language instructions, addressing modes, instruction types, instruction set selection, instruction cycle and execution cycle, floatingpointrepresentation. [6]

2. **Processor and ALU Design:** Computer arithmetic and ALU design,control unit, data path and control path design, microprogramming versus hardware control, RISC vs CISC [8]

3. **Memory Organization:** Memory subsystem, storage technologies, memory arrayorganization, memory hierarchy interleaving, cache and virtual memories and architectural aids to implement these. [6]

4. **Input-Output Organization:**Input-output devices and characteristics, bus interface, data transfer techniques, I/O interrupts. [4]

5. **Advance computer Architecture**: Overview of parallel processing and pipelining, Superscalar processors,study and comparison of uni-processors and parallel processors, speedup.Pipelining: Principles and implementation of pipelining, classification of pipelining processors, pipeline architecture, general pipelining reservation table, design aspect of arithmetic and instructional pipeline, pipelining hazards and resolving techniques. [16]

Outcome(s): On successful completion of this course, students will be able to

- Understand basic structure of a digital computer.
- Perform arithmetic operations of binary number system.
- Know the organization of the control unit, arithmetic and logical unit, memory unit and the
- Describe the operation of performance enhancements such as pipelines, dynamic scheduling, branch prediction, cache, and vector processors.
- Describe modern architectures such as RISC, super scalar

Text Books:

[1] Hayes J. P., "Computer Architecture and Organization", McGraw- Hill, New York, 3rd ed.,2012.
[2] Hwang K., "Advanced Computer Architecture: Parallelism, Scalability and Programmability", McGraw-Hill, New York., 3rd ed ,2012.

Reference Books:

[1] Mano M. M., "Computer System Architecture", Prentice-Hall of India, 3rd ed. 1993

ELECTIVES

CA19.630 **ADVANCED DBMS** **3-0-0-3**

Total Lectures :40

Prerequisite(s): CA 19.607 (Database Management Systems)

Objectives:

- To cover and impart knowledge of various aspects of a Data Base Management systems like, databases, different database models, how transaction is managed, query is processed and different types data [8]

1. **Object based databases:** Introduction, OODM, OODB, OODBMS, ODMG, ORDBMS, ORDBMS design [8]
2. **Parallel and distributed databases:** Introduction, advantages and disadvantages, architecture, Parallel data processing and query parallelism. [8]
3. **Distributed databases:** Introduction, Properties, types, advantages, disadvantages, architecture, design, query processing, concurrency control, recovery control [8]
4. **XML Databases:** XML Databases: XML Data Model – DTD - XML Schema - XML Querying – Web Databases – JDBC – Information Retrieval – Data Warehousing – Data mining. [8]
5. **Emerging Database Technologies:** Internet databases, digital libraries, multimedia databases, mobile [8]

Outcome:

- Design and normalize the relations for any organization.
- Understand transaction processing control.
- Understand Object Oriented databases

Text Books:

[1] **Korth,** "Database Systems Concepts, Design and Applications", 1st Ed., Pearson Ed., 2016

Reference Books:

[1] C. J. Date, "An Introduction to Database Systems", 7th Ed., Narosa Publishing, 2004

[2] Elmsari and Navathe, "Fundamentals of Database Systmes", 4th Ed., A. Wesley, 2004

CA 19.631 **Real Time Systems** **3-0-0-3**

Total Lectures :40

Prerequisite(s): **CA 19.201(Computer Architecture)**

Objectives:

- Real-time scheduling andschedulability analysis
- Formal specification and verification of timing constraints and properties
- Design methods for real-time systems
- Development and implementation of new techniques to advance the state-of-the-art real-time systems research

1. **Introduction:** Issues in Real Time Computing, Structure of a Real Time System. Task Classes, Performance Measures for Real Time Systems, Estimating Program Run times. Task Assignment and Scheduling -Classical Uniprocessor scheduling algorithms, Task Assignment,Mode Changes, and Fault Tolerant Scheduling. [8]
2. **Programming Language and Tools**: Desired Language characteristics, Data Typing, Control structures,Facilitating Hierarchical Decomposition, Packages, Run-time (Exception) Error handling, Overloading andGenerics, Multitasking, Low Level programming, Task scheduling,Timing Specifications, Programming Environments, Run-time Support. [8]
3. **Real time Databases**: Basic Definition, Real time Vs General Purpose Databases, MainMemoryDatabases,Transaction priorities, Transaction Aborts, Concurrency Control Issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time systems. [8]
4. **Real-Time Communication:** Communications Media, Network Topologies Protocols, Fault Tolerant Routing. Fault Tolerance Techniques - Fault Types, Fault Detection. Fault Error containment Redundancy, Data Diversity, Reversal Checks, Integrated Failure handling. [8]
5. **Reliability Evaluation Techniques:** Obtaining Parameter Values, Reliability Models for Hardware Redundancy, Software Error models. Clock Synchronization - Clock, A Nonfault-Tolerant Synchronization Algorithm, Impact of Faults, Fault Tolerant Synchronization in Hardware, Fault Tolerant Synchronization in Software. [8]

Outcomes:

- Fundamental principles for programming of real time systems with time and resource limitations.
- Foundation for programming languages developed for real time programming.
- Use of real time system programming languages and real time operating systems for real time applications.
- Analyse real time systems with regard to keeping time and resource restrictions.

Text Books:

[1] C.M. Krishna, Kang G. Shin, “Real-Time Systems”, McGraw-Hill International Editions,1997

[2] J. S. Liu, Real Time Systems, Pearson Education, 2004

Reference Books:

[1] S. Bennett, “Real Time Computer Control-An Introduction”,Second edition Perntice Hall PTR,1994.

[2] 1. Peter D. Lawrence, “Real time Micro Computer System Design – An Introduction”, McGraw Hill,1988.

CA 19.632 **Software Project Management** **3-0-0-3**

Total Lectures: 40

Prerequisite(s): CA 19.634 (Software Engineering)

Objectives:

- Understand the fundamental principles of Software Project management
- To gain good knowledge of responsibilities of project manager and how to handle these.
- Be familiar with the different methods and techniques used for project management.

1. **Introduction To Software Project Management:** Project Definition, Contract Management Activities Covered By Software Project Management, Overview Of Project Planning, Stepwise Project Planning. [6]

2. **Project Evaluation :** Strategic Assessment, Technical Assessment, Cost Benefit Analysis, Cash Flow Forecasting, Cost Benefit Evaluation Techniques, Risk Evaluation. [6]

3. **Activity Planning:** Objectives, Project Schedule, Sequencing and Scheduling Activities, Network Planning Models, Forward Pass, Backward Pass, Activity Float, Shortening Project Duration, Activity on Arrow Networks, Risk Management, Nature Of Risk, Types Of Risk, Managing Risk, Hazard Identification, Hazard Analysis, Risk Planning and Control. [9]

4. **Monitoring And Control:** Creating Framework, Collecting the data Visualizing Progress, Cost Monitoring, Earned Value, PriortizingMonitoring, Getting Project Back To Target, Change Control, Managing Contracts – Introduction, Types Of Contract, Stages In Contract Placement, Typical Terms Of A Contract, Contract Management – Acceptance. [9]

5. **Managing People And Organizing Teams:**Introduction , Understanding Behavior, Organizational Behaviour: A Background, Selecting The Right Person For The Job, Instruction In The Best Methods, Motivation, The Oldman, Hackman Job Characteristics Model, Working In Groups, Becoming A Team, Decision Making. [10]

Outcomes:

- Student will have good knowledge of the issues and challenges faced while doing the Software project Management and will also be able to understand why majority of the software projects fails and how that failure probability can be reduced effectively.
- Will be able to do the Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques.

Text Books:

[1] Bob Hughes, Mikecotterell, “Software Project Management”, Third Edition, Tata McGraw Hill,2011.

[2] R.Gopalaswamy, "Managing Global Projects", Tata McGraw Hill,2001.

Reference Books:

[1] Jalote, “Software Project Management in Practice”, Pearson Education,2002.

[2] Royce, “Software Project Management”, Pearson Education,2005

CA 19.634 **Software Engineering** **Total Lectures:40**

Credit:3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To understand the basic software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To know about software requirements specification, requirement elicitation, structured system analysis and introduction of object-oriented analysis and design, design techniques.
- To acquire knowledge on implementation issues such as modularity and coding standards.
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study web based-system and application, software re-use, software re-engineering, agile software engineering, software engineering and testing tools.
- To develop teamwork and have project based experience.

1. **Introduction:** Software crisis, Software engineeringApproach and Challenges, Software development process models with comparison: Waterfall, Rapid Prototyping, Spiral, Iterative, V-shape and Evolutionary Model, SEI-CMM. [6]

2. **Software Processes and Requirement Analysis:** Software engineering: a layered technology requirement elicitation, requirement analysis, software requirement and specifications, data flow diagrams, data dictionaries, entity-relationship diagrams. Software Measurement, planning schedule, Risk management,Quality Assurance. [10]

3. **Software Design and Estimation Techniques:** Introduction to object-oriented design, Function and Object Oriented Design concepts, Verification and Validations, Software size and cost estimation Techniques: Size oriented Metrix, FPA and COCOMO. [8]

4. **Testing:** Software testing fundamentals, test case design, white box testing:-basis path testing, control structure testing, black box testing: boundary value analysis, equivalence class testing, decision table testing, cause effect graphing, debugging, testing tools & standards, testing for client/server architecture, [9]

5. **Special Topics:**Brief of software re-use, reverse engineering, software re-engineering, agile software engineering, CASE Tools. [7]

Outcome(s):

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Author a software requirements document and understanding of the proper contents of a software requirements document.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.

Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

[1] R. S. Pressman, Software Engineering – A practitioner's approach,Tata-McGraw- Hill Int. Ed., 8th edition, 2014.

[2] K. K. Aggarwal, Yogesh Singh, Software Engineering, New Age International, 1st edition, 2008.

Reference Books:

[1] Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publisher, 3rdedition, 2005.

[2] Rajib Mall, Fundamentals of Software Engineering, Prentice-Hall, 2ndedition, 2004

ELECTIVES

CA19.642 **Digital Image Processing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CA19.103 (C-Programming)

Objective(s):

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the image segmentation and representation techniques
- To study the image representation in form of features and descriptors

1. **Digital Image Fundamentals:** Elements of digital image processing systems, elements of visual perception, brightness, contrast, hue, saturation, mach band effect, color image fundamentals - RGB, HSI models, image sampling, quantization, dither, two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD. [8]
2. **Image Enhancement and Restoration:** Histogram equalization and specification techniques, noise distributions, spatial averaging, directional smoothing, median, geometric mean, harmonic mean, contra harmonic mean filters, image restoration - degradation model, unconstrained restoration, inverse filtering, removal of blur caused by uniform linear motion. [8]
3. **Morphological Image Processing:** Basics, structuring element, erosion, dilation, opening, closing, hit-or-miss transform, boundary detection, hole filling, connected components, convex hull, thinning, thickening, skeletons, pruning, and reconstruction by dilation and erosion. [8]
4. **Image Segmentation:** Edge detection, edge linking via Hough transform, thresholding, region based segmentation, region growing, region splitting and merging, and segmentation by morphological watersheds, basic concepts, dam construction, and watershed segmentation algorithm. [8]
5. **Image Representation:** Boundary representation, chain code, polygonal approximation, signature, boundary segments, boundary description, shape number, Fourier descriptor, regional descriptors, and topological features. [8]

Outcome(s): On successful completion of this course, students will be able to

- Analyze the basic algorithms used for image processing &image compression with morphological image processing.
- Apply image enhancement and restoration techniques.
- Use image compression and segmentation Techniques.
- Represent features of images.

Text Books:

[1] Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.
[2] Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011.

Reference Books:

[1] Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
[2] William K Pratt, “Introduction to Digital Image Processing”, CRC Press, 13-Sep-2013.

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CA 19. 644 **Artificial Intelligence** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To understand the basic problem solving in Artificial Intelligence.
- To learn different blind as well as heuristic search strategies.
- To understand the various ways of knowledge representation in Artificial Intelligence.

1	**OverviewofA.I.:**IntroductiontoAI,ImportanceofAI,AIanditsrelatedfield,AI techniques.	[4]
2	**Problem space and search:** Defining the problem as a state space search, Production system and its characteristics, Issues in the design of the search problem.	[6]
3	**Heuristic search techniques:** Generate and test, hill climbing, best first search technique, problem reduction, constraint satisfaction	[7]
4	**Game Playing and Predicate Logic:** Minimax, alpha-beta pruning. Predicate logic definition, representation of simple facts in logic, well-formed formula, resolution.	[11]
5	**Knowledge representation and Learning:** Definition and importance of knowledge, Knowledge representation, Various approaches used in knowledge representation, Issues in knowledge representation.Introduction to learning, Types of learning, Introduction to neural networks.	[12]

Outcome(s): On successful completion of this course, students will be able to

- Solve the basic problems and apply searching techniques used in Artificial Intelligence.
- To select knowledge representations to solve AI problems.
- Apply various game playing algorithms.

Text Books:

[1]. R. Elaine and K. Knight, Artificial Intelligence, 3rd ed., Tata McGraw Hill, 2012

Reference Books:

[1]. S. Russell and P. Norvig,ArtificialIntelligence: A Modern Approach, 3rd ed., PrenticeHall, 2009

[2]. D. W. Patterson, Introduction to AI and Expert Systems, PHI, 1999

CA19.646 **Parallel Processing** **3-0-0-3**

Total Lectures: 40

Prerequisite(s): CA 19.201(Computer Architecture)

Objective(s):

- To understand parallel processing and Array processing and their applications
- To understand multiprocessors and multicomputer
- To understand parallel programming languages

1.	**Parallel Processing:** Introduction, data and control parallelism,(concurrency, scalability,speedup, Amolahl's Law), PRAM model of parallel computation, parallel algorithm design	[8]
2.	**Multiprocessors andMulticomputers:** Processor organization, shared memory and message passing systems, message passing interface programming with respect to PARAM 10000.	[9]
3.	**Array Processing:** SIMD array processing, communications, SIMD interconnectionnetworks, algorithms for array processing.	[8]
4.	**Applications:** Parallel algorithms for matrix multiplication, fast Fourier transform, linearsystems, sorting, numerical integration, and optimization.	[7]
5.	**Parallel Programming Languages:** C, C++ and high performance FORTRAN.	[8]

Outcome(s):

- Understanding of parallel processing and array processing
- Understanding of multiprocessors and multicomputers
- Understanding programs of parallel programming languages.

Text Books:

[1] Hwang K., "Advanced Computer Architecture", Tata McGraw-Hill,2003.

[2] Quinn M. J., "Parallel Computing", Tata McGraw-Hill, 2nd ed,2002.

Reference Books:

[1] Hwang K. and Briggs F. A., "Computer Architecture and Parallel Processing", McGraw-Hill, New York.,1984.

[2] Sinha P. K., "Distributed Operating System", Prentice-Hall of India,1997.

CA 19.709 **Distributed Systems** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CA 19.102(Operating Systems), CA 19.204 (Computer Networks)

Objective(s): To make students aware of:

- What a distributed system is, its example, use and utilities.
- Hardware and software requirements/constraints for implementation of distributed systems.
- Abstractions like, RMI, distributed objects, RPC, distributed shared memory etc.
- Notion of time in a distributed system.
- Databases in a distributed system.

1. **Characterization of Distributed Systems:** Definition, distributed systems-Internet, intranet, mobile, ubiquitous computing, resource sharing and World Wide Web challenges- heterogeneity, openness, security scalability failure handling concurrency and transparency. [8]

2. **System Models:** Architecture models- software layers, system architecture, variations on client-server model, interfaces, design requirement for distributed architectures, fundamental and interaction models, and failure and security models. [8]

3. **Distributed Object and Remote Invocation:** Introduction to remote method invocation (RMI) and interface in distributed systems, communication between distributed objects- objects model, distributed objects, distributed objects model and design issues for RMI, implementation of RMI and distributed garbage collection, remote procedures call. [8]

4. **Time and Global State:** Clocks, events and process states, synchronizing physical clocks- synchronization in a synchronous system, Cristian method for synchronizing clocks, Berkley algorithm, network time protocol, global state and consistent cuts. [8]

5. **Distributed Shared Memory:** Introduction, message passing versus DSM, implementation approaches to DSM, design and implementation issues-structure and synchronization model. [8]

Outcome(s): On successful completion of the course the student will be able to:

- Understand the concept of distributed systems.
- Explain the principles underlying the functioning of distributed systems as well as how these principles are applied in distributed systems.
- Comprehend the problems and challenges of distributed systems.
- Understand and estimate the impact of different design choices, system features on distributed systems.

Text Books:

[1] Colouris, “Distributed Systems Concepts and Design”, Addison Wesley, 5th edition, 2011.
[2] George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair,"Distributed Systems" , Pearson Education Limited, 2013

Reference Books:

[1] Pradeep K. Sinha,"Distributed Operating Systems",PHI Learning Pvt. Limited, 2011.

[2] MukeshSinghal, NiranjanShivrathri, “Advanced Concepts in Operating Systems”, TMH, 2011.

CA 19.711 **Data Mining and Warehousing** **3-0-0-3**

Prerequisite(s): **NILTotal Lectures:40**

Objective(s):

- **To learn data mining and warehousing and knowledge base**
- **To learn data marts OLAP**

1.	**Overview:** Concept of data mining and warehousing, data warehouse roles and structures, cost of warehousing data, roots of data mining, approaches to data exploration and data mining, foundations of data mining, web warehousing, web-warehousing for business applications and consumers, introduction to knowledge management, data warehouses and knowledge bases.	[8]
2.	**Data Warehouse:** Theory of data warehousing, barriers to successful data warehousing, bad data warehousing approaches, stores, warehouse and marts, data warehouse architecture, data about data - metadata, metadata extraction, implementing the data warehouse, data warehouse technologies.	[8]
3.	**Data Mining and Data Visualization:** Data mining, OLAP, techniques used to mine the data, market basket analysis, current limitations and challenges to DM, data visualization.	[8]
4.	**Designing and Building the Data Warehouse:** Theenterprise model approach of data mining design, data warehouse project plan, analysis and design tools, data warehouse architecture, specification and development.	[8]
5.	**Web-Based Query and Reporting:** Delivering information over the web, query and reporting tools and business value, architectural approaches to delivering query capabilitiesover the web. Web Based Statistical Analysis and Data Mining: Analytical tools, business value from analytical tools,	[8]

Outcome(s):

- To understand data mining and data warehousing
- To understand and use tools for data mining

Text Books:

[1] Marakas G. M., "Modern Data Warehousing, Mining and Visualisation", Pearson Education Asia, 2003.
[2] Mattison R., "Web Warehousing and Knowledge Management", Tata McGraw-Hill,2002.

Reference Books:

[1] Mallach E., "Decision Support and Data Warehousing", Tata McGraw-Hill,2002.
[2] Hand D., Mannila H., and Smyth P., "Principles of Data Mining", Prentice-Hall of India, 2001.

CA 19.715 **Computer Graphics** **3-1-0-4**

Total Lectures: 40

Prerequisite(s): CA 19.103 (C-Programming)

Objective(s):

- To introduce the students with the graphics mode, with the help of basic algorithms and methodologies.
- The objective of the course is to equip students with fundamental knowledge and basic technical competence in the field of computer graphics.
- Provide an understanding of how a computer draws the fundamental graphics primitives.
- To learn Computer Graphics methodologies/Algorithms and techniques.

1	**Basic Concepts:** Application Areas of Computer Graphics, Graphical User Interface, RGB Color model, CMY color models, Advantages of Computer Graphics.	**[8]**
2	**Graphics Hardware:** Random Scan Displays, Raster Scan Display (with Introduction to Flickering, Interlacing, American Standard Video), Color CRT Monitors, Flat Panel Display (Plasma Panel, Liquid Crystal Display, Electroluminescent Display).	**[7]**
3	**Raster Graphics Algorithms:** Line Drawing Algorithms-DDA, Bresenham's Algorithm, Circle and Ellipse Drawing Algorithms, Filling (Scan-Converting Polygon Filling, Inside Outside Tests Boundary Fill and Area Fill Algorithm). Cohen- Sutherland Algorithm of clipping.	**[12]**
4	**Transformations:** 2-D Transformations (Rotation, Reflection,Shearing, Scaling), Homogeneous Coordinate Representation, and Translation.	**[8]**
5	**Animation Introduction:** Conventional and Computer-Assisted Animation, Animation languages, methods of controlling Animation, basic rules of Animation.	**[5]**

Outcome(s): On successful completion of this course, students will be able to

- Understand basic concepts of computer graphics.
- Acquire knowledge about drawing basic shapes such as lines, circle ellipse, polygon.
- Perform processing of basic shapes by various processing algorithms /techniques.
- Implement two dimensional transformations.

Text Books:

[1]. D. D. Hearn and M. P. Baker, Computer Graphics, 3rd ed., Prentice Hall India, 2011.
[2]. A. Kalbag, Computer graphics & animation, 1st ed., Usborne, 1999.

Reference Books:

[1]. J. D. Foley, A. V. Dam, S. K. Feiner, J. F. Hughes, Computer Graphics Principles and Practice, 2nd ed., Addison Wesley, 1995.
[2]. D. F. Rogers, Procedural Elements for Computer Graphics, 2nd ed., Tata McGraw Hill Publications, 2001.

ELECTIVES

CA 19.741 **Design and Analysis of Algorithms** **Total Lectures: 40Credit:3-0-0-3**

Prerequisite(s): CA-19.209(Discrete Mathematics), CA-19.104 (Data Structures)

Objective(s):

- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms power.

1.	**Introduction:** Fundamentals of algorithms and problem solving, asymptotic notations, time complexity and analysis of algorithms, solutions of recurrence relations, master theorem and summations techniques.	[8]
2.	**Analysis of Sorting and Searching Algorithms:** Linear, binary and interpolation search, insertion, selection, merge, quick and heap sort, stability and other issues, hashing.	[8]
3.	**Algorithm Design Approaches:** Greedy method (knapsack problem, job sequencing problem), dynamic programming (assembly line scheduling, matrix chain multiplication), backtracking (8 queens problem, sum of subsets), branch and bound (0/1 knapsack problem), divide and conquer algorithms (Strassen matrix multiplication), problems based on these design paradigms.	[8]
4.	**Tree and Graph algorithms:** Spanning trees, Prim and Kruskal's algorithm, Huffman coding, BFS and DFS, disjoint set operations, connected components, shortest path algorithms in a graph such as Dijkstra, Bellman Ford, Warshall's etc.	[8]
5.	**Complexity Classes:** P,NP,NP hard and NP complete problems, reducibility, decision and optimization problems, examples of NP complete problems such as 3 CNF, clique, vertex cover and traveling salesman problem, basic introduction of approximation algorithms.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:

- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.
- Modify existing algorithms to improve efficiency.

Text Books:

[1] Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, PHI Learning Private Limited, 3rd edition, 2016.

[2] Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, Computer Algorithms, Silicon Press, 2nd edition, 2008.

Reference Books:

[1] Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 3rd edition, 2012.

[2] Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, 1st edition, 2006.

[3] Donald E. Knuth, The Art of Computer Programming, Volumes 1& 3, Pearson Education, 2009.

CA 19.745 **Compiler Design** **Total Lectures:40**
Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To introduce the major conceptual areas of language translation and compiler design.
- To enrich the knowledge in various phases of compiler, code optimization techniques
- To extend the knowledge of different parsers.
- To provide practical programming skills necessary for construction of a compiler.

1. **Introduction:** Introduction of compiler, compiler structure: analysis-synthesis model of compilation, various phases of a compiler, Symbol table: Role and data structure used for symbols tables .Lexical Analysis: Input buffering, specification & recognition of tokens, error detection &recovery . [8]
2. **Syntax Analysis & Syntax Directed Translation:** Syntax analysis: CFGs, top down parsing, Brute force approach, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence parsing, LR parsers (SLR, LALR, LR), parser generation error detection & recovery. [9]
3. **Syntax Directed Definition**: Construction of syntax trees, bottom up evaluation, S-attribute definition, L-attribute definition, top down translation, bottom up evaluation of inherited attributes, recursive evaluation, analysis of syntax directed definition. [8]
4. **Intermediate Code Generation:** Intermediate code, postfix notation, parse trees & syntax trees, three address code, quadruple & triples, translation of assignment statements, Boolean expressions, statements that alter the flow of control, postfix translation, translation with a top down parser, more about translation: array references in arithmetic expressions, procedures call, declarations, case statements. [8]
5. **Code Optimization & Code Generation:** Loop optimization, the DAG representation of basic blocks, flow graphs, global data-flow analysis, peephole optimization, generating code from DAG, register allocation and assignment. [7]

Outcome(s): On successful completion of this course, the students will be able to

- Use lexical analyzer and parser generator tools.
- Generate intermediate code.
- Be familiar with register allocation.
- Expose compiler code optimization.

Text Books:

1. A. V. Aho, R. Sethi, and J. D. Ullman. Compilers: Principles, Techniques and Tools, Pearson Education, 2nd edition, 2014.
2. Louden, Compiler Construction: Principles and Practice, Cengage Learning, 1st edition, 1997.

Reference Books:

1. Allen I. Holub, Compiler Design in C, Prentice-Hall Inc., 1st edition, 1994.
2. AW Appel, M Ginsburg, Modern Compiler Implementation in C, Cambridge University Press, 1st edition, 2004.
3. J. R. Levine, T. Mason, D. Brown, Lex and Yacc, O'Reilly, 2nd edition, 2000.

CA 19.747 **Neural Network** **3-0-0-3**

Total Lectures:40

Prerequisite(s): CA 19.603(Design and Analysis of Algorithms)

Objective(s):

- To understand neural network and its algorithms
- To understand competitive learning neural network
- To understand activation and synaptic dynamics

1.	**Introduction :** Features , structure and working of Biological Neural Network Trends in Computing Comparison of BNN and ANN, History of neural network research, characteristics of neural networks terminology, models of neuron McCulloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture.	[8]
2.	**Back Propagation Networks :** Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, backpropagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning	[8]
3.	**Activation and Synaptic Dynamics :** Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks.	[5]
4.	**Basic functional units of ANN for pattern recognition tasks:** Basic feedforward, Basic feed back and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks.	[8]
5.	**Competitive learning neural networks :** Components of CL network pattern clustering and feature mapping network, ART networks, Features of ART models, character recognition using ART network. Applications of ANN :Pattern classification – Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron.	[11]

Outcome(s):

- Understanding of neural network and its algorithms
- Understanding of ART model and use that network.

Text Books:

[1] b. Yegnanarayana., “Artificial Neural Networks”, PHI,1999
[2] S. R. Sekaran , P. Vijayalakshmi, “Neural networks, Fuzzy logic and Genetic Algorithms”, PHI.

Reference Books:

[1] 1 S. Kumar, “Neural Networks”, PHI, 2013.

ET 19.465 **Agile Software Development** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): Software Engineering, System Analysis and Design

Objective(s):

- To learn the fundamental principles and practices associated with each of the agile development methods.
- To learn how agile methods scale to large and distributed projects.
- To learn the essentials of collaboration as they apply to agile methods.
- To perform in-depth explorations into aspects of agile development that are particularly relevant to each student through detailed discussion sessions.

1	**Fundamentals of Agile:** The genesis of Agile, introduction and background, Agile manifesto and principles, overview of Scrum, extreme programming, feature driven development, lean software development, Agile project management, design and development practices in Agile projects, test driven development, continuous integration, refactoring, pair programming, simple design, user stories, Agile testing, Agile tools.	[7]
2	**Agile Scrum Framework:** Introduction to Scrum, project phases, Agile estimation, planning game, product backlog, sprint backlog, iteration planning, user story definition, characteristics and content of user stories, acceptance tests and verifying stories, project velocity, burn down chart, sprint planning and retrospective, daily scrum, Scrum roles – product owner, Scrum master, Scrum team, Scrum case study, tools for Agile project management.	[9]
3	**Agile Testing:** The Agile lifecycle and its impact on testing, test driven development (TDD), unit framework and tools for TDD, testing user stories – acceptance tests and scenarios, planning and managing testing cycle, exploratory testing, risk-based testing, regression tests, test automation, tools to support the Agile tester, securing Agile software.	[10]
4	**Agile Software Design and Development:** Agile design practices, role of design principles including single responsibility principle, open closed principle, Liskov substitution principle, interface segregation principles, dependency inversion principle, Agile design, need and significance of refactoring, refactoring techniques, continuous integration, automated build tools, version control.	[10]
5	**Industry Trends:** Market scenario and adoption of Agile, Agile ALM, roles in an Agile project, Agile applicability, Agile in distributed teams, business benefits, challenges in Agile, risks and mitigation, Agile project on cloud, balancing Agility with discipline, Agile rapid development technologies.	[4]

Outcome(s): On successful completion of this course, students will be able to

- Understand concept of agile software engineering and its advantages in software development. Recognize various agile methods.
- Design and manage a project using Scrum.
- Write user stories for project requirements.
- Write test cases for developing features.

Text Books:

1. Ken Schawber, Mike Beedle, Agile Software Development with Scrum, Pearson, 2008.
2. Robert C. Martin, Agile Software Development Principles, Patterns and Practices, Prentice Hall

ET 19.471 **Cloud Computing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 19.306 (Computer Networks)

Objective(s): To learn how to use cloud services.
To implement virtualization and task scheduling

1	**Overview of Cloud Computing:** Brief history and evolution - history of cloud computing, evolution of cloud computing, traditional vs. cloud computing, cloud service models (IaaS, PaaS & SaaS), cloud deployment models (public, private, hybrid and community cloud), benefits and challenges of cloud computing, introduction to AWS public cloud vendor, cost optimization in AWS, basics of virtualization, virtualization technologies, server virtualization, VM migration techniques, role of virtualization in cloud computing, introduction to EC2 service of AWS.	[10]
2	**Working with Private Cloud:** Private cloud definition, characteristics of private cloud, private cloud deployment models, private cloud vendors - CloudStack, OpenStack, Eucalyptus Microsoft, private cloud – benefits and challenges, private cloud implementation in Amazon EC2 service.	[8]
3	**Working with Public Clouds:** What is public cloud, why public cloud, when to opt for public cloud, public cloud service models, public cloud players, infrastructure as a service offering, IaaS vendors, PaaS offerings, PaaS vendors, software as a service, demonstrating public cloud with AWS – storage and database services, private vs. public cloud – when to choose.	[10]
4	**Overview of Cloud Security:** Explain the security concerns in traditional IT, introduce challenges in cloud computing in terms of application security, server security, network security, security reference model, abuse and nefarious use of cloud computing, insecure interfaces and APIs, malicious insiders, shared technology issues, data loss or leakage, account or service hijacking, unknown risk profile, shared security model between vendor and customer in IaaS/PaaS/SaaS, implementing security in AWS.	[8]
5	**Future directions in Cloud Computing:** When and not to migrate to cloud, migration paths for cloud, selection criteria for cloud deployment, issues/risks in cloud computing, future technology trends in cloud computing.	[4]

Outcome(s):

On successful completion the students will be able to:

- Analyze the cloud computing setup with its vulnerabilities and applications using different architectures.
- Design different workflows according to requirements and apply map reduce programming model.
- Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds.

Text Books:

1. Raj Kumar Buyya, James Broberg and Andrezi M Goscinski, “Cloud Computing: Principles and Paradigms”, John Wiley & Sons, 2010
2. Nick Antonopoulos and Lee Gillam, “Cloud computing: Principles, Systems and Applications”, Springer, 2010.

Reference Books:

1. Anthony T Velte, Toby J Velte and Robert Elsenpeter, “Cloud Computing: A Practical Approach”, McGraw Hill, 2010
2. BorkoFurht and Armando Escalante (Editors), “Handbook of Cloud Computing”, Springer, 2010
3. Judith Hurwitz, Robin Bllor, Marcia Kaufman and Fern Halper, “Cloud Computing for Dummies”, John Wiley & Sons, 2010.

RM 19.101 **Research Methodology** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): Communication Skills

Objective(s):

- To understand a general definition of research design.
- To identify the overall process of designing a research study from its inception to its report.
- To be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- To understand the primary characteristics of quantitative research and qualitative research.
- To identify a research problem stated in a study

1. **Introduction**: Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches,ResearchProcess,ValidityandReliabilityin Research. [6]
2. **ProblemFormulation**:Identification,Selection andFormulation ofa ResearchProblem, Criteria ofagoodResearchProblem,Reviewof Literature, Research Gaps. [10]
3. **Research Design**:ResearchFramework, Meaning &SignificanceofResearchDesigns,Featuresofa goodResearch Design, Types of Research Design. [10]
4. **Data Analysis and Simulation Tool**:TypesofData,Sources of Data, Methods of CollectingData,DataPresentation Techniques.Methodsof DataAnalysis, SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [12]
5. **ReportWriting**:Types of Reports,Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [2]

Outcome(s): On successful completion of this course, the students will be able to

- Assess critically the following methods: literature study, case study, structured surveys, interviews, focus groups, participatory approaches, narrative analysis, cost-benefit analysis, scenario methodology and technology foresight.

Text Books:

1. R.Pannershelvam, "ResearchMethodology" PrenticeHall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"ResearchMethodology: MethodsandTechniques",New Age International (p) Limited,Publishers New Delhi, 4ndedition,2018.

Reference Books:

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013

Mody University of Science & Technology
Lakshmangarh (Sikar)

College of Engineering & Technology

Department of Nuclear Science & Technology (NST)

Detailed Syllabus for

M. Tech. (Nuclear Science & Technology)

NU- 501 Quantum Mechanics and Electrodynamics 3-1-0-4

Quantum Mechanics

1. Origin of quantum theory and related experiments, wave-particle duality, wave function and its Born interpretation, uncertainty principle, Schrodinger equation, wave functions, wave packets, probability amplitudes, solutions to Schrodinger equation in one dimensions; Barrier penetration, Potential wells, Simple harmonic oscillator, Schrodinger equation in three dimensions.

[7]

2. Formalism of quantum mechanics; Liner vector space, Function spaces, Hilbert space formalism, inner product and probability, completeness of Eigen functions, delta functions, Bra & Ket notation, matrix representation of an operator, change of basis, unitary transformations.

[6]

3. General treatment of angular momentum, spin, identical particles; SHM problem by operator method; Pauli exclusion principle; Scattering theory; some calculations, Perturbation theory, WKB approximation.

[7]

Electrodynamics

4. Coulomb law and electrostatics, Laplace and Poisson equations, Maxwell's equations, partial polarization, Lorentz force, Poynting theorem. Scalar and vector potentials, Gauge transformations and gauge invariance.

[5]

5. Special theory of relativity, four vectors, Field tensor, Relativistic formulation of electrodynamics, Maxwell equations in covariant form

[4]

6. Relativistic charged particle in an electromagnetic field, Motion in uniform electric and magnetic fields and combinations of E and B fields, Non uniform static magnetic field

[4]

7. Green's function for wave equation (relativistic), Radiation from localized moving charges, Multi pole expansion, dipole and quadrupole radiation, Radiation from accelerated charge

[4]

8. Power radiated by point charge, Larmor's formula, Angular distribution of power, Bremsstrahlung and synchrotron radiation, Dispersion theory, Radiative reaction, Radiative damping

[5]

Text Books:

1. Griffiths D. J., Introduction to Quantum Mechanics, 2nd edition, Pearson, 2009.
2. Griffiths D. J., Introduction to Electrodynamics, 3rd edition, Prentice Hall India, 1999.
3. Ghatak A. K. & Lokanathan S., Quantum Mechanics: Theory and Applications, 5th edition, Macmillan India, 2004.

Reference Books:

1. Schiff L. I., Quantum Mechanics, 3rd edition, Tata McGraw-Hill, 2010.
2. Zettili N., Quantum Mechanics: Concepts & Applications, 2nd edition, Wiley, 2009.
3. Jackson J. D. Classical Electrodynamics, 3rd edition, Wiley, 1998.
4. Lifshitz E. M. & Landau L. D., Quantum Electrodynamics (Course of Theoretical Physics), 2nd edition, Pergamon Press, 1981.

NU- 503 **Nuclear Physics** **3-1-0-4**

1. Basic concepts of general properties of nuclei: Charge, Masses and relative abundances, mass defect, size and shape, binding energy, angular momentum, magnetic dipole moments and electric quadrupole moments, Parity, Nuclear radius, Radioactivity, units of radiation, Aplha, Beta and Gamma decay.

[8]

2. Nuclear forces: The Deutron, Nucleon- Nucleon scattering, p-p and n-n interactions, properties of nuclear force, phase shift analysis, Measurement of nuclear parameters, Mossbaur effect

[8]

3. Nuclear models: Liquid drop model, Fermi gas model, Shell model, Collective model, Compound nucleus and Statistical model

[8]

4. Nuclear reactions: Types of reactions and conservation laws, Reaction dynamics, Scattering and reaction cross sections, the Q of Nuclear reaction, Nuclear fission, Nuclear fusion

[8]

5. Elementary particle physics, Hadrons and leptons, their masses, spin parity decay structure, quarks and gluons, Charge conjugation, The CPT theorem and applications of symmetry arguments to particle reactions, symmetries, weak interactions

[**8**]

Text Books:

1. Krane K. S., Introductory Nuclear Physics, John Wiley, 1987.
2. Roy R. R. & Nigam B. P., Nuclear Physics; Theory and Experiments, 1st edition, New Age International, 1967.
3. Burcham W. E. & Jobes M., Nuclear and particle Physics, 2nd edition, John Wiley, 1995.

Reference Books:

1. Wong & Samuel S. M., Introductory Nuclear Physics, 2nd edition, John Wiley, 1999.
2. Cohen B. L., Concepts of Nuclear Physics, Tata McGraw-Hill edition, 2008.

NU 505 **Reactor Physics** **3-1-0-4**

Nuclear Fission; Delayed Neutrons; Reactor Types, Neutron Slowing-down and Thermalization, Critical Reactor; Multigroup Transport and Diffusion Equations for a Critical Reactor [12]

Reactor Calculations and Homogenization, Multigroup Constants, Group Constants in Resonance Region [8]

Perturbation & Variational Methods; Nodal and Finite-Element Transport Theory Methods; Integral Transport Theory [8]

Non-critical Reactors; Point Reactor Kinetics Equations; Solution of Kinetics Equations; Determination of Kinetics Parameters; Feedback; Xenon Oscillations; Fuel Depletion; Spatial Effects. [12]

Text Books:

1. P. F. Zweifel, *Reactor Physics*, McGraw-Hill, New York (1973).
2. Rudi J.J. Stamm'ler and M. J. Abbate, *Methods of Steady-State Reactor Physics in Nuclear Design*, Academic Pr (1983)
3. K. Sriram and Y. R. Waghmare, Introduction to Nuclear Science and Technology, South Asia Book (1990)
4. S.Garg, F. Ahmed and L.S.Kothari, *Physics of Nuclear Reactors*, Tata McGraw Hill, New Delhi (1986).

NU 520 Nuclear Power Plant Operation and Control 3-1-0-4

1. Applications of Reactor Physics for operation, Function of Delayed Neutron Monitoring System and method of identifying failed fuel, Neutron Flux Monitoring, Steady State operation of reactor [6]

2. Subcritical multiplication and reactor startup- Reactor operation without feedback- Analytic solution of reactor kinetics, Dynamic period , Reactor operation with feedback effects- Achievement of feedback effects, Shutdown margin [6]

3. Energy release and deposition, Heat generation parameters, Neutron flux distributions and power profiles in reactor cores, Power peaking factors, Heat generation in the structure, Reactor shutdown [6]

4. Temperature coefficients of reactivity, reactivity feedback, Loss-of-cooling accidents, Reactivity insertion accidents, Containment pressurization process, Response of a PWR pressurizer to load changes, Nuclear Power Plant control [6]

5. Review of fundamentals: Laplace transforms, frequency response and stability analysis, process identification, Advanced control techniques: Feed forward control, ratio control, cascade control, Computer process control: z-transforms, digital signal conditioning, system identification, stability analysis, classical control algorithms (PID etc.), Introduction to Model predictive and adaptive control schemes [8]

6. Sensors for pressure, flow, leak, level, temperature and composition, valve dynamics, neutronic instrumentation, reactor protection instrumentation, process instrumentation [8]

BOOKs

1. Lamarsh, John. Introduction to Nuclear Engineering. 3rd ed. Englewood Cliffs, NJ: Prentice Hall, 2001
2. Reactor Control Engineering by J M Harrer, Van Nostrand, (1963)
3. Control of Nuclear Reactors and Power Plants, by M. A. Schulz , McGraw-Hill Co., New York (1961)

Suggested Readings:

1. D R Coughanowr, Process Systems Analysis and Control, McGrawHill, 1991**.**
2. G Stephanopoulos, *Chemical Process Control*, Prentice Hall, 1985.
3. S Glasstone and A Sesonske, *Nuclear Reactor Engineering*, Vonostrand, 1981

NU- 522 Radiation Physics Instruments and Shielding 3-1-0-4

1. Atomic and Nuclear Structure, Natural and Artificial Radiation, Units and Measurement, Laws of Decay, Properties of Different Types of Radiation, Production of Radionuclides, Interactions of Charged Particles and Photons, Biological Effects of Ionizing Radiation, Radiation Protection Standards and Their Implementation [**10**]

2. Radiation detectors: Gas-filled ionization detectors-Ionization chambers, proportional counters and GM counters, Pulse height spectra and energy resolution, Semi-conductor detectors – Working of a p-n junction detector, partially and totally depleted detectors, surface barrier detectors, Lithium drifted Silicon detectors (Si(Li)), high-purity Germanium(HPGe) gamma detectors, Particle identification and time of flight technique, Scintillation detectors- scintillation mechanism in inorganic crystal scintillators and organic scintillators, Pulse height spectrum using a monoenergetic gamma ray source, Production and detection of neutrons-typical neutron sources, He proportional counters, fission counters. [**10**]

3. Radiation Instrumentation, Portable Survey Instruments, Use of radiation Survey Instruments, Scintillation Counters Radiation Shielding, Shielding Materials for Different Types of Radiation, Requirement for Shielding, Acceptable Radiation Levels for Various Areas, Merits and Demerits of Shielding Material, Criterion for Selecting Shielding Material [**10**]

4. Protection against Radiation Exposure, External radiation protection, Internal radiation protection, Calculation of Radiation Dose, Field, Man-rem and Duration of Work, Biological and Genetic Effects. [**10**]

Books:

1. Knoll G. F., *Radiation Detection and Measurement*, 3rd Edition, John Wiley and Sons (2000)
2. Martin A. A. & Samuel A. H., Introduction to Radiation Protection, 5th edition, Oxford university Press, (2006)
3. Cember H., Introduction to Health Physics, 3rd edition, McGraw-Hill, (1996)

Suggested Readings:

1. Turner J. E., Atoms, Radiation, and Radiation Protection, 3rd edition, Wiley, 1995.
2. Kapoor S. S. and Ramamurthy V. S., *Nuclear Radiation Detectors*, Wiley Eastern Limited, New Delhi (1986).

NU 523 Simulations in Nuclear Engineering 1-0-6-4

Physical simulation- advantage and limitations, Transport phenomena – concept of physical domain and computational domain- assumptions and limitations in numerical solutions [3]

Introduction to Finite difference Techniques, Finite Element Techniques, Finite Volume Techniques [3]

Basics about Monte Carlo Simulation, Algorithms for Monte carlo simulations [4]

Computational methods to analyze nuclear reactor systems described by various differentials, integral and integro-differential equations, Typical problem studies related with radionuclide decay chain, spatial dependence of radiation diffusion, transient heat diffusion [30]

Text Books:

1. Law, A. M. and Kelton, W. D., Simulation, Modeling & Analysis", 3rd Edition, Tata Mc Graw Hill , New Delhi-2003
2. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom, "The Finite Element Method for Engineers".
3. Banks, J, Carson J. S. H. and Nelson, B. L. " Discrete Event System simulations", 2nd edition , PHI, New Jersey, 1999
4. Elmer E Lewis and warren F Miller Jr., Computational methods of Neutron Transport, Wiley – Inter science, 1993

Reference Books:

1. Hector Guerrero Excel Data Analysis: Modeling and Simulation.
2. James; Biersack, J.P.; Ziegler, M.D. Ziegler, "SRIM - The Stopping and Range of Ions in Matter"
3. COMSOL Multiphysics manuals

NU 524 **Physics and Technology of Nuclear Fusion** **3-1-0-4**

1. Plasma- the fourth state of matter, Debye shielding, Collective behavior, Plasma frequency, Plasma Sheath, Plasma in nature and Laboratory, Industrial applications of plasma **[6]**
2. Basic plasma processes, Ionization and Recombination, Coulomb collision, Radiations from plasmas, Plasma Transport processes **[5]**
3. Motion of charged particles in electric and magnetic fields, Adiabatic invariance, Introduction to kinetic theory, Boltzmann equation, Vlasov plasma model, Fluid model from kinetic model, MHD equation, Plasma equilibrium and stability analysis **[6]**
4. Waves and instabilities in plasma **[5]**
5. Plasma generation using DC, RF and microwave power, Plasma diagnostics- Langmuir probe and Spectroscopy **[5]**
6. Energy crisis and role of fusion, Lawson criterion, Ignition criterion and burn physics, Plasma confinement approaches, Open and closed magnetic systems, alternate confinement concepts **[7]**
7. Fusion technology: Plasma heating, First wall sputtering and cooling, Diverter, Blanket physics, Fusion materials **[6]**

Books:

1. Introduction to Plasma Physics, F. F. Chen, 2nd edition, Plenum Press, (1984)
2. Physics of High Temperature Plasma, G. Schmidt , 2nd edition Burlington, MA: Academic Press (1979)
3. Fusion Research, Thomas J Dolan, Pergamon Press, 1982

Suggested Readings:

4. Industrial Plasma Engineering, Vol.1, Principles, J. R. Roth, Institute of Physics, 2001
5. Fusion Plasma Physics, Weston M Stacy, Wiley-VCH, 2001
6. Plasma physics and Fusion Energy, J. P. Freidberg, Cambridge University Press, 2007

NU 525 **Nuclear Power Engineering – I** **3-1-0-4**

Principles of the conversion of nuclear energy to useful power, Over view of various types of nuclear power plants that have been designed, built and operated, Economics of nuclear vs. other types of power plants. Economics of nuclear power plants, accounting for capital costs, fuel costs and O&M (operations and maintenance) costs, as well as environmental aspects - sustainability, proliferation, safety [6]

Neutron induced reactions-Reaction mechanism-microscopic cross sections-variation of cross section with neutron energy-resonances-1/v law, Nuclear fission-fission products-prompt & delayed neutrons-energy balance per fission-mechanism of fission-fissile and fertile materials[6]

Introduction of Nuclear reactor plant design, Reactor Assembly, Coolant Channels, Moderator and Auxiliary Systems, Primary heat Transport and Auxiliaries, Special Safety Systems and Reactor Shield cooling systems, Detailed features of pressurized water reactor components, including steam generators, Pressurisers and chemical-shim control systems. [12]
Problems related to features of gas-cooled reactor cycles and components, and compare/contrast those features with those of conventional LWRs. Difference in neutron spectrum and fuel type between a fast reactor and a LWR affect fast reactor physics and performance. [8]
Advanced future types of nuclear power plants that are in the design or developing stages. Reactor designs of power plants, their energy conversion principles, cycles and load-following characteristicsCompare and contrast the relative merits of different types of power plants. [8]

Text Books:

1. S. Glasstone & A. Sessoske, Vol I & II, CBS Publishers & Distributors, New Delhi (2009)

2. M. M. El-Wakil, *Nuclear Energy Conversion,* American Nuclear Society; Revised edition (1982)

3. John R. Lamarsh and Anthony J. Baratta, *Introduction to Nuclear Engineering*, 3rd Edition, Prentice Hall (2001).

NU-526 Nuclear Power Engineering-II

Chain reaction-classical four factor formula-eta vs. energy curve-conversion & breeding ratios-thermal and fast reactors.- Neutron lifetime-Conversion & breeding though eta vs. energy curve, Macroscopic cross-section, mean free path, neutron flux ,neutron current, beam attenuation-dependence of flux on space, energy, direction and time- simplified model, Neutron balance equation-rigorous Boltzmann and simplified diffusion equation through Fick's law. Multiplying and non-multiplying media

[10]

Boiling Water Reactors : **[10]**
Reactor Internals and Their Functions, Emergency Safeguard Systems, Reactor Safety, Containment System, Spent Fuel Management

Pressurized Water Reactor: **[10]**
Reactor Internals and Their Functions, Emergency Safeguard System, Reactor Safety, Containment System, Spent Fuel Management

Application of Reactor Physics for Operation **[5]**
Design Basis of Reactor Regulation and Protection System **[5]**

NU 528 **Reactor Thermal Hydraulics** **3-1-0-4**

1. Introduction – Different Reactor Types, Introduction – Types of Fuels and Steam Generators [**3**]
2. Conservation Equations, Heat Transfer – Basics, Basic Modes of Heat Transfer, Conduction Heat Transfer Equations [**4**]
3. Thermal Conductivity, Capacity and Diffusivity 1-D Steady-State Heat Conduction without Heat Generation – Plane Wall, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Hollow Cylinder, Sphere, Series-Composite Slab, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Series-Parallel Composite Slab, Composite Cylinder, Heat Flow Through Composite Structures Critical Thickness of Insulation Variable Thermal Conductivity, Conduction Heat Transfer with Internal Heat Generation Conduction Heat Transfer in Multidimensional Systems [**11**]
4. Transient Heat Transfer, Convective Heat Transfer, Heat Transfer Coefficient with Phase Change Thermosyphon cooling, Dimensional Analysis, Radiation Heat Transfer, Pressure Drop Analysis, Pressure Drop Analysis [**10**]
5. Fuel, Clad and Coolant Temperatures, Sub channel Analysis of Rod Bundle Fuels, Sub channel Analysis of Rod Bundle Fuels, Hotspot and Hot channel Factors, Coolant Channel Orificing, Introduction to Two-phase Flow and Basic Relations, Two-phase Flow and Boiling, Reactor Thermal Hydraulics Critical Heat Flux [**12**]

Books:

1. El-Wakil, M. M., Nuclear Heat Transport, McGraw Hill Book Co., New York (1985)
2. Glasstone S. & Sessonske A., Nuclear Reactor Engineering, Vol I and Vol II CBS Publishers & Distributors, New Delhi (2009)
3. Lahey R. T. and Moody F. J., The Thermal-Hydraulics of Boiling Water Nuclear Reactor, 2nd Edition, (1993)

Suggested Readings:

1. Todreas N. E. and Kazimi M., Nuclear Systems Volume I: Thermal Hydraulics Fundamentals, Taylor & Francis Pubs. 2nd Edition, (1989)

List of Nuclear Laboratory Experiments

1. To verify inverse square law using an α- source (^{241}Am) and p-i-n detector
2. Attenuation of α-particles in air and determination of thickness of mylar foil using α-source
3. Characteristic and dead time of a GM Counter, counting statistics using a GM counter
4. To determine the linear and mass attenuation coefficient of lead/ aluminium/ copper using ^{60}Co source (micro- curie) with GM setup
5. Determination of half life of ^{116}In using a GM counter
6. Determination of end point energy of β – particles by absorption method using a GM counter
7. Determination of gamma energy by using a scintillation detector
8. Determination of energy resolution of a Si- surface barrier detector with an ^{241}Am alpha source
9. Determination of the photo peak efficiency of a NaI (Tl) scintillation detector as a function of gamma ray energy.
10. Study of γ-γ directional correlation using a ^{60}Co source and a pair of scintillation Detectors
11. Study of angular distribution of Compton scattered gamma rays using scintillation spectrometer and deduction of total scattering cross section.
12. Determination of rest mass of electron by measuring the energy of Compton scattered gamma rays using a scintillation spectrometer.
13. Measurement of resolving time of a fast-slow coincidence set-up and determination of true-to- chance ratio.
14. Measurement of energy of β-particles using a β–ray spectrometer

NU 532 **Plasma Laboratory** **0-0-2**

List of Plasma Experiments

1. Glow discharge characteristic- Paschen curve
2. Density and electron temperature measurement using Langmuir probes in the glow discharge.
3. To study the conditions of striations in Plasma
4. Plasma confinement studies using magnetic field
5. Dielectric barrier discharge- plasma generation at atmospheric pressure
6. Ion acoustic wave propagation in plasma

Third Semester

NU- 603 Fast Breeder Reactors and Nuclear Engineering Materials 2-1-0-3

1. Fast breeder Reactor : Breeding requirements and fast reactors, Fast reactor system features, Oxide fuels in fast reactors, Carbide/Nitride fuels in fast reactors, Metal fuel development (emphasis on U-Pu-Zr) **[4]**

2. Fast reactor physics, Four-group flux and adjoint flux distributions, Reactivity and stability, System response to accident initiators **[3]**

3. Fast reactor thermal hydraulics: sodium heat transfer, Natural circulation in fast reactors, SGTR mitigation. **[3]**

4. Nuclear Materials and Processing: Nuclear fuels: Metallic, ceramic (Oxides, MOX and Carbide fuels)- fabrication, properties and applications, Reactor Core Materials: Zircalloys, Zr-Nb alloy--- fabrication, properties and applications in reactors, Heavy water: production process, purification and applications **[10]**

5. Fuel Chemistry, Solid Fission Products, Swelling and Fission Gas Bubbles, Fission Gas Release, Corrosion in Nuclear Reactors, Plant Life Extension **[5]**

6. Nuclear waste; types - liquid waste - solid waste - aerial effulent -disposal of fuel or wastes; waste categories – low - level waste - intermediate level waste - high level waste. Basics about Nuclear Waste treatment, PUREX, Waste forms for long-term storage **[5]**

Books:

1. Waltar A. E. and Reynolds A.B., Fast Breeder Reactors, Pergamon Press, New York (1981).
2. Bendict M., Pigford T. and Levi H., Nuclear Chemical Engineering,
3. Wilson P. D., Nuclear Fuel Cycle: From ore to wastes, Oxford Press, 1996

Suggested Readings:

1. Callister D., Fundamentals of Material Science & Engineering, Wiley
2. Raghvan V., Physical Metallurgy: Principles & Practices,
3. Gupta C. K., Materials in Nuclear Applications

NU-605 Nuclear Plant Safety & Regulatory Frame work 2-1-0-3

1. Nuclear power plant safety requirements, Basic concepts in safety and reliability, Loss of coolant accident, Conceptual design of safety systems, Risk and reliability analysis of systems, Operational safety procedures, Manrem budgeting and control, Surface contamination and control

[15]

2. Role of Atomic Energy Regulatory Board (AERB) and Department of Atomic Energy (DAE), Legislation, rules and regulations for safe electricity generation, Legislation for regulation and its effective implementation for nuclear power plants, Role of Central and State Electricity Regulatory Commissions, Applicable AERB Safety Codes, Guides and Technical Specifications, Surveillance requirements and systems, Comparison with the regulatory framework of conventional industry

[15]

Books:

1. Lewis E. E., Nuclear Power Reactor Safety, E. E. Lewis, Wiley-Inter science publication, 1977
2. M. Rosen, Regulatory Codes and Guides issued by the International Atomic Energy Agency (IAEA), (1985)

Suggested Readings:

1. Mishra K. B., Reliability Analysis and Prediction, Elsevier Publications, (1992)
2. Haldar A. and Mahadevan S., Probability, Reliability and Statistical Methods, John Wiley & Sons (2000)
3. Codes and Guides issued by the Atomic Energy Regulatory Board) (AERB), (1982), Niyamak Bhavan, Anushaktinagar, India

SESSION 2020-2021

Mody University of Science & Technology, Lakshmangarh (Sikar)

School of Engineering & Technology

Course structure for

PhD

(In compliance of University Grants Commission (Minimum Standards and Procedures for Award of Ph.D. Degree) Regulations, 2016 & 2019)

SCHEME OF EVALUATION

for Research Methodology, Research and Publication Ethics

Ph.D.
PROGRAMME

SL. NO.	COURSE CODE	SUBJECT	CREDITS	MIN. QUALIFYING MARKS/ Grade	MAX. MARKS
1	RM20.711	Research Methodology	4	64/B	100
2	CPE-RPE101*	Research and Publication Ethics	2	64/B	100
3		Core Subject	4	64/B	100
4		Seminar-I, Seminar-II	4	64/B	100

***Amended w.e.f. January 01, 2020, as per UGC D.O. No. F-1-1/2018(Journal/CARE)**

Evaluation Scheme:

Course Code	Course Title	Contact Hours per Week			Credits	ETE Duration	Weight age (%)		
		L	T	P		Hours	CW*	MTE	ETE
RM20.711	Research Methodology	3	-	2	4	3	30	20	50
CPE-RPE 101	Research and Publication Ethics	1	-	2	2	3	40	20	40

- *Practical evaluation is under the category of CW.

RM20.811 **Research Methodology** **3-0-2-4**

Course Objectives:

1. To equip students with knowledge, abilities and insight in research methodology and related interdisciplinary fields.
2. To plan and design research using scientific and statistical methods.

1. Introduction to Research: Meaning, nature, purpose and motivation; Types of research – exploratory, descriptive, causal, and analytical; Research process; Definition of construct and variables and types of variables; Bases for choosing a topic; Problem definition; Literature review, Identification of research gap; Formulation of objectives; Signification and relevance of research objectives. **[06]**

2. **Research Design and Sampling:** Research Design - Meaning, need, features, types, important concepts, developing a research plan. **[06]**
Sampling: Census and Sample Survey, implications and types of sampling, process of sample selection, criteria and characteristics of selecting a good sample.

3. Scaling and Methods of Data Collection: Definition and types of scales, construction of measurement scale, errors, test of sound measurement scale. **[06]**
Methods of data collection: Types, sources and methods (Qualitative and Quantitative).

4. Statistical Tools for Data Analysis*: Measures of central tendency – Mean, Median, Mode, Quartiles, Deciles and Percentiles , Measures of Dispersion: Standard Deviation – Variance – Coefficient of Variance, Skewness, Correlation – Karl Pearson's coefficient of Correlation, Rank Correlation, Regression: Method of Least Squares. Formulation of hypothesis-Testing of hypothesis, Type I and Type II Errors. Parametric tests: Z-test, t-test, F-test, Analysis of Variance; One-Way and Two- way classification. Non parametric tests – Chi-Square test. **[09]**

5. Application of Computer in Research*: MS office and its application in Research, Use of Internet in Research – Websites, Search Engines, E-journal and E-Library – INFLIBNET. **MS-Excel:** Data representation, application of inbuilt formulas, formulation of equation using BODMAS rule in MS-Excel. **[06]**

6. Foundation of Research and Report Writing*: Significance and technique of interpretation, importance of report writing, types of reports, structure and components, writing research proposal and synopsis, planning phase of report writing (cauterization), Bibliography, Appendices, referencing, Style Manuals – APA style, MLA style, ASA style, Harvard/IEEE etc), plagiarism, journals, citations and indexing, funding agencies, ethics in research, characteristics of a good research report. **[06]**

Remark: 39 Hours for Lecture and 26 Hours for Practical*.

Course Outcome:

1. Develop the ability to understand and analyse the problems and able to connect the problem with practical and present scenario.
2. Develop the ability to think independently as well as scientifically towards for continuous lifelong learning process.
3. Analyse the situation, convert into problem and find its solution.

Suggested Readings

1. Aczel and Sounderpandian (2008). Complete Business Statistics. Tata-McGraw Hill. India.
2. Anderson, Sweeney, William, Cam (2014). Statistics for Business and Economics. Cengage Learning. India
3. Cooper Donald R and Schindler Pamela S. (2006). Business Research Methods. McGraw-Hill Education. India
4. Gupta, S.L., Gupta, H. (2011). SPSS 17.0 for Researchers. International Book House (Pvt.) Limited, (2), New Delhi.
5. Gupta S. P. (2014). Statistical Methods. Sultan Chand and Sons. India
6. Krishnaswami, O. R., Ranganatham M. (2011). Methodology of Research in Social Sciences. Himalaya Publishing House. India
7. Kothari C. R. (2004). Research Methodology: Methods and Techniques. New Age International (P) Publisher. New Delhi
8. Lambert, Joan , Frye, Curtis D. (2016). Microsoft Office 2016 Step By Step. PHI
9. Levin and Rubin (2008). Statistics for Management. Dorling Kindersley Pvt Ltd. India
10. Sekaran Uma (2003). Research Methods for Business. Wiley India.
11. Zikmund, Babin, Carr, Griffin (2003). Business Research Methods. Cengage Learning, India.
12. https://www.proschoolonline.com/blog/top-10-data-analytics-tools

CPE-RPE 101 Research and Publication Ethics 1-0-2-2 (3 hrs)

OBJECTIVE: This course has total 6 units focusing on basics of philosophy of science and ethics, research integrity, publication ethics. Hands-on-sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, research metrics (citations, h-index, Impact Factor, etc.) and plagiarism tools will be introduced in this course.

Theory

RPE 01: Philosophy and Ethics (4)

1. Introduction to philosophy: defination, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions

RPE 02: Scientific Conduct (4)

1. Ethics with respect to science and research.
2. Intellectual honesty and research integrity.
3. Scintific misconducts: Falsification, Fabrication, and Plagiarism (FET)
4. Redundant publications: duplicate and overapping publications, salami slicing
5. Slective reporting and misrepresentation of data

RPE 03: Publication Ethics (7)

1. Publication ethics: defination, introduction and importance
2. Best practics/ standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: defination, concept, problem that lead to unethical behavior and vice versa, types
5. Violation of publuication ethics, authorship and contributorship
6. Identificationnof publication misconduct , complaints and appeals
7. Predatory publishers and journals

PRACTICE

RPE 04: Open Access Publishing (4)

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journals Suggester, etc.

RPE 05: PUBLICATION MISCONDUCT

A. Group Discussions **(2)**
   1. Subject specific ethical issues, FFP, authorship
   2. Conflicts of interst
   3. Complaints and appeals: examples and fraud from India and abroad.

B. Software tools **(2)**
   - Use of plagiarism software like Turnitin, Urkund and other open source software tools

RPE 06: Databases and Research Metrics

A. Databases **(4)**
   1. Indexing databases
   2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics **(3)**
   1. Impact Factor of Journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
   2. Metrics: h-index, g index, i10 index, altmetrics

CS 702 **Advances in Computer Science and Engineering** **Total Lectures: 52**
4-0-0-4

Prerequisite(s): Knowledge of core subjects of computer science and engineering.

Objective(s): To strengthen the knowledge of core subjects of computer science and engineering.
To provide research orientation to the students and latest developments in core areas.

1. **Digital Computer Organization and Architecture:** Boolean algebra, Combinational and sequential circuits. Minimization, Number representations and computer arithmetic (fixed and floating point), Machine instructions and addressing modes, ALU, data-path and control unit, Instruction pipelining, memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode). [10]
2. **Data Structures and Algorithms:** Arrays, stacks, queues, linked lists, trees, binary search, trees, binary heaps, graphs, recursion, searching, sorting, hashing, asymptotic worst case time and space complexity, algorithm design techniques: greedy, dynamic programming and divide-and-conquer, graph search, minimum spanning trees, shortest paths, programming in C. [10]
3. **Theory of computer science and compiler design:** Regular expressions and finite automata, context-free grammars and push-down automata, regular and context-free languages, pumping lemma, Turing machines and undecidability, compiler design: lexical analysis, parsing, syntax-directed translation, runtime environments, intermediate code generation. [10]
4. **Operating System and Database:** Processes, threads, inter-process communication, concurrency and synchronization, deadlock, CPU scheduling, memory management and virtual memory, file systems. **Databases:** ER-model, relational model: relational algebra, tuple calculus, SQL, Integrity constraints, normal forms, file organization, indexing (e.g., B and B+ trees), transactions and concurrency control. [12]
5. **Computer Networks:** Concept of layering. LAN technologies (Ethernet), flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state), TCP/UDP and sockets, congestion control, Application layer protocols (DNS, SMTP, POP, FTP, HTTP), basics of Wi-Fi, network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls. [10]

Outcome(s): This course supports the achievement of the following outcomes:

1. Ability to apply knowledge of advanced principles of computing to the analysis of computer engineering problems.
2. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
3. Ability to maintain life-long learning and continue to be motivated to learn new subjects.

Reference Books:

1. M. Morris Mano, "Computer System Architecture", Pearson Education, 3rd edition, 2008.
2. Thomas H. Cormen, "Introduction to Algorithms", PHI, 3rd edition, 2012.
3. John E. Hopcroft, Rajeev Motwani, J D Ullman, "Introduction to Automata Theory, Languages and Computation", Pearson, 3rd edition.
4. A V Aho, R Sethi, J D Ullman, "Compilers: Principles, Techniques and Tools", Pearson, 2nd edition, 2014.
5. Galvin, Silberschatz, Gagne, "Operating System Concepts", Wiley India, 9th edition, 2015.
6. Navathe, "Fundamentals of Database Systems", Addison Wesley, 5th edition, 2007.
7. Tanenbaum, "Computer Networks", PHI, 4th edition, 2002

EC702 Advances in Electronics & Communication Engineering **Total Lectures:52**

4-0-0-4

Objective: The course focuses on the basic theory and techniques used in the area of digital signal processing, VLSI design, Microwave Engineering, Antenna & Wave Propagation and Digital Data communication. It also offers a profound understanding of the design, analysis and applications of some complex circuits and devices with the help of computer aided simulation and synthesis tool for hardware design.

Prerequisite:

Basic understanding of core engineering courses given in the syllabus, is required.

VLSI Design Technology

MOS modeling and performance parameters, Design aspects: Review of MOS transistor models , Concept of Scaling and deep submicron VLSI design, Low Power VLSI design, Issues related to high speed VLSI Design (CMOS technology), New trends in Digital VLSI design, Example of Mixed VLSI Design, Advanced Testing and Verification Approaches, Wafer cleaning processes and wet chemical etching techniques. Introduction to hardware description languages (VHDL), logic, circuit and layout verification. MEMS **[10]**

Microwave & Radar Engineering

Maxwell's Equation, Wave Equation and Boundary conditions, Transmission lines, Microwave Passive Components, Measurements of Wavelength, Frequency, Impedance, SWR etc., Q of Cavity, Microwave Linear Beam Tubes, Reflex Klystron. Traveling Wave Tube, Transferred Electron Devices, Principle of operation of Radar, Radar equation, CW and Frequency Modulated Radar, MTI and Pulse Doppler Radar **[12]**

Antenna & Wave Propagation

Introduction of Antenna & its parameters. Reciprocity theorem, Review of microwave antennas- Parabolic Reflector, Cassegrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication. Frequency- independent antennas, Scattering and diffraction. Internal-equation methods, current distribution: Self and mutual impedances. **[10]**

Digital Data Communications

Local Area networks:- token ring, Ethernet, Traditional, Fast and GIGA bit Ethernet, FDDI, DIGITAL MULTIPLEXING :- TDM , T1 carrier , CCITT , CODECS, COMBO CHIPS , North American Hierarchy , Line Encoding , T-carrier , Frame Synchronization Inter Leaving Statistical TDM FDM , **[10]**

Hierarchy ,Wave Division Multiplexing .

Signal Processing

Multi-rate Digital Signal Processing: Introduction, Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D, Filter Design and Implementation for sampling rate Conversion. Linear Prediction And Optimum Linear Filters: Forward and backward linear prediction; Properties of the linear prediction – error filters; Applications of linear prediction., Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters. Power Spectral Estimation: Principle and traditional methods of spectral estimation; Modern methods of parametric estimation; Applications of spectral analysis,. **[10]**

Course Outcomes:

This course supports the achievement of the following outcomes:

4. Ability to apply knowledge of advanced principles to the analysis of electrical and computer engineering problems.
5. Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving engineering problems.
6. Ability to use the appropriate state-of-the-art engineering references and resources, including IEEE research journals and industry publications, needed to find the best solutions to electrical and computer engineering problems.
7. Ability to maintain life-long learning and continue to be motivated to learn new subjects.
8. Ability to be competitive in the engineering job market.

Text books

1. R.E Collin, "Antennas & Radio Wave Propagation", Mc-Graw Hill
2. D M Pozar,"Microwave Engineering", JohnWilley & Sons
3. Proakis, Rader, Ling, and Nikias, Advanced digital signal processing, Macmillan, 1992
4. John P. Uyemura : Introduction to VLSI Circuits and Systems, John Wiley & Sons,Inc, 2002
5. Electronic communication systems, fundamentals through advanced - W. TOMASI, Pearson 4th Edition.
6. Introduction to Radar, M. I. Skolnik, McGraw Hill.

Reference books

1. Annapurna das & Sisir K das, Microwave Engineering Tata Mcgraw Hill.

2. Data communication and networking - B.A. Forouzen

3. Kin. Lu. Wong, "Compact and Broadband Microstrip Antenna", John Wiley & Sons

4. S. Stergiopoulos (editor), "Advanced Signal Processing Handbook: Theory and Implementation for Radar, Sonar, and Medical Imaging Real-Time Systems", CRC Press LLC, 2001.
5. Neil Weste and David Harris, "CMOS VLSI Design ", 4thEd., Addison Wesley, 2011.

EE 702 **Advances in Electrical Engineering** **Total Lectures: 52**

4-0-0-4

Objective: To provide an exposure on the basic principles and techniques used in the area of ultra-capacitor, control systems and its sliding modes control, Smart Grid, Renewable Energy Integration. It also offers a profound understanding of the design, analysis and applications of Smart Grid, Renewable Energy integration with the help of computer aided simulation and synthesis tools / ETAP Software.

Pre-requisite: Basic understanding of core engineering courses given in the syllabus is required.

1. **Ultra- Capacitor:** Introduction, History, Basic principles of Ultracapacitors, Principles and energy storage mechanism, EC vs. Aluminum (Al) electrolytic capacitors, Capacitors vs. batteries, Benefits and limitations of Ultracapacitors, Ultracapacitor vs. Flywheels, Applications, Cell voltage, Comparison with battery or other energy storage devices, Cost of EC capacitors, Electrochemical Double Layer Capacitor: basic construction, Components of Ultracapacitor, EC capacitor sizes, Future of energy storage industry, Uninterruptible power supply and backup power. [8]
2. **Applications & Future Scenario of Ultra- Capacitor:** Modern day applications of Ultra capacitor, Future application growth, New material developments, Cost reduction, Ultra capacitor may overtake batteries, Market trends, ultra capacitors in the grid, Vehicular applications, Ultra capacitors in wind turbines, Water Desalination/Purification, New Ultra capacitor work at constant voltage, Electrochemical flow Ultra capacitor, Micro Ultra capacitor, Ultra capacitor for resistance welding. [8]
3. **Advanced control systems and Smart Meter :** Introduction, Intuitive theory of sliding mode control, Sliding Surface, sliding mode, concept of equivalent control, sliding mode equations, sliding mode observer/differentiator, second order sliding. Details Description of Smart Meter, Benefits of Smart Meter, Technical Configurations of Smart Meter, Components of Smart Meter Network in Distribution System, Characteristics, Communication Protocols. [12]
4. **Classical sliding modes:** Introduction, state feedback sliding mode control: Regular form, Eigen valve placement, quadratic minimization. State feedback control laws design: Single input system, multi-input system, unmatched uncertainty, output tracking with integral action. Output based hyper plane design, control law development. Integral sliding mode control: Problem formulations, control design objective, ISM control design. [8]
5. **Smart Grid and Renewable Energy:** Introduction, Characteristics of Smart Grid, Traditional Grid Versus Smart Grid, Evolution of Smart Grid, Components of Smart Grid, The Environmental Impacts of Smart Grid, Technologies Required for Smart Grid. Introduction, Solar Energy, Wind Energy, Distributed Energy Resources Integration Challenges, Forecasting and Scheduling, Impacts of Renewable Energy into the Grid. [16]

Course Outcomes: This course helps our students to apply the knowledge of advanced principles, state of-the-art design techniques, software tools, and research methods for solving challenges of Smart Grid, Renewable Energy Integration and ultra capacitor.

Text Books:

1. R. P. Deshpande, "Ultra -capacitors: Future of Energy Storage", Mc-Graw Hill

Education.

2. C-Edwards & S.K. Spurgeon, "Sliding mode control: Theory & Application", Taylor & Francis, 1998.
3. Shawkat Ali A. B. M., Smart Grids Opportunities, Developments and Trends, Springer-Verlag, London , 2013

Reference Books:

1. B. E. Conway, "Electrochemical Super capacitors: Scientific Fundamentals and Technological Applications", Kluwer Academic / Plenum Publishers (1999)
2. Utkin V.I., "Sliding modes in control & optimization", Springer-verlay, 1992.
3. Momoh James., Smart Grid Fundamentals of Design and Analysis, John Wiley &Sons, Inc., Hoboken, New Jersey, 2012

ME 702 **Advances in Mechanical Engineering** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite(s): M.Tech./M.E. or equivalent degree in Mechanical Engineering, Production Engineering, Industrial Engineering, Metallurgical Engineering and knowledge of core subjects in these stream.

Objective(s):

- *To strengthen the knowledge of core subjects of mechanical engineering.*
- *To provide research orientation to the students and latest developments in core areas.*

1. **Advanced Theory of Elasticity (3-dimensional problems):** **[10]**
Theories of Stress and strain, Transformation of stress and strain, Linear stress-strain temperature relations, Applications of energy methods, Torsion (Narrow rectangular cross Section, Hollow thin wall torsion members) Bending (Unsymmetrical bending, Curved beam**),** Plates.

2. **Experimental Stress Analysis:** **[6]**
Strain Measurement Methods: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits

3. **Advances in Production & Industrial Engineering :** **[16]**
Friction, Explosive welding, under water welding, Methods of measuring welding defects by Radiographs, Ultrasonic flow detector and metallurgical analysis to prevent-premature failure. Atomic emission spectrometer, Residual stress analysis in Welding, Solid Phase Welding and Cold Pressure welding. Full mould casting, Continuous Casting, Shape Casting, Casting Defects, Solidification process in casting. Metal cutting principles & design of machine tools, Conversion of cutting tool nomenclature, Thin and thick zone model. Trends towards development of new metal cutting processes including dry machining and environmentally conscious machining.ERP and Supply Chain Management (ERPSCM), the emergence and need for ERP concept; Modules and Architectures of a typical ERP System, Selection and implementation of ERP Systems.

4. **Introduction to Optimization Techniques:** **[6]**
Engineering application of Optimization, Formulation of design problems as mathematical programming problems, classification of optimization problems.

5. **Advance Thermodynamics and Heat Transfer** **[14]**
Thermodynamics Relations:- Mathematical theorems, Maxwell relations, T-ds equations, Energy Equations, General Relations involving internal energy, enthalpy & entropy, Thermodynamics Relations involving specific heat , Clapeyron equation, Joule Thomson Coefficient, Introduction to convection, review of conservation equations - Forced convection in laminar flow - Exact and approximate solutions of Boundary layer energy equation for plane isothermal plate in longitudinal flow - problems. Forced convection heat transfer in laminar tube flow - forced convection in turbulent flow – Internal Flows-Correlations-Problems

Outcome(s): *This course supports the achievement of the following outcomes*

- *Current trends in the rapidly evolving field*
- *The intellectual and philosophical framework necessary to explore wide spectrum of research in mechanical engineering.*
- *To contribute to expanding the frontiers of knowledge and to provide research training.*
- *Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, and research methods for solving engineering problems*

Text Books:

1. Timoschenko S.P. and Goodier J.N, "Theory of elasticity" McGraw-Hill Publishers
2. Dally and Riley, "Experimental stress analysis", McGraw-Hill Publishers
3. B.H. Amstead, Philip F, Ostwald and Myron L, "Manufacturing Processes" Begeman, John

NU–702 Advances in Nuclear Science & Technology **Total Lectures: 52**

4-0-0-4

1. **Thermal Hydraulics:** Thermal Hydraulic Characteristics of various reactors; Reactor Heat Generation & decay heat; Thermodynamics of fuel-coolant interaction & Containment pressurization; Thermal Analysis of Fuel Elements: Turbulent flow, Pressure Drop in bundles/area changes, Heat Transfer, Flow Regimes , Void-Quality-Slip Relations & Models, Pressure Drop, Critical Flow; 2-phase heat transfer: Boiling crises, Critical Heat flux, Thermal design and analysis: Multiple and Sub-channels **[8]**

2. **Nuclear Materials:** Survey of Material Selection and Mechanical Properties of fuel, structure, cladding, moderator and reflector, The Language of Materials Science Symmetry, Thermodynamics Phase of Diagrams & Phase Transformations, Free Energy Origins of Phase Diagrams, Material Deformation and Failure Free Energy, Point Defects, Dislocations, 2D & 3D Defects, Stress, Strain, Plasticity, Creep, Fracture, Failure, Radiation Damage and Effects, Stopping Power, Displacement Rates, Radiation Point Defect Kinetics, Radiation Effects in Materials & Fuels. **[8]**

3. **Nuclear Fuel Cycle:** Nuclear Fuel Resources: Mining and Milling, Conversion, Enrichment through Gas Diffusion, Centrifuge, Separation Nozzle and Lasers; Reactor Physics Calculations: Core Reload, Fuel Depletion, Burnable Poison & Control Rods, In core fuel management: multiple batches & fuel loading patterns, extendable burn up; Reprocessing and Recycling: PUREX, UREX; Materials Accountability, U & Pu recycle Economics **[10]**

4. **Nuclear Safety, Security and Safeguards:** Introduction to nuclear security; International and national legal framework regulating of nuclear security; Threat assessment; Physical protection systems design and evaluation; Physical protection technologies and equipment; Nuclear security culture; Nuclear power plant safety requirements, Basic concepts in safety and reliability, Conceptual design of safety systems, Nuclear Safeguard, Nuclear material accountancy and inventory control of radioactive material. **[10]**

5. **Radiation Detection and Plasma Technology :** Radiation sources, Synchrotron radiation, Counting statistics and error prediction, General properties of radiation detectors, Scintillation detectors, PMT & Photo diodes, Semiconductor diode detectors, Gamma ray spectroscopy, Background and detector shielding Plasma production in lab using D.C., A.C., RF and Microwave, Glow and Arc discharge, DBD discharges, Atmospheric Pressure plasma jets, Spectroscopic diagnostics, Applications of non- equilibrium plasmas, Plasma Torches & applications, Important Tokomak experiments, Plasma heating, Plasma wall interaction. **[16]**

Text Books:

1. Collier, J. G., and J. R. Thome. *Convective Boiling and Condensation*. 3rd ed. NY: Oxford University Press.

2. Todreas, N. E. and M. S. Kazimi. *Nuclear Systems*. Vol 1& 2. New York, NY: Francis & Taylor, 2012
3. Allen, Todd, Jeremy Busby, et al. "Materials Challenges for Nuclear Systems." *Materials Today* 13, no. 12 (2010):
4. Was, G. S *Fundamentals of Radiation Materials Science: Metals and Alloys*. Springer, 2007,
5. Jiang, Qing, and Zi Wen. *Thermodynamics of Materials*. Springer, 2011
6. The Nuclear Fuel Cycle by Nicholas Tsoulfanidis, ANS publication 2012
7. E. E. Lewis, Nuclear Power Reactor Safety, *Wiley-Inter science* publication, 1977
8. International Atomic Energy Agency, Development, Use and Maintenance of the Design Basis Threat, IAEA Nuclear Security Series No. 10, IAEA, Vienna (2009)
9. Roth, J. R., Industrial Plasma Engineering, Vol. 1 & 2, IOP Publishing Ltd, 1995
10. John Wesson Tokomaks (4th Edition), Oxford University Press, 2011
11. Knoll, G. F., Radiation detection and Measurement, 3rd edition, Wiley India, 2009

Reference Books:

1. International Atomic Energy Agency, Handbook on Physical Protection of Nuclear Material and Facilities, IAEA-TECDOC-1276, Vienna (2002).
2. Dolan, T. J, Fusion Research :Principles, Experiments & Technology, Pergamon Press, 2000

CS 19.203 **Data Structures** **Total Lectures: 40**

Credit:3-0-0-3

Pre-requisite(s): CS 19.101 (Programming Language)

Objective(s):

- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1. **Introduction:** Basic terminology, elementary data organization, algorithm, efficiency of an algorithm, time and space complexity, asymptotic notations, time-space trade- off, abstract data types. [4]
2. **Array & Linked list:** Definition, single and multidimensional arrays, representation of arrays: row major order, and column major order, application of arrays, sparse matrices and their representations. Singly linked lists, doubly linked list, circular linked list, insertion, deletion, traversal, polynomial representation and addition, generalized linked list. [10]
3. **Searching & Sorting:** Sequential search, binary search, comparison and analysis, hash function, collision resolution strategies, insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort. [10]
4. **Stack & Queue:** Primitive stack operations: push and pop array and linked list implementation of stack, application of stack: prefix and postfix expressions, evaluation of postfix expression, recursion, and tower of Hanoi problem. Queue operations, circular queues, array and linked list implementation of queues, dequeue and priority queue [8]
5. **Tree:** Binary trees, binary tree representation, tree traversal algorithms: inorder, preorder and postorder, threaded binary trees, Huffman algorithm, binary search trees AVL trees. [8]

Outcome(s): On the successful completion of the course, the student will be able to:

- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:

1.Lipschutz, "Data Structures" Schaum's Outline Series, TMH, Revised Edition Feb. 2014

2. Horowitz and Sahani, Fundamentals of Data Structures, University Press, 2nd Edition, 2008.

Reference Books:

1.Aaron M. Tenenbaum, YedidyahLangsam and Moshe J. Augenstein, Data Structures Using C and C++, PHI, 2nd Edition, 2012.

2. D. Samanta, Classic Data Structures, PHI, 2nd Edition, 2009

3. Jean Paul Trembley and Paul G. Sorenson, An Introduction to Data Structures with applications, McGraw Hill, 2nd Edition, 2003.

CS-19.205 **Objected Oriented Programming** **Total Lectures: 40**

3-0-0-3

Objective: The objective of this course is to:

1. cover issues related to the definition, creation and usage of classes, objects and methods.
2. Discuss the principles of inheritance and polymorphism.
3. Provide the foundation of good programming skills by discussing key issues of the design of object-oriented software, including programming design and documentation.
4. Cover the basics of API and to explore the java abstract programming interface.

Pre-requisite: Programming Language

1. **Overview:** Introduction to OOP, OOP concepts, interactive Development Environments: Eclipse/Net Beans, basics of OOP, importance of Java Primitive data types, type casting, arrays, ArrayList, operators and control structures, identifiers, constants and literals. [9]

2. **Classes and Inheritance:** Class fundamentals, objects, constructors, this keyword, garbage collection, the finalize() method, overloading methods, understanding static & final, exploring the string class. Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, the object class, using abstract classes, interface. [10]

3. **Package, and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, user defined exception, assertions [10]

4. **Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managing threads, thread class built-in functions. [4]

5. **I/O and String Handling:** I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer. [7]

Outcome: Upon completion of this course, students are able to:

1. Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
2. Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
3. Develop programs using the in-built Java API and the Java standard class library.
4. Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifies, automatic documentation through comments, error exception handling).
5. Use of development environment like Eclipse for collaborative programming

Text Books:

1. Herbert Schildt, Java the Complete Reference, Herbert Schildt, 8th Edition, 2011.
2. Bert Bates and Kathy Sierra, Head First Java, O'Reilly,2005

Reference Books:

1. Allen B. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
2. Paul Deitel, Harvey Deitel, Java How To Program (Early Objects), 10th Edition, 2014.
3. E. Balaguruswamy, Programing with Java A Primer, Tata Mc. Graw Hill, 2007

EC 19.201	Electronic Devices and Circuits	Total Lectures: 40 3-0-0-3

Objective To acquire fundamental knowledge of operation, design and application of various Electronic devices and circuits.

Pre-requisite Basic Electronics and Physics of electron.

1. **Junction Diode:** Junction breakdown**,** Current components in a p-n diode, Quantitative analysis of p-n diode characteristics and equivalent circuit, diode resistance, interconnections of diodes, transition and diffusion capacitance. [6]

2. **Transistors**: Operation of transistor, transistor current components, transistor circuit configurations, transistor biasing schemes and operating point stabilization, hybrid-pi model of BJT, low and high frequency models of JFET, MOS Devices - NMOS, PMOS and CMOS [11]

3. **Small Signal Amplifiers at Low Frequency:** Coupling schemes for multistage amplifiers, frequency response of coupled amplifier, RC coupled transistor amplifier, transformer coupled transistor amplifier, cascode circuits, Differential amplifier, Darlington amplifier. [7]

4. **Power Amplifiers:** Power amplifier circuits, class-A, class-B, class-AB, class-C, push pull amplifiers- class-A, class-B, Class- AB, complementary symmetry push-pull and quasi-complementary symmetry, push-pull amplifiers. [8]

5. **Oscillators:** Classification criterion for oscillation, tuned collector, Hartley, Colpitts, RC phase shift, Wien bridge and crystal oscillators, astable, monostable and bistable multivibrators, Schmitt trigger [8]

Outcome: After completion of this course, students would be able to understand the working phenomena and applications of various electronic devices and circuits. Knowledge gained from this course would also be utilized to design different electronic circuits and devices.

Text Books:

1. Robert L. Boylestad & Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education, 11th Edition, 2013.
2. Thomas L. Floyd, Electronic Devices, Pearson Education, 10th Edition , 2018.

Reference Books:

1. Bell, David A., Operational Amplifiers & Linear ICS, Prentice Hall of India, 3rd Edition, 2018.
2. J. Millman & C. C. Halkias, Electronic Devices and Circuits, McGraw Hill

EC 19.202 **Digital Electronics** **Total Lectures: 40**

Objective: The aim of this course is to present the principles and techniques of combinational and sequential digital logic design and optimization at a gate level. The use of transistors for building gates is also introduced. **3-0-0-3**

Pre-requisite: Basics of Electronics Engineering

1. **Number Systems and Boolean Algebra:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic, Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [5]
2. **Logic Gates and Simplification of Boolean Functions:** Basic Logic gates, Universal gates, K-map representation, incompletely specified functions, simplification realization with gates, Quine-Mc Cluskey method. [5]
3. **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]
4. **Sequential Circuits and Programmable Logic :** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters, PAL, PLA. [10]
5. **Introduction to Verilog HDL:** Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools. Gate Level Modeling: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State Gates, Array of Instances of Primitives, Design of Flip-flops with Gate Primitives, Delays, Strengths and Construction Resolution, Net Types, Design of Basic Circuits. [10]

Outcomes: Upon successful completion of this course, students should be able to:

1. Gain fundamental knowledge of the basic logic gates such as AND, OR, NAND NOR, EX-OR and their implementation in Logic Circuits.
2. Design multipliers, Combinational Circuits and registers.

Text Books:

1. M. M. Mano and M. D. Ciletti, Digital Design, Pearson Education, 4th Edition, 2009.
2. T. L. Floyd and R.P. Jain, Digital Fundamental, Pearson Education, 8th Edition, 2009.

References

1. V. K. Puri, Digital Electronics: Circuits and Systems, Tata McGraw-Hill, 4th Edition, 2001.
2. R. P. Jain, Modern Digital Electronics, Tata McGraw-Hill, 4th Ed, 2003.

EC 19.203 **Semiconductor Physics** **Total Lectures: 40**

3-0-0-3

Objective: The aim of the course is to develop physics and engineering strategies of semiconductor materials and to discuss their functionalities in modern electronic and optoelectronic devices

Pre-requisites : Basic Modern physics , Optics

1	**Introduction -** Solids, Crystals and Electronic grade materials, Formation of energy bands in solids, Concept of hole, Density of states and Fermi level, Intrinsic and extrinsic semiconductors, Direct and indirect semiconductors Recombination and Generation of carriers,	[8]
2	**Fermi distribution and energy** - Density of states - Valance and conduction band density of states - intrinsic carrier concentration - intrinsic Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors - Bandgap Engineering.	[8]
3	**Carrier transport –** Drift and Diffusion: Equations of state – Continuity and Poisson equation, Carrier transport by Drift: Low field, High field and very high field (Impact ionization) - Einstein relation, phonon scattering. Macroscopic transport: Carrier transport by Diffusion	[8]
4	**Generation and recombination** - Electron - hole pair: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons: Origin, electronic levels and properties Radiative and nonradiative recombination (Shockley - Read - Hall and Auger) processes. Carrier transport - continuity equations. Optical constants: Kramers - Kronig relations.	[8]
5	**Optical processes in semiconductor**, choice of materials for LED, LED power and efficiency, LED structures - Planar LED, Dome LED, Surface Emitting LED, Edge Emitting LED, Optical detection principle, quantum efficiency, Photoconductor, p-n photodiode, p-i-n photodioe, APD, Heterojunction diode, optocouplers.	[8]

Outcome: This course will provide the students with a basic understanding of the physics and principles of semiconductor material.

Text Books:

1. Kevin F Brennan, The Physics of Semiconductors, Cambridge Univ. Press, 2012.
2. Peter Y Yu and Manuel Cardona, Fundamentals of Semiconductors, Springer, 4th Edition, 2010.

Reference Books

1. D. A. Neamen, Semiconductor Physics and Devices, 3rd Ed., Tata McGraw-Hill, 2003.
2. S.M. Sze, Physics of Semiconductor Devices, John Willey, 3rd Ed., 2007.

EC 19.204 **Integrated Circuits and Applications** **Total Lectures: 40**

3-0-0-3

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: Electronics Devices and Circuits

1. **Differential Amplifier:** Operational amplifier, bipolar and FET differential amplifiers, constant current source, current mirror, level translator, block diagram of operational amplifier, frequency response and stability, operational amplifier parameters, offset compensation techniques. [5]

2. **Application of Op-amp:** Inverting and non-inverting amplifiers, voltage follower, integrator and differentiator circuits, instrumentation amplifier, current to voltage converter and voltage to current converter, voltage to frequency conversion, analog simulation of differential equations using operational amplifiers. [5]

3. **Oscillators and Active Filters:** Phase shift, Wein bridge, quadrature, square wave, triangular wave, saw tooth wave and voltage controlled oscillator, Low pass, high pass, band pass and band reject filters, designing of second order filters using Butterworth approximations, higher order filters and state variable filters. [15]

4. **ICs and Applications:** Clipping and clamping circuits, comparator, LM-311 comparator, schmitt trigger, log and antilog amplifiers, half and full wave rectification, IC-8038, IC LF-398, IC-555. [5]

5. **Voltage Regulator and PLL:** Voltage regulator IC-723, switching regulators, regulator IC series 78xx, 79xx, building blocks of PLL, IC-565 and its applications, four-quadrant multiplier and its applications. [10]

Outcomes: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. R. A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI, New Delhi, 3rd Edition.
2. B. P. Singh and Rekha Singh, Electronic Devices and Integrated Circuit", Pearson Education, 2003.

Reference Books:

1. R. F. Coughlin and F. F. Driscoll, Operational Amplifiers & Integrated Circuits, Pearson Education, 5th Edition, 2001.
2. S. Franco, Design with Operational Amplifiers and Analog Integrated Circuits, Pearson Education, 3rd Edition, 2003.

EC 19.206	Principles of Electromagnetics	Total Lectures: 40

Objective: To develop the understanding of basics concepts of electromagnetic field theory and its applications. **3-0-0-3**

Pre-requisite: Basic understanding of laws of Physics and Mathematics

1. **Introduction:** Transformation of a point and a vector in different coordinate systems, Differential length, area, volume Physical meaning of gradient, divergence and curl, Laplacian of a scalar, Divergence theorem, Stoke's theorem, review of electrostatic and magneto static fields. [5]
2. **Time Varying Fields and Maxwell's Equations:** Faraday's law of electromagnetic induction, Maxwell's equations in integral and differential form, potential functions, electromagnetic boundary conditions. [5]
3. **Electromagnetic Waves:** Introduction, Helmholtz wave equation, Wave equations and their solutions for free space, lossy dielectric, Lossless dielectrics and good conductor medium, Poynting vector and the flow of power. Reflection of plane wave at dielectric media and conducting surfaces for normal incidence. [15]
4. **Transmission lines:** Types of transmission lines, transmission line parameters, two conductor transmission line equations, input impedance, standing wave ratio and power of transmission lines, smith chart, transmission line impedance matching techniques. [5]
5. **Guiding Structures:** General wave behaviors along uniform guiding structure, rectangular and circular wave guides, wave propagation in rectangular and cylindrical cavity resonators. [10]

Outcomes: After completion of the course, students would be able to apply Knowledge of electromagnetic principles in engineering and solve curriculum problems.

Text Books:
1. Matthew N. O. Sadiku, Principles of Electromagnetics, Oxford University Press, 4th Edition, 2015.
2. William H. Hayt: Engineering Electromagnetic, TMH, 8th Edition, 2013.

Reference Books:
1. David J. Griffiths, Introduction to Electrodynamics (Third Edition); Pearson Education, 4th Edition, 2013.
2. M. L. Sisodia and G. S. Raghuvanshi, Microwave Circuits and Passive Devices, New Age Publication, 1987.

EC 19.411 **Telecommunication Switching Systems** **Total Lectures: 40**

3-0-0-3

Objectives:

1. To acquire knowledge on simple telephone communication and basics of switching system.
2. To get acquainted with electromechanical switching systems.
3. To gain knowledge on digital switching systems, stored program control system, traffic engineering, telephone networks and ISDN.
4. To apply the knowledge of Telecommunication Switching in designing switching systems.

Pre-requisite: Analog communication

1. **Introduction to Switching Systems:** Introduction, simple telephone communication, basics of switching system
2. **Electromechanical Switching Systems: Introduction to Strowger switching system,** Crossbar switching systems, single stage and multistage switching systems, common control, pulse dialling, tone dialling.
3. **Digital Switching Systems:** Stored Program Control, centralised SPC, distributed SPC, software architecture, application software, space division, and time division switching, time multiplexed space division, time multiplexed time division switching and combination switching.
4. **Traffic Engineering:** Erlang's equation, blocking probability and B-D equation.
5. **Telephone Networks:** Subscriber loop, digital subscriber loop, high speed digital transmission over subscriber line, wire-in, wire-less media, coaxial cables, optical fibre cables, microwave propagation, satellite transmission, numbering plan, charging plan, Inchannel signalling, common channel signalling.
6. **ISDN and ATM Standards:** ISDN architecture, channels, interfaces, protocol, B-ISDN architecture, frame relay, ATM protocols

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of telecommunication Switching Systems.
2. Able to describe different mechanical and electronic switching systems, telephone networks.

Able to design various switching systems.

Text Books:

1. Thiagarajan Viswanathan, Telecommunication Switching Systems and Networks, PHI, 2nd Edition, 2015.
2. J. E. Flood, Telecommunication Switching, Traffic and Networks, Pearson Education, 1st Edition, 1999.

References:

1. John C. Bellamy, Digital Telephony, Wiley Publications, 3rd Edition, 2000.

EC 19.412 **Wireless Networks** **Total Lectures: 40**

3-0-0-3

Objectives: To acquire fundamental knowledge of various types of wireless networks and apply them to wireless communication applications.

Pre-requisite: Analog Communication, Digital Communication

1. **Introduction:** Introduction to wireless networks, Wireless communication systems – Paging system, cordless telephone system, cellular telephone system [4]

2. **Basics of cellular communication systems:** Frequency reuse, channel assignment, call handoff, interference and system capacity, Mobile radio propagation – path loss and fading, 2G, 2.5 G and 3G wireless networks [10]

3. **Multiple Access Techniques:** Frequency Hopped Multiple Access, Code Division Multiple Access, Hybrid Spread Spectrum Multiple Access, Packet Radio, Carrier Sense Multiple Access, Reservation Protocol [10]

4. **Equalization, Diversity and Channel Coding:** Fundamentals of equalization, Linear equalization, Nonlinear equalization, Diversity techniques – space diversity, time diversity, frequency diversity, polarization diversity, RAKE receiver, Block code and convolution code. [8]

5. **Wireless Networking:** Wireless local area network, RF and IR WLAN, advantages and applications, IEEE 802.11, IEEE 802.16, HYPERLAN, Bluetooth, WiMax, Ultra-Wide Band communication. [8]

Outcomes: After completion of the course, students would be able
1. To apply wireless communication concepts and ideas to engineering applications and
2. To develop high performance wireless communication network.

Text Books:
1. T. S. Rappaport, Wireless Communication, Principles and Practice, Pearson Education, 2nd Edition, , 2009
2. Upena Dalal, Wireless Communication, Oxford University Press, 1st Ed., 2009.

References:
1. Jochen Schiller, Mobile Communications, , Pearson Education, 2nd Edition, 2012
2. Vijay Garg, Wireless Communications and Networking, First Edition, Elsevier, 1st Edition, 2007.

EC 19.413 **Fiber Optics Communication** **Total Lectures: 40**

3-0-0-3

Objectives:
1. To acquire knowledge on basics of Optical Fibers.
2. To get acquainted with different types of optical fiber.
3. To gain knowledge on transmission characteristics of optical fiber, fabrication, cabling, jointing techniques.
4. To apply the knowledge of optical fiber communication in designing fiber optic systems for communication.

Pre-requisite: Analog Communication

1. **Basic Concepts of Optical Communication:** Introduction to wave propagation in planar optical waveguides, ray theory, introduction to electromagnetic mode theory, phase and group velocity. [9]

2. **Fiber Configurations and Mode Theory:** Wave propagation in cylindrical fibers, modes and mode coupling, step and graded index fibers, single-mode fibers. [5]

3. **Signal Degradation in Optical Fibers:** Introduction to transmission characteristics of fibers, attenuation, material absorption and scattering loss, bend loss, dispersion, intra modal and intermodal dispersion in step and graded index fibers, overall dispersion in single and multi-mode fibers. [9]

4. **Fiber Fabrication and Fiber Joints:** Preparation of different types of fibers, optical fiber cables and stability of characteristics, Fiber alignment, fiber splices, connectors, couplers. [10]

5. **Optical Fiber Communication Systems:** Fiber amplifiers system, description of an optical fiber communication system, system design, power budget, hybrid fiber coaxial system and WDM technology. [7]

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of Optical Fiber Systems. Able to describe different mechanical and electronic switching systems, telephone networks.
2. Able to describe different types of fibers, losses, dispersion, jointing techniques, fabrication, cabling etc.
3. Able to design various fiber optic communication systems.

Text Books:
1. John M. Senior, Optical Fiber communications, Pearson Education, 3rd Edition, 2009.
2. Gerd keiser, Optical Fiber communication, Tata McGraw Hill, 5th Edition, 2013.

EC 19.414	Business Support System – Intelligent Network (BSS-IN)	Total Lecture: 40 3-0-0-3

Objectives:
1. To acquire knowledge on advanced intelligent networks
2. To get acquainted with different protocols like TCP/IP/SCTP.

Pre-requisites: Linux Basic, Database Basic, TCP/IP Basic.

1	**Introduction to Telecom Market:** Customer and Vendors, How Adds and promotion benefits, Statistics (Postpaid/Prepaid).	**[2]**
2	**GSM Basic and Evolution:** Architecture, Call Flows (Cover RAN/CORE/IN), OSI/SS7 Basic, Evolution (2G to 5G)	**[4]**
3	**Intelligent Network Overview:** Common Charging Architecture - High Level Common Architecture, Charging Mechanisms, Charging Functions- Offline Charging Funtions; Offline Charging Funtions; Architecture Mapping ,Charging Principles; Charging data generation and quota supervision; Charging information utilization, OCS - Required Functionality, OCS - Reference Model/Architecture, OCS Rating Function, OCS Functionality Message Flows, OCS CDRs, Policy Control And Charging; Reference Architecture; Policy Control Requirements; Reference Points; Functional Entities; PCC Rules; QoS Rules; PCC Procedure and Flows, Refill And voucher management, Subscriber/Customer management - Customer Care	**[11]**
4	**Unit 4*: Billing Mediation and Provisioning Basic** CDR, UDR, TAP files, RAP files, NRTRDE, Billing System architecture (Mediation, usage and tariff database, formatting and rating processes, invoice generation),Types of usage (duration, volume, QoS, day and time, number of events, type of service),Types of rating (batch rating, pre-event rating, post-event rating, backwards rating, prepaid balance management, spending control/unbilled limit), Standard rating functions (staircase, offset, linear), Parameters of billing (usage & recurring &onetime charges, discounts & fees & taxes),Types of billing (regular, on-demand, immediate, simulation, information), Different product features (supports MVNO, real-time discounts, cross discounts, shared balances, multiple balances), Different marketing tools (business partners, bundles and counters, F&F, free units, discounts), Typical Telecom Environment: Multivendor environment, Std Protocols & proprietary Interfaces, Integration challenges, File Mediation fundamentals: ASN.1, Need, Typical Use Cases, Architecture, Event Mediation fundamentals: Diameter, 3GPP, Need, Typical Use Cases, Architecture Provisioning fundamentals: MML, CAI, CAI-3G etc, Need, Typical Use Cases, Architecture	**[12]**
5	**Protocols/Tools and 3PP Services integration with BSS :** TCP/IP/SCTP; Stack Description ; Connection Flow; Messages Flow; Use Cases ,SIGTRAN/SS7; Stack Description; Connection Flow; Messages Flow; Use Cases, DIAMETER; Stack Description; Connection Flow ;Messages Flow; Use Cases, CAMEL ; Stack Description; Connection Flow ;Messages Flow ;Use Cases, Integration With CRBT/MoMo, IVR Services, Practical Example/Use Cases.	**[11]**

Outcomes: After completion of the course, students would be able to
1. apply knowledge on advanced intelligent networks and ideas to engineering applications
2. describe intelligent networks, Protocols/Tools

EC 19.415 **Cellular and Satellite Communication** **Total Lectures: 40**

3-0-0-3

Objective:
1. The student gains the knowledge of the fundamental principles of cellular and satellite communication techniques and basic information about the cellular communication with their practical implementation.
2. This course helps in understanding the design of transmitter and receiver models for the cellular industry as well as defense application.

Pre-requisite: Analog Communication, Digital Communication

1.	**Cellular Communication:** Introduction to cellular communication systems and review of mobile radio propagation	[6]
2.	**Digital Cellular System:** Cellular concept, digital cellular mobile system, GSM architecture, GSM technologies, micro-cellular systems, third generation mobile communication systems and personal communication system.	[8]
3.	**Access Techniques:** Multiple access in cellular system, spread spectrum multiple access, code division multiple access, CDMA standard and IS-95.	[8]
4.	**Communication Satellite and Satellite Link Access:** Orbital mechanism and look angle determination of a satellite, spacecraft subsystem, launching of satellite, communication subsystem and transponder, Satellite link design, multi-beam and regenerative satellite, analog and digital multiple accessing in satellite.	[12]
5.	**Communication Satellite System:** Earth station, VSAT terminals, INTELSAT, INMARSAT, INSAT system and their applications, global mobile satellite system.	[6]

Outcomes:
1. The student will be able to get concepts of cellular communication systems and various satellites.
2. The student will analyze and have to design the different circuits for transmission and reception of signals for cellular communication.

Text Books:
1. Timothy Pratt and Charles W. Bostian, Satellite Communication, Wiley, 1st Edition, 2003.
2. T. S. Rappaport, Wireless Communication, Principles and Practice, 2nd Edition, Pearson Education, 2009.

Reference Books:
1. Ray E. Sheriff, Y. Fun Hu, Mobile Satellite Communication Networks, John Willey & Sons, Edition 3, 2003.
2. Madhavendra Richharia, Satellite Communications Systems: Design Principles, McGraw-Hill, Edition 2, 1999.

EC 19.421 **System Design Using HDL** **Total Lectures: 40**

3-0-0-3

Objective:
1. To acquire fundamental knowledge of designing of digital systems using VHDL.
2. Students will acquire practical working knowledge of creating digital circuits using commercial Computer-Aided-Design (CAD) tools.

Pre-requisite: Knowledge of digital logic and digital circuits are highly desired.

1. **Programmable Logic Design:** ASIC, ROM, PLA, PAL, CPLD and FPGA. [3]
2. **VHDL Based Design and fundamentals:** An overview of VHDL, Role of VHDL in system design, Introduction to CAD tools for system design, Introduction to Xilinx IDE software. Entity and architecture declaration, Introduction to behavioural, dataflow and structural models, package, package declarations and package body. [9]
3. **Basic Elements of VHDL:** Data objects – constant, variable and signal, Data types – scalar and composite, Predefined Operators – logical, relational, shift, adding and multiplying, Overloading – literal and operator. [4]
4. **VHDL Statements:** Process, variable assignment, signal assignment, sequential statements, conditional statements, loop**,** if, case, next statements, assertion and report statements, signal drivers and signal assignment statements, conditional signal assignments, select and generic, Subprograms: Application of functions and procedures, Overloading and signal assignments, Component declaration, Component instantiation. [10]
5. **Combinational and Sequential Circuit Design:** VHDL models of combinational circuits such as Adder, Multiplexer, De-multiplexer, Encoder, Decoder, Code converters, Comparators, Parity generators, Multipliers and implementation of Boolean functions, VHDL Models of sequential such as edge triggered D flip flop, T flip flop and J K flip flop, serial in serial out register, serial in parallel out register, parallel in parallel out register, counter, memory, ALU. [14]

Outcomes: After completion of the course, students would be able to:
1. Identify, formulate, and solve engineering problems
2. To use the technique, skills, and modern engineering tools necessary for engineering practice.

Text Books:
1. J. Bhaskar, VHDL Primer, Pearson Education Asia, 3rd Ed
2. Douglas L. Perry, VHDL Programming by Examples, Tata McGraw Hill, 4th Ed.

References:
1. John F. Wakerly, Digital Design: Principles and Practices, 2016.
2. Peter J. Ashenden, Beginner's guide to VHDL, 2012.

EC 19.422	Nano Electronic Devices	Total Lectures: 40
		3-0-0-3

Objective: In this course modeling aspects of Nano electronic devices are discussed from perspective of circuit applications.

Prerequisite: Electronic Devices and Circuits

3.	**Shrink-down approaches:** Introduction, CMOS Scaling, short channel effects	[2]
4.	**Nano Scale Devices:** The nanoscale MOSFET, Fin FETs, Vertical MOSFETs, limits to scaling, system integration limits (interconnect issues etc.), Resonant Tunneling Transistors.	[10]
5.	**Atoms-up approaches:** Molecular electronics involving single molecules as electronic devices, transport in molecular structures, molecular systems as alternatives to conventional electronics (advantages and limitations), Materials for nanoelectronics, nanostructures.	[8]
6.	**Nano-Fabrication and Characterization:** Photolithography, Electron beam Lithography, Advanced Nano-Lithography, Thin-Film Technology, MBE, CVD, PECVD, Atomic Force Microscope, Electron Microscopy (TEM, SEM), Photon Spectroscopy	[10]
7.	**Carbon nanotube electronics & Printed Electronics:** band structure & transport, Overview of Flexible/Printed Electronics: OLEDs, OFETs, Organic Solar Cells, spintronics devices.	[10]

Outcomes: Once the student has successfully completed this course, he/she will be able to answer the following questions or perform following activities:

1. Able to explain the basic concepts of Nano scale devices
2. Able to describe different nano fabrication technologies like lithography, photo lithography etc.

Text Books:

1. Introduction to Nanotechnology, C.P. Poole Jr., F.J. Owens, Wiley (2003), C.P. Poole Jr., F.J. Owens, Wiley (2003).
2. Nano electronics and Information Technology (Advanced Electronic Materials and Novel Devices), Waser Ranier ,Wiley-VCH,2003 .

References:

1. Fundamentals of nano electronics by George W Hanson Pearson publications, India 2008

EC 19.423 **Embedded and Real Time Operating Systems** **Total Lectures: 40**

3-0-0-3

Objective:
1. To provide broad understanding of the requirements of Real Time Operating Systems.
2. To make the student understand, applications of these Real Time features using case studies.

Prerequisite: Computer Organization

1.	**Introduction:** Introduction to UNIX/LINUX, Overview of Commands, File I/O, (open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec).	[5]
2.	**Real Time Operating Systems**: Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use	[10]
3.	**Objects, Services and I/O**: Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem	[10]
4.	**Exceptions, Interrupts and Timers**: Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.	[10]
5.	**Case Studies of RTOS**: RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, and Tiny OS.	[5]

Outcomes:
1. Be able to explain real-time concepts such as preemptive multitasking, task priorities, priority inversions, mutual exclusion, context switching, and synchronization, interrupt latency and response time, and semaphores.
2. Able describe how a real-time operating system kernel is implemented.
3. Explain how the real-time operating system implements time management.

Text Books:
1. Qing Li, Real Time Concepts for Embedded Systems, Elsevier, 2011.
2. Rajkamal, Embedded Systems- Architecture, Programming and Design, 2007, TMH.

References:
1. Sri ram V Iyer, Pankaj Gupta, Embedded real time systems programming, TMH, 2004.
2. frank Vahid, Tony D. Givargis, Embedded system design- A unified hardware/software introduction, John Willey, 2002.

EC 19.424 **Advanced Embedded Systems** **Total Lectures: 40**

3-0-0-3

Objective:
1. To teach the Fundamentals on design attributes of functional units of a Processor
2. To discuss on Hardware software partitioning in system design
3. To teach intra & Inter processor Communications
4. To discuss strategies for processor Communications

Prerequisite: Microprocessor Programming and Interfacing

1.	**Introduction to Embedded Hardware and Software:** Terminology – Gates – Timing diagram – Memory – Microprocessor buses – Direct memory access – Interrupts – Built interrupts – Interrupts basis – Shared data problems – Interrupt latency - Embedded system evolution trends – Interrupt routines in an RTOS environment.	[8]
2.	**System Modelling with Hardware/Software Partitioning:** Embedded systems, Hardware/Software Co-Design, Co-Design for System Specification and modelling- Single-processor Architectures	[6]
3.	**Memory:** Memory write ability and storage performance – Memory types – composing memory – Advance RAM interfacing communication basic –	[8]
4.	**Microprocessor interfacing**: I/O addressing – Interrupts – Direct memory access – Arbitration multilevel bus architecture – Serial protocol – Parallel protocols – Wireless protocols – Digital camera example.	[8]
5.	**Concurrent Process Models and Hardware Software Co-Design:** Modes of operation – Finite state machines – Models – HCFSL and state charts language – state machine models – Concurrent process model – Concurrent process – Communication among process –Synchronization among process – Implementation – Data Flow model. Design technology – Automation synthesis – Hardware software co-simulation – IP cores – Design Process Model.	[10]

Outcomes: After completing this module, students will be expected to be able to:
1. Implement a RTOS based embedded system and uunderstand the embedded systems design process.
2. Define a specification for an embedded system.
3. Design an embedded system based on a specification.

Text Books:
1. David. E. Simon, An Embedded Software Primer, Pearson Education, 2001.
2. Frank Vahid and Tony Gwargie, Embedded System Design, John Wiley & sons, 2002.

References:
1. Tammy Noergaard, Embedded System Architecture, A comprehensive Guide for Engineers and Programmers, Elsevier, 2006
2. Raj Kamal, Embedded Systems- Architecture, Programming and Design, Tata McGraw Hill, 2006.

EC 19.425 **ASIC Design** **Total Lectures: 40**

3-0-0-3

Objective: The educational objectives of the ASIC design course are:

1. Graduates who desire to pursue an engineering career in VLSI Design arena will be widely employed in positions they find appropriate and desirable.
2. Graduates who desire to pursue higher degrees will be successful in gaining admission and advancing in programs they find appropriate and desirable

Prerequisite: VLSI Design

1.	**Introduction to ASICs:** Types of ASICs, Design flow, CAD tools used in ASIC design.	[6]
2.	**CMOS logic cells:** Combinational logic cells, Sequential Logic cells, Data path Logic cells, I/O cells, Cell compilers.	[8]
3.	**ASIC Library Design:** Transistor as resistors, Transistor as parasitic capacitance, Logic Effort, library cell design, library architecture.	[8]
4.	**Gate Design**: Gate array cell design, standard cell design, data path cell design.	[6]
5.	**Programmable ASICs:** Antifuse, Static RAM, EPROM, EEPROM technology, Practical issues. DC output, AC output, DC input, AC input, Clock input, Power input, Xilinx I/O Block, Actel ACT routing resources, Elmore's constant.	[12]

Outcomes:

1. Ability to apply in-depth knowledge of VLSI design principles, systems, and devices to the solution of real time problems.
2. Ability to design and evaluate a component or system to meet desired needs within the field of VLSI design.
3. Ability to function as a member of a multidisciplinary team in the solution of engineering problems such as providing CAD solution for device fabrications.

Text Books:

1. Michael John Sebastin Smith, Application - Specific Integrated Circuits – Pearson Education, 6th Ed., 2009.
2. Farzad Nekoogar and Faranak Nekoogar, From ASICs to SOCs: A Practical Approach, Prentice Hall PTR, 2003.

References:

1. S. D. Brown, R. J. Francis, J. Rox, Z. G. Uranesic, Field Programmable Gate Arrays, Kluwer Academic Publishers, 1992.
2. Andrew Brown, VLSI Circuits and Systems in Silicon, McGraw Hill, 1991.

EC 19.431 **Transform Techniques** **Total Lectures: 40**

3-0-0-3

Objective:
1. To provide broad understanding of the Transforms.
2. To make the student understand, applications of Continuous and Discrete wavelet transforms

Prerequisite: Signal Processing and Applications

1.	**Transforms:** Walsh, Hadamard, Haar and Slant Transforms, DCT, DST, KLT,– definition, properties and applications	[10]
2.	**Continuous Wavelet Transform (CWT):** Short comings of STFT, Need for wavelets, Wavelet Basis Concept of Scale and its relation with frequency, Continuous time wavelet Transform Equation- Series Expansion using Wavelets- CWT- Tiling of time scale plane for CWT.	[8]
3.	**Multi Rate Analysis:** Need for Scaling function – Multi Resolution Analysis, Two-Channel Filter Banks, Perfect Reconstruction Condition, Relationship between Filter Banks and Wavelet Basis.	[8]
4.	**Discrete Wavelet Transform (DWT):** DWT, Structure of DWT Filter Banks, Daubechies Wavelet Function, Applications of DWT.	[8]
5.	**Special Topics:** Wavelet Packet Transform, Multidimensional Wavelets, Bi-orthogonal basis- BSplines, Lifting Scheme of Wavelet Generation, Multi Wavelets	[6]

Outcomes: Ability to apply in-depth knowledge of Transforms and wavelets to the solution of real time problems.

Text Books:
1. Raghuveer M. Rao and Ajit S. Bopardikar, Wavelet Transforms-Introduction theory and applications, Pearson Education, Asia, New Delhi, 2003.
2. Soman. K. P, Ramachandran. K.I, Insight into Wavelets from Theory to practice, Prentice Hall India, First Edition, 2004.

References:
1. C. Sydney Burrus, Introduction to Wavelets and Wavelet Transforms, PHI, 1st Edition, 1997.
2. Stephen G. Mallat, A Wavelet Tour of Signal Processing, Academic Press, 2nd Edition, 2006.

EC 19.432 **Digital Image Processing** **Total Lectures: 40**

3-0-0-3

Objective:
1. To provide broad understanding of the Transforms.
2. To make the student understand, applications of Continuous and Discrete wavelet transforms

Prerequisite: Signal Processing and Applications

1.	**Introduction Digital Image processing:** Origin, fundamental steps, Component of Image processing system, Fundamental of digital image: visual perception, Image sensing and acquisition, sampling and quantization, Some Basic Relationships between Pixels Mathematical tools used in image processing.	[6]
2.	**Image Transforms:** Two-dimensional orthogonal & unitary transforms, Properties of unitary transforms, two dimensional discrete Fourier transform, discrete cosine transform, sine transform, Hadamard transform, Haar transform, Slant transform, KL transform	[7]
3.	**Image Enhancement:** Image Enhancement in Spatial domain, Some Basic Gray Level Transformations, Histogram Processing, Enhancement Using Arithmetic/Logic Operations, Basics of Spatial Filtering, Smoothing Spatial Filters, Sharpening Spatial Filters, Image Enhancement in the Frequency Domain, Smoothing Frequency-Domain Filters, Sharpening Frequency Domain Filters, Homomorphic Filtering.	[10]
4.	**Image Restoration:** A Model of the Image Degradation/Restoration Process, Noise Models, Restoration in the Presence of Noise Only-Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Function, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering, Constrained Least Squares Filtering, Geometric Mean Filter, Geometric Transformations.	[10]
5.	**Color Image Processing:** Color Fundamentals, Color Models, Pseudocolor Image Processing, Basics of Full-Color Image Processing, Color Transformations, Smoothing and Sharpening.	[7]

Outcomes:
1. Be able to explain several image enhancement techniques in spatial domain and frequency domain.
2. Able describe noise models and filtering techniques.

Text Books:
1. Digital Image Processing - Rafael C. Gonzalez and Richard E. Woods, 2 Edition, Pearson Education, 2001.
2. Fundamentals of Digital Image Processing - Anil K. Jain, Pearson Education, PHI, 2001

References:
1. Chanda and D. Dutta Majumdar "Digital Image Processing and Analysis", PHI, 2003

EC 19.433 **Adaptive Signal Processing** **Total Lectures: 40**

3-0-0-3

Objective:
1. This course treats adaptive signal processing algorithms for extracting relevant information from noisy signals.
2. The emphasis is on recursive, model based estimation methods for time-varying systems.

Prerequisite: Signal Processing and Applications

1.	**Introduction:** Definition and characteristics, general properties open and closed loop adaptation.	[1]
2.	**Adaptive Linear Combiner:** General description, input signal and Weight vectors, desired response and error performance function, gradient and minimum mean square. Theory of Adaptation with Stationary Signals: Input correlation matrix, Eigenvalues and eigenvectors of the correlation matrix, and their geometrical significance. Basic ideas of gradient search methods, gradient search by Newton's method and method of steepest descent, gradient component estimation by derivative measurement, effects of gradient noise, on weight vector solution, excess MSE, time constant and misadjustment, performance comparison of Newton and S.D. methods.	[12]
3.	**Adaptive Algorithms:** Least mean square algorithm, convergence, learning curve noise in Weight vector misadjustment and performances of LMS algorithms, sequential regression algorithm, adaptive recursive LMS algorithm, random search algorithm.	[10]
4.	**Recursive Least Square Algorithm:** Preliminaries, matrix inversion lemma, exponentially weighted RLS algorithm, update recursion for the sum of weighted error squares, convergence analysis of RLS algorithm	[8]
5.	**Adaptive Filter Structures:** Lattice structures, all poles and all zeroes versions, adaptive lattice predictor. Lattice LMS algorithms, and lattice SER algorithms, adaptive filters with orthogonal signals, DFT and lattice preprocessors	[9]

Outcomes:
1. Design and apply optimal minimum mean square estimators and in particular linear estimators. To understand and compute their expected performance and verify it.
2. Design, implement and apply Wiener filters (FIR, non-causal, causal) and evaluate their performance.
3. Design, implement and apply LMS, RLS, and Kalman filters to given applications.

Text Books:
1. Widrow and Stearns, Adaptive Signal Processing, Pearson Education, 1999.
2. Simon Haykin, Adaptive Filter Theory, Pearson Education, 2008.

References:
1. Cowan & Grant, Adaptive Filters, Prentice Hall, 1985.
2. John R. Treichler, Theory and Design of Adaptive Filters, PHI, 1987.

EC 19.434 **Speech Processing** **Total Lectures: 40**

3-0-0-3

Objective:
1. This course treats speech processing algorithms for extracting relevant information from noisy signals.
2. The emphasis is on Linear Predictive Coding, Homomorphic Speech Processing

Prerequisite: Signal Processing and Applications

1.	**Fundamentals of Digital Speech Processing:** Anatomy & Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulatory Phonetics, The Acoustic Theory of Speech Production- Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals.	[8]
2.	**Time Domain Models for Speech Processing:** Introduction- Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.	[10]
3.	**Linear Predictive Coding (LPC) Analysis:** Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, Comparison between the Methods of Solution of the LPC Analysis Equations, Applications of LPC Parameters: Pitch Detection using LPC Parameters, Formant Analysis using LPC Parameters.	[10]
4.	**Homomorphic Speech Processing:** Introduction, Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, The Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, The Homomorphic Vocoder.	[7]
5.	**Speech Enhancement:** Nature of interfering sounds, Speech enhancement techniques: Single Microphone Approach: spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter, Multi microphone Approach.	[5]

Outcomes:
1. Design and apply optimal Linear Predictive Coding. To understand and compute their expected performance and verify it.
2. Design, implement and apply Speech Enhancement techniques and evaluate their performance.

Text Books:
1. L. R. Rabiner and S. W. Schafer, Digital Processing of Speech Signals, Pearson Education.
2. Douglas O'Shaughnessy, Speech Communications: Human & Machine, 2nd Edition, Wiley India, 2000.

References:
1. Thomas F. Quateri, Discrete Time Speech Signal Processing: Principles and Practice, 1st Edition, PE.
2. Ben Gold & Nelson Morgan, Speech & Audio Signal Processing, 1st Edition, Wiley.

EC 19.435 **Digital Signal Processors and Architecture** **Total Lectures: 40**

3-0-0-3

Objective: To give an exposure to the various fixed point & a floating point DSP architectures and to develop applications using these processors

Prerequisite: Signal Processing and Applications

1.	**Introduction to Digital Signal Processing:** Introduction, A Digital signal Processing System, The sampling process, Discrete time sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), Linear time invariant systems, Digital filters, Decimation and interpolation, Analysis and Design tool for DSP systems -MATLAB	[8]
2.	**Computational Accuracy in DSP Implementations:** Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of error in DSP implementations, A / D Conversion errors, DSP Computational errors, D/A Conversion Errors, Compensating filter.	[8]
3.	**Architectures for Programmable DSP Devices and Pipelining:** Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External interfacing. Execution Control and Pipelining: Hardware looping, Interrupts, stacks, Relative branch support, Pipelining and Performance, Pipeline depth, interlocking, branching effects, Interrupt effects, Pipeline Programming models.	[12]
4.	**Programmable Digital Signal Processors:** Commercial Digital signal -Processing Devices, Data Addressing modes of TMS320C54XX DSPs, Data Addressing modes of TMS320C54XX Processors, Memory Space of TMS320C54XX Processors, Program Control, TMS320C54XX instructions and programming, On -Chip Peripherals, Interrupts of TM320C54XX Processors, Pipeline Operation of TM320C54XX Processors.	[6]
5.	**Interfacing Memory and I/O Peripherals to Programmable DSP Devices:** Memory space organization, External bus interfacing signals, Memory Interface, Parallel I/O interface, Programmed I/O Interupts and I/O, Direct memory access (DMA), A Multichannel buffered serial port (McBSP), McBSP Programming, a CODEC interface circuit, CODEC programming, A CODEC DSP interface example.	[6]

Outcomes: By the end of the course the student will be able to:

1. Recognize the fundamentals of fixed and floating point architectures of various DSPs.
2. Learn the architecture details and instruction sets of fixed and floating point DSPs
3. Infer about the control instructions, interrupts, and pipeline operations.

Text Books:

1. Avtar Singh and S. Srinivasan, Digital Signal Processing, Thomson Publications, 2004.
2. B. Venkata Ramani and M. Bhaskar, Digital Signal Processors, Architecture, Programming and Applications, TMH, 2004.

References:

1. Sen M. Kuo & Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, 2004.
2. Lapsleyet, DSP Processor Fundamentals, Architectures & Features, S. Chand & Co., 2000.

EC-19. 308 **Antenna and Wave Propagation** **Total Lectures: 40**
3-0-0-3

Objective: To impart knowledge on basics of antenna theory and to analyze and design a start of art antenna for wireless communications and RADAR.

Pre-requisite: Principles of Electromagnetics

1. **Introduction**: Basic properties of transmitting, and receiving antenna, gain, bandwidth, and polarization, Effective aperture and Friss transmission formula. [4]

2. **Physical Concept of Radiation:** Retarded potentials hertzian dipole, antenna parameters, radiation pattern, gain, directivity, effective aperture, reciprocity and radiation from dipoles of arbitrary length. [6]

3. **Theory of Array Antenna: A**rrays of point sources, Endfire and Broadside arrays, Log-periodic, Yagi-uda arrays, Analysis of Rhombic antenna. Design of Rhombic Antennas, Loop Antenna: Radiation from small loop and its radiation resistance. Helical antenna: Normal and axial mode operation. synthesis of antenna arrays using Schelkunoff polynomial method, Woodward-Lawson method. [10]

4. **Frequency Independent Antenna:** Slot, horn antenna, parabolic antenna, aperture antennas and microstrip antenna: Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas. [8]

5. **Wave Propagation:** Propagation in free space. Propagation around the earth, surface wave propagation, structure of the ionosphere, Sky wave propagation- propagation of plane waves in ionized medium, Determination of critical frequency, MUF. Fading, troposphere propagation, Super refraction, antenna for aeronautical mobile systems, cell-site and mobile antenna, adaptive antennas. [12]

Outcomes: After completion of the course, students will be able to

1. Select the appropriate portion of electromagnetic theory and its application to antennas.
2. Distinguish the receiving antennas from transmitting antennas, analyze and justify their characteristics.
3. Assess the need for antenna arrays and mathematically analyze the types of antenna arrays.
4. Distinguish primary from secondary antennas and analyze their characteristics by applying optics and acoustics principles.
5. Outline the factors involved in the propagation of radio waves using practical antennas.

Text Books:

1. C. A. Balanis, Antenna Theory and Design, John Wiley & Sons, 3rd Ed, 2005.
2. W. L. Stutzman, and G. A. Thiele, Antenna Theory and Design, John Wiley & Sons, 2nd Ed, 1998.

Reference Books:

1. R. E. Collin, Antennas and Radio Wave Propagation, Tata McGraw-Hill, 5th Edition, 2017.
2. K.D. Prasad, Antenna and Wave Propagation, Satya Prakashan, 3rd Edition, 2003

EC-19.301 **Microprocessor and Microcontroller** **Total Lectures: 40**
3-0-0-3

Objective: To develop an in-depth understanding of the operation of microprocessors and microcontrollers, machine language programming & interfacing techniques.

Pre-requisite: Digital electronics

1. **The 8086 Microprocessor Architecture :** Architecture, details of sub-blocks such as EU, BIU; memory segmentation and physical address computations, pin diagram and description of various signals, minimum and maximum mode of operations, supporting chips viz. 8284, 8288 and memory mapping [8]

2. **Programming of 8086:** Addressing modes of 8086, instruction set of 8086, assembly language programming, counters and time delays, stack structure of 8086 and subroutine. [7]

3. **Interfacing of 8085 / 8086 with Programmable Chips:** Interfacing of 8255 Programmable peripheral interface, 8251 USART, 8253/8254 Programmable Interval Timer and Direct Memory Access Controller 8237/8257 DMA, 8259 Programmable Interrupt Controller. [8]

4. **Introduction to Microcontrollers, Architecture and Memory Interfacing:** Overview of the 8051 family, 8051 Microcontroller's Architecture, Pin configuration, Common memory types and Tradeoffs, External Memory interfacing. [7]

5. **Programming and Interfacing of 8051:** Addressing modes of 8051, instruction set of 8051, assembly language programming of 8051, stack structure of 8085, delays, and subroutines, Applications of interrupts, timer/counter and serial port, Components of Integrated Development Environment for software development, Interfacing of 8051 with sensors, Keyboard, ADC, DAC, LCD, Stepper Motor and D.C motor [10]

Outcomes: Upon completion of this course, the student will be able to:

1. The student will learn the internal organization of some popular microprocessors and microcontrollers.
2. The student will learn hardware and software interaction and integration and memory.

Text Books:

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and Application with the 8085, Penram International Publishing, 6th Edition, 2013.
2. M. A. Mazidi, The 8051 Microcontroller & Embedded Systems, Pearson Education, 2nd Edition, 2006.

Reference Books:

1. I. Scott McKenzie and Raphael C.W. Phan, The 8051 Microcontroller, Pearson Education, 4th Edition, 2007.
2. D. V. Hall, Microprocessors and Interfacings; TMH, 3rd Edition, 2012.

EC-19.302 **VLSI Design** **Total Lectures: 40**

3-0-0-3

Objective:
1. Graduates who desire to pursue an engineering career in VLSI Design arena will be widely employed in positions they find appropriate and desirable.
2. G Graduates who desire to pursue higher degrees will be successful in gaining mission and advancing in programs they find appropriate and desirable.

Pre-requisites: Electronics Devices and Circuits, Digital Electronics.

1. **Basic VLSI Design Issues:** IC design techniques- hierarchical design, design abstraction and computer-aided design [4]

2. **MOS Transistor Theory:** Current-voltage characteristics of MOSFETS, threshold voltage and body effect, MOSFET design equations, second order effects, MOSFET capacitances [8]

3. **NMOS and CMOS Inverter:** NMOS and CMOS inverters, W/L ratio for NMOS and CMOS inverters, β_n/β_p ratio, noise margin, NMOS and CMOS Voltage transfer Characteristics, CMOS delay and power dissipation [8]

4. **MOS Inverter's Switching Characteristics:** Calculation of delay times, Inverter design with delay constraints [6]

5. **Stick Diagram & VLSI Circuit Design Techniques:** Stick diagrams, CMOS design style, design rules: lambda based design rules, layout design, Inverter equivalent of series and parallel MOS circuits, logic design with delay and power constraints, worst case design, complex logic design [14]

Outcomes:
1. Ability to apply knowledge of mathematics, basic science, and engineering to solve problems encompassing fundamental areas of VLSI design.
2. Ability to apply in-depth knowledge of VLSI design principles, systems, and devices to the solution of real time problems.
3. Ability to design and evaluate a component or system to meet desired needs within the field of VLSI design.

Text Books:
1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, PHI, 3rd Edition, 2011.
2. Neil H.E. Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 4th Edition, 2011.

Reference Books:
1. Jab M. Rabaey, Anantha Chandra Kasan, Borivoje Nikolic, Digital Integrated Circuits - A Design Perspective, PHI, 2nd Edition, 2012.
2. Michal John Sebastian Smith, Application-Specific Integrated Circuits, Pearson Education, 6th Edition, 2009.

EC-19.303 **Principles of Analog Communication** **Total Lectures: 40**
3-0-0-3

Objective:
1. To develop a fundamental understanding on communication systems with emphasis on analog modulation techniques.
2. To appreciate the mathematical concepts that form the foundations of analog communication

Pre-requisite: Signals and Systems, Statistics and Probability Theory

1. **Linear Modulation Techniques:** Basic blocks of communication systems, Review of signals and systems, Linear Modulation, Time domain and frequency domain description of AM (DSB-FC), DSB-SC, SSB and VSB signals. Generation and detection of linear modulation techniques, Super-heterodyne receivers and design. [12]
2. **Angular Modulation Techniques:** Basic concepts, Frequency Modulation Spectrum Analysis of FM Wave, Generation and detection of narrow band and wide band frequency modulation, Phase modulation, FM detection techniques-phase locked loops, Commercial broadcasting systems. [8]
3. **Sources of Noise and their characterization:** Random Variables, Random process and their characterization. Noise in Analog communication System. SNR calculations for synchronous detection of DSB and SSB and envelope detection of AM, SNR calculations for angle modulation system. Pre-emphasis and de-emphasis. Threshold effect in angle modulation. [8]
4. **Multiplexing and Multiple Access Techniques:** Frequency division Multiplexing, time division multiplexing, multiple access techniques. [5]
5. **Sampling and Pulse Modulation:** Sampling theorem – ideal and natural sampling and reconstruction, Pulse-Amplitude Modulation, Pulse-Time Modulation. [7]

Outcome: Upon completion of this course, the student will be able to:
1. Apply the basic knowledge of signals and systems and understand the basics of communication system and analog modulation techniques.
2. Evaluate the communication system performance in the presence of noise and summarize the merits and demerits of all the conventional analog modulation system.

Text Books:
1. B P Lathi, Zhi Ding, Modern Digital and Analog Communication Systems, Oxford university press, 4th Edition, 2009.
2. Taub and Schilling, Principles of Communication Systems, TMH, 4th Edition, 2013.

Reference Books:
1. Kennedy, Davis, Electronic Communication Systems , TMH, 6th Edition, 2017.
2. S. Haykins, Communication Systems , Wiley , 5th Edition, 2009.

EC-19.304 **Advance Radio Access Network (ARAN)** **Total Lectures: 40**
3-0-0-3

Objective: To acquire skills on different legacy and advance RAN's Architecture, Design & Optimization along with latest industries concepts on 5G, IOT, Volte, RAN Cloud etc.

Prerequisite: Digital Modulation Techniques & Data Transmission, Antenna and Wave Propagation, Basics of Mobile Communication

1. **Basics of Mobile Communication:** Microwave Theory, Propagation Models, Modulation Theory, Antenna Theory [4]

2. **Introduction to RAN:** Telecom E2E approach, RAN Life Cycle**,** RF basics,. Latest Industry Concepts – 5G, IOT, Volte, RAN Cloud [4]

3. **RAN Overview**: Introduction to Cellular Concepts, Introduction to Power Control, Introduction to Protocol Stacks, GSM, WCDMA, LTE (Overview, Architecture, Air Interface), Generalized Call Flows [12]

4. **RAN Design:** RF Design Overview, Initial Radio Network Design (Link Budget, Radio Network Dimensioning & Nominal Design), Final Radio Network Design, Radio Planning Tools & IBS Introduction, Radio Propagation Model Tuning, LRAN Initial Radio Network Design (Sample Report) [10]

5. **RAN Optimization:** Pre Launch Optimization (Process Overview, Introduction to Drive Testing (Data Collection Methodology, Data Post Processing),Post Launch Optimization, (Process Overview, Introduction to Counters and OSS, KPI Improvement Methodology) [10]

Outcome: After completion of this course, students would be able to

- Understand the industry level ways of working of RAN with different design and optimization techniques.
- Students will get heads up in terms of upcoming advance technology concepts.

Text Books:

1. Ericsson Academy (Ericsson Internal)
   - Air Interface
   - Protocol and Procedures
   - GSM, UMTS, LTE Fundamentals
   - RAN Design & Performance Management.
2. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2007.

Reference Books:

1. John G. Prokis and Masoud Salehi, Digital Communication, McGraw-Hill, 5th Edition, 2008.
2. J. Schiller, Mobile communications, Pearson, 2nd Edition, 2004.

EC-19.305 **Signal Processing and Applications** **Total Lectures: 40**
3–1–0-4

Objective:

- To understand the fundamental characteristics of continuous- and discrete-time signals and systems in terms of both the time and transform domains and to develop the mathematical skills to solve problems involving convolution and sampling.

Pre-requisite: Mathematics I

1. **Representation and classification of Signals**: Signal classification - Continuous and discrete time, Periodic - aperiodic, even - odd, energy - power, Deterministic - random, real valued - complex exponential, sinusoidal, time scaling, time shifting, Sampling and discrete time processing of continuous-time signals, Concept of frequency in continuous-time and discrete-time signals. [6]
2. **Basics of Systems and Transformation**: Properties of systems – linearity, time invariant, causal, stable, inverse, static and dynamic, system impulse response, convolution, correlation, Transformation - Fourier series, continuous time and discrete time Fourier transform, Laplace transform, z-transform, its properties, limitations and inverse transforms, pole – zero concept, computation of impulse response and transfer function using transforms. [6]
3. **Analysis of Continuous time and discrete time systems:** Block diagram representation, linear time-invariant (LTI) systems, interconnection of LTI Systems, discrete time systems and their types, systems with finite and infinite duration impulse response, recursive and non-recursive structures, system realizations in direct , transpose, cascade and parallel forms. [8]
4. **DFT, FFT and DCT Algorithms:** Discrete Fourier transform (DFT), linear convolution using DFT, efficient computation of the DFT - Fast Fourier transform (FFT) algorithms, radix-2 & 4 FFT algorithms, discrete cosine transform (DCT) - DCT-1 and DCT-2, energy compaction property of DCT. [10]
5. **Digital Filter Design:** Review of analog filters – comb and notch types, Design of infinite Impulse Response (IIR) filter from analog filters - Bilinear and Impulse invariant transformation, Finite Impulse Response (FIR) filter - amplitude & phase responses, linear phase filters, transversal filters, windowing techniques, comparison between IIR and FIR filters. [10]

Outcome: After completion of the course, students will be able to

- Understand the process of sampling and spectral characteristics of periodic and aperiodic signals using Fourier analysis and determine the response of LTI system using Fourier analysis convolution.

Text Books:

1. A.V. Oppenheim, A.S. Willsky and S.H. Nawab, Signals and Systems, PHI, 2nd Edition, 1997.
2. S. K. Mitra, Digital Signal Processing A Computer Based Approach, Tata McGraw-Hill, 4th Edition, 2013.

Reference Books:

1. Michel J. Robert, Fundamentals of Signals and Systems, MGH International Edition, 2008.
2. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, Pearson Education, 4th Edition, 2012.

EC-19.306 **Digital Communication** **Total Lectures: 40**

3-0-0-3

Objective: The objective of this course is to introduce the students to the basic concepts of digital communication. The aim of this course is to study the fundamental aspects of digital communication systems. The understanding of the fundamentals of digital communication by studying theory, numerical and implementation of circuits.

Pre-requisite: Basics of Communication Systems and Techniques.

1. **Model of a Communication System:** Introduction, advantages of digital communication over analog communication, probability theory random process and random variables. **[6]**

2. **Digital Communication Techniques:** Sampling theorem and techniques, uniform and non-uniform quantization techniques, PCM, DPCM, DM, and ADM, compression standards **[8]**

3. **Multiplexing:** time division multiplexing and synchronization, Digital multiplexing hierarchy, Electrical representation of binary sequences Bandwidth requirement of PCM. **[2]**

4. **Information Theory and Coding:** Channel capacity, Shannon capacity, source entropy, Shannon-Fano, Huffman coding, linear block codes and syndrome decoding, cyclic codes, BCH codes, convolution, Viterbi coding and decoding. **[10]**

5. **Digital Modulation Techniques:** Base-band transmission, inter-symbol interference and adaptive equalization, digital modulation and demodulation techniques, bandwidth consideration of different digital modulation schemes, matched filter and probability of error analysis, carrier and timing recovery techniques. **[14]**

Outcome: After completion of the course, students will be able to

1. The students can understand the concepts of digital communication.
2. They acquire and apply the knowledge to implement the concepts for designing an efficient communication system.
3. They become able to identify, analyse and implement new ideas in digital communication systems for proposing alternate solutions.

Text Books:

1. B. P. Lathi, Modern Digital and Analog communication Systems, Oxford University Press, 4th Edition, 2018.
2. Taub and Schilling, Principles of Communication Systems, TMH, 4th Edition, 2013.

Reference Books:

1. Kennedy, Davis, Electronic Communication Systems , TMH, 6th Edition, 2017.
2. S. Haykins, Communication Systems , Wiley , 5th Edition, 2009.

EC-19.307 **Microwave Engineering** **Total Lectures: 40**
3-0-0-3

Objective: To acquire fundamental knowledge of Microwave and apply in engineering applications.

Pre-requisite: Electromagnetic Field Theory

1. **Introduction:** Microwaves, Generation: Brief idea of microwave tubes and microwave solid state devices, properties and applications. [3]

2. **Microwave Circuits:** Equivalent voltage and current definition in waveguides, concept of impedance, impedance matrix, admittance matrix, scattering matrix and transmission matrix**.** [7]

3. **Microwave Passive Devices:** Excitation of waveguides through probes, loops and apertures. Terminations: matched loads and short, attenuators, phase shifters, two hole directional coupler, E-plane tee, H-plane tee, magic tee, microwave propagation in ferrites, isolators and circulators. [10]

4. **Microwave Active Devices:** Reflex Klystron, Two cavity Klystron, Travelling Wave Tubes, Magnetrons, Gyrotron, construction, operation and practical applications of Gunn diode, Tunnel diode and IMPATT diode**.** [14]

5. **Microwave Measurements:** Detection of microwaves, measurement of microwave power, impedance, frequency, VSWR, Q-factor and scattering parameters. [6]

Outcome: After completion of the course, students would be able to apply microwave concepts and equations in engineering and solve voltage and current equations.

Text Books:

1. David M. Pozar, Microwave Engineering, John Willey & sons, 3rd Edition, 2005.
2. Samuel Y. Liao, Microwave devices and Circuits, Pearson Education, 3rd Edition, 2008.

Reference Books:

1. Annapurna Das & Sisir K Das, Microwave Engineering, Tata McGraw-Hill, 3rd Edition, 2014.
2. M. L. Sisodia and G. S. Raghuvanshi, Microwave Circuits and Passive Devices, New Age Publication, 1st Edition, 2017.

EE 19. 303 **Control System Engineering** **Total Lectures: 40**

3-0-0-3

Objective: The student gains the knowledge of the fundamental principles of analog and digital control system engineering, time response and frequency response analysis with its practical implementation. This course helps in understanding the design of Compensator and PID controller for the Automatic control of Industry.

Pre-requisite: Mathematics, Network Analysis & Synthesis

1. **Introduction:** Industrial control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of feedback. [8]

2. **Reduction Techniques:** Block diagram reduction and signal flow graph representation of systems. [4]

3. **Time Domain Analysis:** Standard test signals, time response of 1st and 2nd order systems for standard test inputs, time domain design specifications i.e. rise time, peak time, delay time, peak overshoot, settling time and steady state error etc., different types of feedback systems, Steady state errors for unit step, unit ramp and unit parabolic inputs. **C**oncept of stability: conditions for stable system, relative and marginal stability, Routh-Hurwitz criterion. Root-Locus technique. Construction of Root-loci. [12]

4. **Frequency Domain Analysis:** Relationship between time and frequency response. Polar plots. Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Introduction to Controller Design: Frequency-domain methods of design. Application of conventional Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers. [12]

5. **State Variables:** Analysis of systems, state vector, state space, advantages of state space techniques, state space representation, State variable analysis and design. [4]

Outcome: At the end of this course, students will demonstrate the ability to

- Understand the concept of stability and its assessment for linear-time invariant systems.
- Design simple feedback controllers.
- Knowledge of stability analysis and improvement of stability for control system.
- Benefit the graduates who wish to work in core sector industry as most of the core sector is state-of-art control.

Text Books:

1. K. Ogata, "Modern Control Engineering," Pearson Education/Prentice Hall of India, 4th Edition, 2003.
2. I. J. Nagrath and M. Gopal, "Control System Engineering," New Age International Publishers, 2nd Edition, 2003.

Reference Books:

1. Syed Hasan Saeed, "Automatic Control Systems (with MATLAB Programs)," S.K. Kataria & Sons Publishers, 6th Edition, 2008.
2. Samarjit Ghosh, "Control Systems: Theory and Applications," Pearson Education, 2nd Edition, 2012.

EE 19.203 **Network Analysis & Synthesis** **Total Lectures: 40**
3-0-0-3

Objective: This course helps in analysis of A.C & D.C circuits and it also help to design the circuit models for the minor and major projects.

Pre-requisite:

1. **Network Theorems:** Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks. [10]

2. **Solution of First and Second Order Networks:** Solution of first and second order differential equations for Series and parallel R-L, R-C, RL-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer. [8]

3. **Electrical Circuit Analysis Using Laplace Transforms:** Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances. [8]

4. **Two Port Network:** Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks. [6]

5. **Synthesis of Passive Network:** Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [8]

Outcome: At the end of this course, students will demonstrate the ability to

- Apply network theorems for the analysis of electrical circuits.
- Obtain the transient and steady-state response of electrical circuits.
- Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
- Analyse two port circuit behavior.

Text Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.

Reference Books:

1. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
3. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

EE-19.304 **Power Electronics** **Total Lectures: 40**
3-0-0-3

Objective:
- To introduce to students the theory and applications of power electronics systems for high efficiency, renewable and energy saving conversion systems
- To prepare students to know the characteristics of different power electronics switches, drivers and selection of components for different applications
- To develop students with an understanding of the switching behavior and design of power electronics circuits such as DC/DC, AC/DC, DC/AC and AC/AC converters

Prerequisite: Network Analysis and Synthesis, Basics of Electronics Engineering, Engineering Mathematics

1. **Introduction to Power Devices:** Review of power semiconductor devices, SCR, Static and dynamic characteristics, Turn-on and Turn-off methods and circuits, Ratings and protection of SCRs, Series and parallel operation of thyristor, Other members of thyristor family. [8]

2. **Controlled AC to DC Converter:** Principle of phase control, Single phase half wave circuit with different types of loads, Single phase and three phase semi converter and full converter bridge circuits, Single phase dual converters and their operation with circulating and non-circulating currents. [10]

3. **Controlled AC to AC Converter:** AC Voltage Controllers - Types of single-phase voltage controllers, Single phase voltage controller with R and RL type of loads, gate pulse requirements to trigger the SCRs of ac voltage controllers. Cycloconverters - Principles of operation, Single phase to single phase step up and step down cycloconverters. Three phase to single phase cycloconverter. [10]

4. **Controlled DC to DC Converter:** Introduction to dc chopper, Principle of chopper operation, Control strategies, Types of choppers and its operation. [5]

5. **Controlled DC to AC Converter:** Introduction to inverter, Single phase VSI: half bridge and full bridge inverters. Three phase bridge inverters with 180 degree and 120 degree modes of operation, Series and parallel inverters, Introduction to current source inverters. [7]

Outcome:
- The student will be able to understand the principle of operation of commonly employed power electronic converters
- The student will be capable of analyzing non-linear circuits with several power electronic switches
- The student will be equipped to take up advanced courses in Power Electronics and its application areas

Text Books:
1. Rashid, M., "Power Electronics", Prentice Hall of India Private Limited, 4th Edition, 2006.
2. P.S. Bimbhra, "Power Electronics," Khanna publishers, 5th edition, 2012.

Reference Books:
1. Mohan, N., Undel, T.M. and Robbins, W. P., "Power Electronics: Converter Applications and Design," John Wiley and Sons, 3rd Edition, 2007.
2. Jain, A., "Power Electronics and its Applications," Penram International Publishing (India) Pvt. Ltd., 4th Edition, 2008.
3. Dubey, G.K., Doradla, S.R., Joshi, A. and Sinha, R.N.K., "Thyristoried Power Controllers," New Age International (P) Limited, Publishers, 2nd Edition, 2004.

MA 19.201 **Mathematics III** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

Pre-requisite: Mathematics I and Mathematics II

1. **Linear Programming:** Introduction with formulation; Graphical method; Simplex method, Artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method). [12]

2. **Numerical Methods:** Solution of system of equations (Gauss elimination and Gauss -Seidel methods); Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector, Runge-Kutta method of order four). [08]

3. **Complex Analysis:** Function of complex variable, analytic function, Cauchy- Riemann equations(without proof); Integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula(without proof), zeros and singularities of complex functions, residues. [08]

4. **Integral Transform I**: Basics of Laplace transform and inverse Laplace transform; First and Second Shifting theorems; Convolution theorem (without proof); Laplace transform of Unit Step function, Dirac Delta function and periodic function. [06]

5. **Integral Transform II**: Solution of ordinary differential equations with initial conditions by Laplace transforms; Fourier series of periodic functions, even and odd functions, Fourier half-range series; Basics of Fourier transforms with properties. [06]

Outcome: After completion of the course, students would be able to apply the knowledge of linear programming, numerical methods, complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.
3. Jain R.K. and S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 2003.

MA 19.202 **Statistics and Probability Theory** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

Pre-requisite: Mathematics I, Mathematics II, and Mathematics III

1. **Introductory Ideas:** Recapitulation of basics of permutation, combination and probability theory; Law of addition and law of multiplication; Conditional probability; Total probability; Bayes' theorem (with proof)and it's applications. [08]

2. **Random Variables and Distribution:** Discrete and continuous random variables; Types of distributions with basic properties; Probability mass and density functions; Cumulative distribution function; Mean, variance and standard deviation of distributions; Discrete types (Binomial and Poisson) and Continuous types (Normal, Uniform and Exponential); Applications of basic ideas of these distributions. [10]

3. **Sampling and Testing of Hypothesis:** Sampling distribution of mean and variance; Central limit theorem; Simple and Composite hypothesis; Type I and Type II errors with graphical interpretations; Level of significance and tests of significance for large and small samples with applications. [08]

4. **Correlation and Regression:** Simple, partial and multiple correlations; Linear regression with applications. [06]

5. **Queuing Theory and Queuing Models:** Birth and death process; Pure birth and pure death process; Classification of queuing models: $[(M/M/1):(FCFS/\infty/\infty)]$, $[(M/M/1):(SIRO/\infty/\infty)]$, $[(M/M/1):(FCFS/N/\infty)]$, $[(M/M/C):(FCFS/\infty/\infty)]$; Applications of queuing models. [08]

Outcome: After completion of the course, students would be able to apply the knowledge of Statistics and Probability theory in engineering and solve curriculum problems.

Text Books:

5. S.Palaniammal, Probability and Random Processes, PHI, 2013.
6. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH, 2018.
2. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, 2002.
3. Dass and Verma, Higher Engineering Mathematics, S. Chand, 2019.

RM 19.101 **Research Methodology** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): Communication Skills

Objective(s):

- To understand a general definition of research design.
- To identify the overall process of designing a research study from its inception to its report.
- To be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- To understand the primary characteristics of quantitative research and qualitative research.
- To identify a research problem stated in a study

1. **Introduction:** Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research. [6]
2. **Problem Formulation:** Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature, Research Gaps. [10]
3. **Research Design:** Research Framework, Meaning & Significance of Research Designs, Features of a good Research Design, Types of Research Design. [10]
4. **Data Analysis and Simulation Tool:** Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis, SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [12]
5. **Report Writing:** Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [2]

Outcome(s): On successful completion of this course, the students will be able to

- Assess critically the following methods: literature study, case study, structured surveys, interviews, focus groups, participatory approaches, narrative analysis, cost-benefit analysis, scenario methodology and technology foresight.

Text Books:

1. R. Pannershelvam, "Research Methodology" Prentice Hall India, New Delhi, 2nd Edition, 2013.
2. C. R. Kothari, "Research Methodology: Methods and Techniques", New Age International (p) Limited, Publishers New Delhi, 4nd edition, 2018.

Reference Books:

1 William G.Zikmund, "Business Research Methods", Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, "Research Methods for Business Students" Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, "Business Research Methods" Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013

UC 19.201 **Introduction to Management and Leadership** **Total Lectures: 26**
2-0-0-2

Objective: This Course, Management and leadership focus on understanding seminal and contemporary leadership theories and principles. To provide a basis of understanding to the students with reference to the working of the business organization through the process of management.

Pre-requisite:

1. **Introduction to Management :** Nature of Management, Meaning, Definition, it's nature purpose, importance & Functions, Management as Art, Science & Profession-Management as social System Concepts of management-Administration-Organization **[4]**
2. **Evolution of Management Thought:** Contribution of F.W.Taylor, Henri Fayol ,Elton Mayo , Chester Barhard & Peter Drucker to the management thought. Various approaches to management (i.e. Schools of management thought)Indian Management Thought. **[5]**
3. **Functions of Management:** Planning - Meaning - Need & Importance, types levels - advantages & limitations. Organizing - Elements of organizing & processes, Delegation of authority - difficulties in delegation – Decentralization, Staffing - Meaning & Importance, Controlling - Process & Techniques, Coordination - Need – Importance. **[6]**
4. **Introduction to Leadership**: Leadership styles, qualities of a good leader, role of a leader, trait approach to leadership, behaviour approaches to leadership; Situational theories; Transformational Leadership transactional leadership, Neutralizers and substitutes to leadership. **[6]**
5. **Emerging Challenges to Leadership**: Leadership in changing workplace, Leader's role in fostering teamwork, Overcoming traditional thinking Methods to enhance creative problem solving, Climate for creative thinking, Leadership practices for innovation, Ethical leadership development, Cultural sensitivity, intelligence, and global leadership skills. **[5]**

Outcome: On successful completion of the course, students will be able to Work effectively and collaboratively with others in diverse management contexts.

Text Books:

1. Dr. L.M.Parasad, "Principles & practice of management", Sultan Chand & Sons - New Delhi, 2015
2. Stephen P.Robbins "Organizational Behavior" Pearson Publisher,16th Edition, 2014

Reference Books:

1. Principles of Management, By Tripathi, Reddy Tata McGraw Hill, 2012
2. Essential of Business Administration - K.Aswathapa Himalaya Publishing House, 2014
3. Hughes, R., Ginnett, R., & Curphy, G. Leadership: Enhancing the lessons of experience, McGraw Hill, 7th Edition, 2017
4. Northouse, P. G. "Leadership: Theory and Practice" Sage Publications, New Delhi, 7th Edition 2015.

UC 19.202 **Business Environment** **Total Lectures: 26**
2-0-0-2

Objective: To familiarize the students about the background of the spectrum of business and its environment (internal and external).

Pre-requisite: Good General knowledge.

1. **Dimensions of Business Environment**: Nature and characteristics of contemporary business; Types of business environment - general and task environment, Internal (Value system, Organization structure, Human Resource, Company image and brand value, Physical assets) and external Environment (micro and macro), Environmental analysis and strategic Management. [5]
2. **Social Environment**: Concept and salient features of Indian culture and values, Impact of culture on business, Cultural resources, Ethics and social responsibility of business, Consumerism. [5]
3. **Political and legal Environment*:*** Impact of competing political ideologies and role of government, Political Stability and Instability on Business Activities, Legal framework for establishing a business unit in India, Competitive Conditions, Foreign Direct Investment in India. [5]
4. **Economic Environment**: Economic systems – Market, Planned and Mixed economy; Indian economy – overview; Economic reforms in India; Economic policies – Determinants of National Income, Privatization, Fiscal policy and Monetary policy. [6]
5. **Technological Environment:** Features of technology; Impact of technology; Management of technology; status of technology in India; Policy for research and development in India. [5]

Outcome: Understanding real life situations vis-à-vis economic, social, legal, political and technological systems in the country and analyzing the impact of changes on different industries and trends in different sectors of the economy and society.

Text Books:
3. Business Environment, Francis Cherunilam, 1st Edition, 2018.
4. Essentials of Business Environment, K Aswathappa, HPH, 12th Edition, 2014.

Reference Books:
5. Business Environment, BN Ghosh, OUP, 2015
6. Business Environment: Text & Cases (3rd Edition), Justin Paul, McGraw Hill, 2016.
7. Business Environment, AC Fernando, Pearson, 2016

EE 19.101 **Elements of Electrical Engineering** **Total Lectures: 40**
3-1-0-4

Objective: This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

Pre-requisite: Nil

1. **DC Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation using mesh and nodal method. Network Theorems - Superposition, Thevenin, Norton and Maximum power transfer Theorems. Time-domain analysis of first-order RL and RC circuits. [8]

2. **AC Circuits:** Basic terminologies, representation of sinusoidal waveforms, average, rms and peak values of a.c. quantities, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). [8]

3. **Three Phase A.C. Circuits:** Three phase supply, phase sequence, star connection, delta connection, relationship between phase and line quantities in 3-phase circuits, measurements of three phase power under balanced condition. [6]

4. **Transformers:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, Transformer testing: open circuit and short circuit test, losses in transformers, regulation and efficiency. Basics of auto-transformer and three-phase transformer connections. [10]

5. **Electrical Machines:** DC Machines – construction, functions of each part, working principle, EMF and torque equations, types of dc machines. AC machines – classification of a.c. machines, construction, operating principles of ac machines. [8]

Outcome: At the end of this course, students will demonstrate the ability to

- To understand and analyse basic electric and magnetic circuits.
- To study the working principles of electrical machines.

Text Books:

1. Kothari, D. P., and I. J. Nagrath, "Theory and Problems of Basic Electrical Engineering," PHI Learning Pvt. Ltd., 1998.
2. Fitzgerald, Arthur Eugene, David E. Higginbotham, and Arvin Grabel, "Basic electrical engineering," McGraw-Hill Series in Electrical Engineering, Auckland: McGraw-Hill, 1981, 5th ed.(1981).

Reference Books:

1. H.Cotton, "Advanced Electrical Technology," CBS Publication. 1967.
2. Vincent Del Toro, "Electrical Engineering Fundamentals," 2nd Edition PHI Publication. 1972.
3. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", PHI Publication, 1st Edition, 2007.

EE 19.201 **Electrical Machines-I** **Total Lectures: 40**
3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction details and performance of D.C machines and Transformer.

Pre-requisite: Elements of Electrical Engineering

1. **Basic Concepts of Electrical Machines:** Introduction, Electromagnetic induction, flux linkage, statistically and dynamically induced emf, Classification and description of electrical machines, Generator and motor principles, Leakage flux, Losses and efficiency, Rating and loss dissipation, Electrical and mechanical degrees, Heating and cooling of electrical machines. [8]

2. **Introduction to D.C. Machines:** Constructional parts of d.c. machines and their function, Principle of operation, Armature winding: Lap and wave, Simplex and duplex, Method of excitation, Classification, Derivation of emf and torque equations, Process of commutation, Armature reaction, Interpoles, Compensating winding and equalizer rings. [6]

3. **D.C. Generators:** Operating characteristics: Magnetization, Internal and external characteristics, Critical resistance and critical speed, Process of building up of voltage, Causes of failure of voltage build-up and remedies, Parallel operation of d.c. generators, Applications. [7]

4. **D.C. Motors:** Basic equation for voltage, Power, Torque and speed, Condition for maximum power, Operating characteristics: Torque-current, Speed-current and Torque-speed characteristics. Comparison, Starters, Speed control methods, testing of d.c. machines: Swinburne, Hopkinson's and Series field tests. Calculation of efficiency, Applications. [7]

5. **Transformers:** Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses. Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Three-winding transformers. Cooling of transformers. [12]

Outcome: At the end of this course, students will demonstrate the ability to

- Understand the concepts of magnetic circuits.
- Understand the operation of dc machines.
- Analyse the differences in operation of different dc machine configurations.
- Analyse single phase and three phase transformers circuits.

Text Books:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

Reference Books:

1. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
2. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

EE 19.202 **Electrical Machines-II** **Total Lectures: 40**
3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to the working principles, construction and performance of A.C machines and synchronous machines.

Pre-requisite: Electrical Machine-I

1. **Fundamentals of AC Machine Windings:** Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor. [8]
2. **Pulsating and Revolving Magnetic Fields:** Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field. [6]
3. **Induction Machines:** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines. [12]
4. **Single Phase Induction Motors:** Constructional features double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications. [5]
5. **Synchronous Machines:** Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division. [9]

Outcome: At the end of this course, students will demonstrate the ability to

- Understand the concepts of rotating magnetic fields.
- Understand the operation of ac machines.
- Analyse performance characteristics of ac machines.

Text Books:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

Reference Books:

1. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
2. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
4. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons, 2007.

EE 19.203 **Network Analysis and Synthesis** **Total Lectures: 40**
3-0-0-3

Objective: This course helps students in analyzing the A.C & D.C circuits and it also provides design exposure to circuit models for minor and major projects.

Pre-requisite: Elements of Electrical Engineering (EE 19.101)

1. **Network Theorems:** Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation theorem. Analysis with dependent current and voltage sources. Node and Mesh Analysis. Concept of duality and dual networks. [10]
2. **Solution of First and Second Order Networks:** Solution of first and second order differential equations for Series and parallel R-L, R-C, RL-C circuits, initial and final conditions in network elements, forced and free response, time constants, steady state and transient state response. Mutual coupled circuits, Dot Convention in coupled circuits, Ideal Transformer. [8]
3. **Electrical Circuit Analysis Using Laplace Transforms:** Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Transfer function representation. Poles and Zeros. Frequency response (magnitude and phase plots), series and parallel resonances. [8]
4. **Two Port Network:** Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks. [6]
5. **Synthesis of Passive Network:** Hurwitz polynomials, positive real functions, elementary synthesis procedures, properties of LC immittance function, synthesis of LC driving point immittance, properties of RC driving point impedances, synthesis of RC impedances or RL admittances, properties of RL impedances and RC admittances, synthesis of RLC functions. [8]

Outcome: At the end of this course, students will demonstrate the ability to

- Apply network theorems for the analysis of electrical circuits.
- Obtain the transient and steady-state response of electrical circuits.
- Analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
- Analyse two port circuit behaviors.

Text Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.

Reference Books:

1. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
3. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

EE 19.204 **Electrical Measurement and Instrumentation** **Total Lectures: 40**
3-0-0-3

Objective: To make students conversant with concepts of measurement and various electrical and electronics instruments, transducers and bridges.

Pre-requisite: Basic Electrical engineering, Basic Electronics Engineering

1. **Concepts of Measurements:** Introduction, accuracy and precision, repeatability, errors in measurement, sources of errors, types of errors, statistical analysis of measurement data, graphical representation of measurement, data as distributions, Gaussian graph and precision indices. [8]
2. **Analog Instruments:** Types of operating torques in an analog instrument, Moving coil, moving iron, electrodynamic and induction instruments-construction, operation, torque equation and errors. Shunts and multipliers. Applications of instruments for measurement of single-phase power and single-phase energy. Errors in wattmeter and energy meter and their compensation and adjustment. [10]
3. **Bridge:** DC bridges for measurement of resistance Wheatstone bridges, Kelvin's double bridges and AC bridges for measurement of L, R, C & M, Maxwell's bridges, Anderson's bridges, De-Sauty Bridge, Wein bridge. [7]
4. **Transducers:** Introduction , Classification, Selection Criteria, Characteristics, Construction, Working Principles and applications of following Transducers- RTD, Thermocouples, Thermistors, LVDT, Strain Gauges. [7]
5. **Potentiometers and Instrument Transformers:** Crompton's DC and AC polar and coordinate types. Applications, Electronic Multi-meter, Q meter, Vector Impedance meter. Oscilloscope in frequency, phase and amplitude measurements. Instrument transformers. Ratio and Phase angle errors and their reduction. [8]

Outcome: Students will be able to understand electrical and electronic measuring devices and instrumentation like bridges, transducers, CRO etc.

Text Books:

1. J. B. Gupta , "Electrical Measurements and Measuring Instruments", S. K. Kataria & Sons, Reprint Edition, 2012.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements & Instrumentation", Dhanpat Rai and Co., 2005.

Reference Books:

1. Albert D. Helfrick, Wiliam D. Cooper, "Modern Electronic Instrumentation and Measurement Techniques", PHI Learning Private Limited, 2011.
2. Prithwiraj Purkait, Budhaditya Biswas, Santanu Das, Chiranjib Koley, "Electrical and Electronics Measurements And Instrumentatio", McGraw-Hill Education, 1st Edition, 2013.
3. F.W. Golding and Widdis, Electrical Measurements and Measuring Instruments, 5th Edition, 2010.

EE 19.501 **Energy Resources** **Total Lectures: 40**

3-1-0-4

Objective:
- To provide an exposure on various concepts of Non-renewable and renewable energy and also its domestics and industrial applications
- To understand the environmental and economic aspects of renewable energy sources

Prerequisite: Power Plant Engineering

1. **Commercial Energy:** Coal, Oil, Natural Gas, Nuclear power and Hydro – their utilization pattern, future projections of energy consumption, environmental impact of fossil fuels, Energy scenario in India – Growth of energy sector and its planning in India. [8]
2. **Bio Energy:** Biomass resources and their classification, Biomass conversion processes, Thermo chemical conversion - direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, types of biogas Plants, applications, alcohol production from biomass, bio diesel production, Urban waste to energy conversion, Biomass energy program in India. [8]
3. **Solar Energy:** Solar radiation at the earth's surface, measurements and estimation of average solar radiation, solar thermal flat plate collectors, concentrating collectors, solar thermal applications, solar electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells, Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant, Net metering concept. [8]
4. **Wind Energy:** Nature of the wind, power in the wind, factors influencing wind, wind data and energy estimation, wind speed monitoring, wind resource assessment, Betz limit, site selection, wind energy conversion devices, classification, applications, safety and environmental aspects, wind energy potential and installation in India -Repowering concept. [8]
5. **Other Types of Energy:** Ocean energy resources, principle of ocean thermal energy conversion (OTEC), ocean thermal power plants, ocean wave energy conversion, tidal energy conversion, small hydro, geothermal energy, geothermal power plants, hydrogen production and storage, Fuel cell: principle of working, various types, construction and applications. [8]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understanding of commercial energy and renewable energy sources
- Knowledge in working principle of various energy systems
- Capability to do basic design of renewable energy systems

Text Books:
1. Peter Gevorkian, Sustainable Energy Systems Engineering, McGraw Hill, 4th edition2006.
2. Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press, 3rd edition, 2012.

Reference Books:
1. Veziroglu, T.N., Alternative Energy Sources, Vol 5 and 6, McGraw-Hill, 6th Edition 2011.
2. Twidell, J.W. and Weir, A., Renewable Energy Sources, EFN Spon Ltd, 2nd Edition, 2006.

EE 19.502 **Energy Management and Auditing** **Total Lectures: 40**
3-1-0-4

Objective:
- To provide a broad knowledge on current energy scenario and audit for various applications.
- To acquire the in-depth knowledge of the Energy management systems.

Prerequisite: Renewable Energy System

1. **Energy Scenario**: Role of Energy Managers in Industries , Energy monitoring, auditing & targeting , Economics of various Energy Conservation schemes, Total Energy Systems [8]
2. **Energy Audit**: Various Energy Conservation Measures in Steam, Losses in Boiler. Energy Conservation in Steam Systems, Case studies. [8]
3. **Basics of Energy Conservation:** Energy conservation in Centrifugal pumps, Fans & Blowers, Air compressor, energy consumption & energy saving potentials, Design consideration. [8]
4. **Refrigeration & Air conditioning:** Heat load estimation, Energy conservation in cooling towers & sprays ponds; Case studies Electrical Energy, Energy Efficiency in Lighting, Case studies. [8]
5. **Energy Management:** Organizational background desired for energy management motivation, detailed process of M&T-Thermostats, Boiler controls, proportional, differential and integral control, optimizers; compensators. [8]

Course Outcome: Upon successful completion of this course, students should be able to
- Perform energy audit on the systems and know in depth the energy management systems.

Text Books:
1. Eastop T.D & Croft D.R, Energy Efficiency for Engineers and Technologists, Logman Scientific & Technical, ISBN-0-582-03184, 1990.
2. Reay D.A, Industrial Energy Conservation, 1st Edition, Pergamon Press, 6th edition, 2008.

Reference Books:
1. L. C Witte, Philip S. Schmidt, D. R. Brown, Industrial Energy Management & Utilization, Hemisphere Publisher Corp., 1st edition, 1988.
2. Power System Engineering 2nd Ed. D P Kothari, I J Nagrath, McGraw-Hill, 4th edition, 2008.

EE 19.503 **Solar Energy Engineering** **Total Lectures: 40**
3-1-0-4

Objective:
- To develop the ability to understand / analyze the various solar energy design principles.
- To study the various applications of solar energy and storage systems.

Prerequisite: Renewable Energy System.

1. **Introduction:** Source of radiation, solar constant, solar charts, Measurement of diffuse, global and direct solar radiation: pyrheliometer, pyranometer, pyregeometer, net pyradiometer-sunshine recorder. [5]

2. **Solar Non-Concentrating Collectors**: Design considerations, Classification- air, liquid heating collectors, Derivation of efficiency and testing of flat plate collectors, Analysis of concentric tube collector, Solar green house. [6]

3. **Solar System Design**: Classification, Concentrator mounting, Focusing solar concentrators, Heliostats. Solar powered absorption A/C system, water pump, chimney, drier, dehumidifier, still, cooker. [12]
Photo-Voltaic Cell: Characteristics-cell arrays-power electric circuits for output of solar panels, choppers, inverters, batteries-charge regulators, Construction concepts.

4. **Energy Storage**: Sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change-Glauber's salt-organic compounds. [10]

5. **Solar Energy Applications**: Introduction and principle of operation of solar cooker, solar air heater, solar water heater, solar distillation, solar pond, solar thermal power generation – Greenhouse - Solar PV system. [7]

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze and design the solar energy system with energy storage devices and perform the selection based on techno-economic view point.

Text Books:
1. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd Edition, Taylor & Francis, 2000, Indian reprint, 2003.
2. Edward E. Anderson, "Fundamentals for solar energy conversion", Addison Wesley Publ. Co., 2nd Edition 2000.

Reference :Books
1. G. N. Tiwari and M. K. Ghosal, "Fundamentals of Renewable energy Sources", Narosa Publishing House, New Delhi, 4th Edition,2007.
2. Energy Studies, Second Edition, by W. Shepherd and D. W. Shepherd, Imperial College Press, London,3rd Edition, 2004.

EE 19.504 **Wind Energy Technology** **Total Lectures: 40**

3-1-0-4

Objective: To provide the current status, importance, future trends and potential for Wind energy technologies as a complement to, or replacement for, conventional technologies.

Prerequisite: Renewable Energy System

1. **Wind Resource:** Wind characteristics: Meteorology of wind – wind speed distribution across the world – spatial and temporal factors – Eolian features - Biological indicators. Wind measurement: Anemometers – balloon trackers. Wind energy conversion systems (WECS) - classifications. [8]

2. **Wind Energy Conversion:** Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and Strip theory; Maximum power coefficient; Prandlt's tip loss correction; Rotor design and characteristics; Power, torque and speed characteristics – Wind turbine performance measurement – Loading analysis. [8]

3. **Wind Turbines Types:** Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator. [8]

4. **Wind Energy Application:** Wind pumps: Performance analysis, design concept and testing; Principle of Wind Energy Generators; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies. [8]

5. **Cost Economics**: Wind resource assessment and R & D costs, Fixed and variable costs, Value of wind energy, Life cycle costing and cash flow of wind power projects, Wind project owners / developers, Wind energy market. [8]

Course Outcome: Upon successful completion of this course, students should be able to

- Understand the atmospheric processes that produce wind energy.
- Explain the fundamental principle of wind turbine operation.
- Analyze the economics of wind energy.
- Explain recent commercial developments in wind energy and its future potential.

Text Books:

1. S. Rao & B. B. Parulekar, Energy Technology, Khanna publishers, 4th Edition, 2005.
2. T. Burton, D. Sharpe, N. Jenkins and E. Bossanyi, Wind energy Handbook, John Wiley & Sons, 6th Edition, 2011.

Reference Books:

1. Mukund. R. Patel, Wind and Solar Power Systems, Taylor & Francis, 2nd Edition 2001.
2. L .L. Freris, Wind Energy Conversion Systems, Prentice Hall, 4th Edition, 2010.

EE 19.505 **Advanced Energy Storage System** **Total Lectures: 52**
4-0-0-4

Objective:
- To develop the ability to understand / analyze the various types of energy storage.
- To study the various applications of energy storage systems.

Prerequisite: Power Plant Engineering

1. **Introduction:** Necessity of energy storage, types of energy storage, comparison of energy storage technologies, Applications. [7]

2. **Thermal Storage System:** Thermal storage, Types, Modelling of thermal storage units, Simple water and rock bed storage system, pressurized water storage system, Modelling of phase change storage system, Simple units, packed bed storage units, Modelling using porous medium approach, Use of Transys. [9]

3. **Electrical Energy Storage:** Fundamental concept of batteries, measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries, Lead Acid, Nickel-Cadmium, Zinc Manganese dioxide and modern batteries: zinc-Air, Nickel Hydride, Lithium Battery. [12]

4. **Fuel Cell:** Fuel Cell, History of Fuel cell, Principles of Electrochemical storage, Types, Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis, advantage and drawback of each type. [10]

5. **Alternate Energy Storage Technologies:** Flywheel, Super capacitors, Principles & Methods, Applications, Compressed air Energy storage, Concept of Hybrid Storage, Applications. [14]

Course Outcome: Upon successful completion of this course, students should be able to
- Analyze various types of energy storage devices and perform the selection based on techno-economic view point.

Text Books:
1. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons, 2nd edition, 2011.
2. Ru-Shiliu, Leizhang, Xueliang Sun, Electrochemical technologies for energy storage and conversion, Volume 1 & 2, Wiley publications,2nd Edition, 2012.

Reference Books
1. James Larminie and Andrew Dicks, Fuel cell systems Explained, Wiley publications, 1st edition, 2003.

EE 19.506 **Solar Photovoltaic Engineering** **Total Lectures: 40**

3-1-0-4

Objective:
- To attain a broad comprehension of solar photovoltaic systems used for various applications.
- To know in depth the types and design of various PV-interconnected systems.

Prerequisite: Renewable Energy System

1. **Photovoltaic Basics:** Structure and working of Solar Cells - Types, Electrical properties and Behavior of Solar Cells – Cell properties and design - PV Cell Interconnection and Module Fabrication - PV Modules and arrays -Basics of Load Estimation. [8]

2. **Stand Alone PV Systems:** Schematics, Components, Batteries, Charge Conditioners - Balance of system components for DC and/or AC Applications - Typical applications for lighting, water pumping etc. [8]

3. **Grid Connected PV Systems:** Site selection and land requirements - Techno-economic analysis of solar PV power plants - Environmental considerations. Schematics, Components, Charge Conditioners, Interface Components - Balance of system Components - PV System in Buildings. [8]

4. **Design of PV Systems:** Radiation and load data - Design of System Components for different PV Applications - Sizing and Reliability - Simple Case Studies. [8]

5. **Solar Economics:** Application of economic methods to analyze the feasibility of solar systems to decide project / policy alternatives - Net energy analysis - and cost requirements for active and passive heating and cooling - for electric power generation - and for industrial process-heating. [8]

Course Outcome: Upon successful completion of this course students will be able to
- Explain basics of solar photovoltaic systems.
- To know in depth of its types and design of various PV-interconnected systems.

Text Books:
1. CS Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2nd Edition 2011.
2. Martin A. Green, Solar Cells: Operating Principles, Technology and System Applications, Prentice- Hall, 4thEdition, 2011.

Reference Books:
1. Nelson J., The Physics of Solar Cells, Imperial College Press, 2nd Edition, 2003.
2. Thomas Markvart, Solar Electricity, John Wiley and Sons, 2nd Edition, 2012.

EE 19.507 **Biomass and Small Hydel Plants** **Total Lectures: 52**
4-0-0-4

Objective:
- To provide understanding of the processes for converting biomass feedstocks to fuels by various approaches.
- To learn to evaluate technological, economic and business dimensions of energy production from biomass.
- To provide understanding of energy generation from small hydro power plant and hydel power plants management.

Prerequisite: Renewable Energy Sources

1. **Biomass Resources and Biomass Properties:** Biomass: definition, classification, availability, estimation of availability, consumption and surplus biomass, energy plantations. Potential of biomass and assessment. [8]
2. **Energy Conversions Techniques:** Thermo chemical conversion: Direct combustion, incineration, pyrolysis and gasification; Biomass stoves, improved chullahs and some exotic designs, Biological conversion: Biodegradation and biodegradability of substrate; Biochemistry and process parameters of biomethanation; Biogas digester types; Digester design and biogas utilisation; Bioconversion of substrates into alcohol: Methanol & ethanol Production, Chemical conversion: Hydrolysis and hydrogenation; Solvent extraction of hydrocarbons; Bioethanol; Chemicals from biomass. [11]
3. **Bio Diesel:** History, Production methods of Bio-diesel: Transesterification, Fuel quality, standards and properties, Availability of Raw materials for bio-diesel, Applications, Bio-diesel potential in India. [8]
4. **Waste To Energy** Introduction to Energy from waste, classification of waste as fuel, agro based, forest residue, industrial waste, Environmental monitoring system for land fill gases, Environmental impacts; Measures of mitigate environmental effects due to incineration. [7]
5. **Hydro Power:** Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works. [9]
6. **Hydel Plant Management:** Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in North East India. [9]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understand the challenges and problems associated with the use of various bioenergy sources with regard to future resource and the environment.
- Evaluate the cost-benefit of various biomass energy conversion processes.
- Identify remedies/potential solutions to the supply and environmental issues associated with biomass based energy resources.
- Conceptualize energy generation techniques and understand different small hydro power plant and hydel power plants management.

Text Books:
1. Capareda S, Introduction to biomass energy conversion, CRC Press, 4thEdition, 2014.
2. Harvey A. & Brown A, Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes. Practical Action publication, 2nd Edition, 2003.

Reference : Books
1. Brown RC and Stevens C, Thermo-chemical Processing of Biomass: Conversion into Fuels, Chemicals and Power, Wiley and Sons, 4th Edition, 2011.

EE 19.508 **Environmental Impact of Energy System** **Total Lectures: 52**

4-0-0-4

Objective: To achieve environmental improvements and know the environmental values and behavior.

Prerequisite: Power Plant Engineering.

1. **Impact of Energy Systems on Environment:** Environmental degradation due to energy production and utilization, Primary and Secondary pollution such as SOx, NOx, SPM in air, thermal and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Sociological and Economical problems due to Thermal and other energy projects. Physiological, ecological and environmental and health problems due to energy plants. Methods of Environmental Impact Assessment. [12]
2. **Pollution Due To Thermal, Hydel and Nuclear Power Plants:** Potential sources of Pollution in thermal power plant, Air, water, land pollution due to estimation for thermal power plant. Environmental pollution limits guidelines for thermal power plant pollution control. Various pollution control equipments such as dust collector, bag filter, electrostatic separator, working principle and selection criteria, designing the pollution control system, methods and limitation. Water pollution in thermal power plant, physical and chemical methods of pollution control, Land pollution effect of land pollution, measurement of land pollution. Limitations and advantages of pollution control systems. Hydrothermal plant environmental assessment, hydrothermal plant and rehabilitation measures for hydrothermal plant. Nuclear power plants and environmental pollution, pollution control measures. Effect of Hydroelectric power stations on ecology and environment. [14]
3. **Industrial and Urban Waste & Waste Energy Recovery:** Industrial waste, Waste and effluent treatment, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy. Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control. [10]
4. **Environmental and Pollution Control Laws:** United Nations Framework Convention on Climate Change (UNFCC), Protocol, Conference of Parties (COP) 19 Clean Development Mechanism (CDM), Prototype Carbon Funds (PCF) Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project. [10]
5. **Global Environmental Concern:** Global Environmental Issues, ozone layer depletion, Global Warming, Green House Gases Emission. [6]

Course Outcome: Upon successful completion of this course, students should be able to:

- Understand environmental effects and act accordingly to improve the environmental conditions globally.

Text Books:

1. W. K. Foell, Management of Energy Environment Systems, John Wiley and Sons, 6th Edition, 2013.
2. M.C. MacedoJr, Energy Management and Control Systems, John Wiley and Sons, 4th Edition, 2004.

Reference Books:

1. J. G. Rau, D.C. Wood, Environmental Impact Analysis Handbook, McGraw Hill, 7th Edition, 2005.
2. J. M. Fowler, Energy & Environment, McGraw Hill,, ERIC, 2nd edition, 2009.

EE 19.509 **Power System and Smart Grid** **Total Lectures: 52**

4-0-0-4

Objective:

- To provide the students a systems perspective of modern electricity markets and a systems approach to address various issues faced by the electricity sector.
- To present the student a vision of how Smart Grid will transform the current electricity grid to a reliable and sustainable modern energy system.

Prerequisite: Transmission and Distribution, Power System Analysis.

1. **Supply Side and Demand Side of Electricity:** Basics of electricity, Fossil fuels and hydro power plants, Renewable and alternative energy, Supply curve, Load characteristics, Load curve and load duration curve, Demand side management. [11]
2. **Transmission and Distribution Network:** Physical law of electricity, AC vs. DC power flow, Optimal Power flow and unit commitment models, Distribution network basics. [10]
3. **Basic Elements of Smart Grid:** The origin of power grid, dependency on power grid, desirable features of power grid, reliability, security, economic, efficiency, environmental friendly, safety. [11]
4. **Key Characteristics of Smart Grid:** Demand-side participation, Impact of Smart Grid on reliability, Impact of Smart Grid on air pollutant emissions reduction. [10]
5. **Issues Related to Smart Grid:** Communication and sensing in a smart grid, smart grid threats, vulnerabilities, cyber security strategies. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Gain Knowledge about the economic fundamentals of power systems and electricity markets.
- Understand the concepts of various components of Smart Grid, and their impacts on the energy industry, including renewable integration, demand side management, and greenhouse gas emission reduction.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 4th Edition, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 4th Edition, 2009.

Reference Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2017.

EE 19.510 **Power System for Renewable Energy Sources** **Total Lectures: 52**
4-0-0-4

Objective: To know the grid integration of renewable energy sources, different machines, and power electronics devices uses in renewable energy power plants.

Prerequisite: Power System Analysis, Renewable Energy System.

1. **Introduction To Renewable Energy Grid Integration:** Concept of mini/micro grids, and smart grids. Review of synchronous generators, Introduction to power system stability problems: rotor angle stability, voltage stability and voltage collapse, classification of stability. Modelling of synchronous machines: transformations, synchronous machine representation in stability studies. [12]

2. **Introduction To Induction Machines:** Electrical characteristics, slip, speed torque characteristics etc. Self-excited induction generator, Constant speed Induction generators, Variable speed Induction generators, Doubly fed Induction generators. [10]

3. **Introduction To Power Electronic Devices:** AC/DC converters, PWM, THD. Permanent magnet synchronous generator, solar PV systems, fuel cell, aqua electrolizer. [10]

4. **Issues in Integration of Different Generators:** Issues in integration of synchronous generator based, induction generator based and converter based sources together. Network voltage management (discusses the issue of voltage levels). [10]

5. **Power Quality Management:** Voltage dips, harmonics and flickers. Frequency management. Influence of WECS on system transient response – IEEE standard and Polices. [10]

Course Outcome: Upon successful completion of this course, students should be able to:

- Analyze the power quality management in renewable power plants.

Text Books:

1. Marco H. Balderas, Renewable Energy Grid Integration, Nova Science Publishers, New York, 2009.
2. Nick Jenkin, Janaka Ekavayake, Wind Energy Generation Modeling and Control, Wiley-Blackwell, 2nd Edition, 2009.

Reference : Books:

1. AJ Wood and BF Wollenberg, Power Generation, Operation and Control, John Wiley & Sons, New York, 4th Edition, 2006.

EE 19.512 **Power Electronics for Renewable Energy Source** **Total Lectures: 52**

4-0-0-4

Objective:
- To impart knowledge on Standalone, Grid connected and Hybrid renewable energy systems.
- To understand the different types of Electrical Machines and Power Converters employed for renewable energy conversion systems

Prerequisite: Power Electronics, Renewable Energy System.

1. **Introduction:** Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission), Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems. [12]

2. **Electrical Machines For Renewable Energy Conversion:** Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG. [8]

3. **Power Converters:** Solar: Block diagram of solar photo voltaic system, Principle of operation: line commutated converters (inversion-mode), Boost and buck-boost converters, selection of inverter, battery sizing, array sizing, Wind: three phase AC voltage controllers, AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters. [12]

4. **Analysis of Wind and PV Systems:** Stand-alone operation of fixed and variable speed wind energy conversion systems and solar system, Grid connection Issues, Grid integrated PMSG and SCIG Based WECS Grid Integrated solar system. [10]

5. **Hybrid Renewable Energy Systems:** Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Wind-PV, Maximum Power Point Tracking (MPPT). [10]

Course Outcome: Upon successful completion of this course, students should be able to:
- Understand the concepts of Standalone, Grid connected and Hybrid Energy System
- Understand different types of Electrical Machines and Power Converters employed for Renewable Energy Conversion Systems.

Text Books:
1. Leon Freris, David Infield, Renewable Energy in Power Systems, John Wiley & Sons, 2008.
2. Rashid .M. H, Power Electronics Hand book, Academic press, 1st edition, 2007.

Reference Books:
1. Rai. G.D, Non-Conventional Energy Sources, Khanna publishes, 2nd Edition, 2010.
2. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, John Wiley & Sons, 4th Edition, 2011.
3. S. N. Bhadra, D. Kastha, Wind Electric Systems, Oxford University Press, 5th Edition, 2005.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of ME

Course structure for

B.Tech ME

ME 19.201 **Mechanics of Solids** **Total Lectures: 40**

Credit 3-0-0-3

Prerequisite (s): ME 19.101, MA 19.101

Objective(s):

- *To acquaint with the basic concepts of stress and deformation in solids.*
- *To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.*
- *Learn the fundamental concepts of the method of superposition, flexibility method, and stiffness method as applied to problems involving statically determinate and indeterminate axial and torsional members, and beams.*

1. **Compound Stress and Strains:** Introduction, objective of the course, stresses on inclined sections, strain energy, impact loads and stresses, state of plane stress, principal stress and strain, maximum shear stress, Mohr's stress circle, three dimensional state of stress & strain, generalized Hook's law. **[6]**

2. **Beams:** Axial force, shear force and bending moment diagrams for statically determinate (uniform and variable loading) beams including beams with internal hinges for different types of loading. Pure Bending**,** normal stresses in beams, shear stresses in beams due to transverse and axial loads, composite beams. Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams, combined bending & torsion of solid & hollow shafts. **[12]**

3. **Columns, Struts and Trusses:** Buckling and stability, slenderness ratio, combined bending and direct stress, struts with different end conditions, Euler's theory for pin ended columns, effect of end conditions on column buckling, Rankine Gordon formulae, examples of columns in mechanical equipments and machines. Truss- Introduction, simple truss and solution of simple truss, method of joints and method of sections. **[10]**

4. **Thin and Thick cylinders:** Introduction, difference between thin walled and thick walled pressure vessels, Thin walled cylinders, hoop and axial stresses and strain, volumetric strain. **[6]**

5. **Curved Beams:** Bending of beams with large initial curvature, position of neutral axis for rectangular and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression. **[6]**

Outcome(s):

- Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems for simple tri- dimensional elastic solids.
- Solve problems relating to pure and non-uniform bending of beams and other simple structures.
- Solve problems relating to torsional deformation of bars and other simple tri- dimensional structures.
- Understand the concept of buckling and be able to solve the problems related to isolated bars.

AHEP4 Mapping with Module outcomes	• C2: Student will understand the engineering mechanics principles and apply them to analyze the practical problems. • C3: Student can identify the analytical approach to describe the simple mechanical components. • C5: Student can apply advanced problem-solving skills, technical knowledge and understanding, to establish rigorous and creative solutions that are fit for purpose for all aspects of the problem.

Text Books:

1. R.K. Bansal, "A textbook of strength of materials", New Delhi: Laxmi Publications, 2010
2. Khurmi, R. S., "Strength of Materials: Mechanics of Solids". S. Chand Limited, 2005

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.202 **Kinematics of Machines** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME 19.101

Objective(s):

- *To provide basic concept of kinematics and kinetics of machine elements.*
- *Know different machine elements and mechanisms.*
- *Select Suitable Drives and Mechanisms for a particular application.*
- *Develop ability to come up with innovative ideas.*

1. **Basics Of Mechanisms:** Terminology and definitions - degree of freedom mobility, Kutzbach criterion, Grashoff's law, kinematic inversions of 4-bar chain and slider crank chains, mechanical advantage, transmission angle, description of common mechanisms- single, double and offset slider mechanisms, quick return mechanisms, straight line mechanism. **[8]**

2. **Kinematics:** Displacement, velocity and acceleration analysis in simple mechanisms- Graphical Method of velocity and acceleration analysis for different mechanisms- instantaneous centre of velocity - angular velocity ratio theorem. coriolis acceleration. **[8]**

3. **Kinematics of Cam:** Classifications, displacement diagrams, parabolic simple harmonic and cycloidal motions, layout of plate cam profiles, derivatives of follower motion, high speed cams, circular arc and tangent cams, standard cam motion, pressure angle and undercutting. **[8]**

4. **Friction drives:** Introduction, belt and rope drives, open and crossed belt drives, velocity ratio, slip, power transmission, effect of mass of belt on power transmission, maximum power transmission, initial tension and maximum tension, pivots and collars, uniform pressure and uniform wear. **[8]**

5. **Gears:** Spur gear terminology and definitions, fundamental law of toothed gearing and involutes gearing, inter changeable gears, gear tooth action, terminology, interference and undercutting , non-standard gear teeth , helical, bevel, worm, rack and pinion gears (basics only), gear trains , parallel axis gear trains, epicyclic gear trains, differentials , automotive transmission gear trains. **[8]**

Outcome(s):

- Identify mechanisms and predict their motion.
- Calculate the degrees of freedom of mechanisms.
- Draw velocity and acceleration diagrams of various mechanisms.
- Construct CAM profile for the specific follower motion.
- Select appropriate power transmission mechanism.

AHEP4 Mapping with Module outcomes	• C2: Student can understand of engineering principles and the ability to apply them to analyse key engineering processes. • C3: Student can describe the performance of systems and components through the use of analytical methods • C4: Student can understand of the use of technical literature and other information sources

	• C5: Student can investigate and define the problem, identifying any constraints. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems. • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Rattan S. S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Edition 2014.

2. Shigley J. E and Uicker J.J, "Theory of Machines and Mechanisms", Oxford University Press, 5th Edition 2017.

Reference Books:

1. Thomas B, "Theory of Machines", Pearson Education India, 3rd Edition 2010.

2. Norton R. L, "Kinematics and dynamics of machinery", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1st Edition 2009.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.203 **Engineering Thermodynamics** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): MA 19.101

Objective(s):

- *Identify and use units and notations in thermodynamics*
- *State and illustrate the first and second laws of thermodynamics*
- *Identify and explain the concept of entropy, enthalpy, specific energy, reversibility and irreversibility*
- *Apply the first and second laws of thermodynamics to formulate and solve engineering problems for (i) closed systems, (ii) open systems, and (iii) power cycles*
- *Ability to understand and effectively communicate the fundamentals of thermodynamic analyses and to articulate the basic environmental, economic, and sustainability considerations to the non-thermodynamicist*
- *Use thermodynamic (steam) tables, charts, and equation of state (e.g. the ideal gas law) to obtain appropriate property data to solve thermodynamics problems*

1. **Basic Concepts and Definitions:** Introduction and definition of thermodynamics, dimensions and units, systems, surroundings, property, energy, thermodynamic path, process and cycle, thermodynamic equilibrium, quasi static process, energy and its forms, work and heat, gas laws. **[8]**
   Zeroth and First Law of Thermodynamics: Zeroth law of thermodynamics, temperature scale, First law of thermodynamics, calculation of work in various processes and sign convention, first law of thermodynamics applied to open systems, steady flow systems and their analysis, steady flow energy equations for boilers, condensers, turbine, compressors, pumps and throttling process, etc., PMM-I.

2. **Second Law of Thermodynamics:** Limitations of first law of thermodynamics, thermal reservoir, heat engine, heat pump and refrigerator, statement and equivalence of the Kelvin Plank and Clausius statements, reversible and irreversible processes, Carnot cycle, Carnot engine, Carnot theorem and its corollaries, thermodynamic temperature scale, PMM-II. **[10]**
   Entropy: Clausius inequality, concept of entropy, calculation of entropy change, principle of entropy increase, temperature-entropy diagram, Second law analysis of a control volume, statement of third law of thermodynamics, available and unavailable energy, availability and irreversibility, second law efficiency.

3. **Properties of Steam**: Pure substance, property of steam, triple point, critical point, sub-cooled liquid, saturation states, superheated states, phase transformation process of water, graphical representation of P-V-T data, Properties of steam. Steam tables and Mollier chart. **[8]**
   Ideal Gas and Real Gas: Ideal gas, Real gas, Internal energy, enthalpy and specific heats of an ideal gas, equations of state, Dalton's law of partial pressures, Gibbs Dalton law, Thermodynamic properties of gas mixtures.

4. **Thermodynamic Relations:** Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation**.** **[8]**
   Power Cycles: Otto cycle, Diesel cycle, Dual cycle, Brayton cycle and Ericsson cycle.

5. Vapour Power Cycle: Rankine cycle, comparison of Carnot and Rankine cycle, modified Rankine cycle, effect of operating conditions on its efficiency, properties of ideal working fluid in vapour power cycle, Reheat cycle, regenerative cycle, bleeding extraction cycle, feed water heating co-generation cycle. **[6]**

Outcome(s):

- *Understand the thermodynamics implication and thermodynamics explanation for the states of matter.*
- *Understand and apply basic energy conservation equations for kinetic, potential and flow energies.*
- *Understand the concepts of enthalpy, entropy and the basic laws of thermodynamics.*
- *Understand and solve thermodynamic cycle problems, including the Carnot ideal cycle, the Otto cycle, the Diesel Cycle, Rankine and Brayton*
- *Understand thermodynamic tables, charts, and equation of state (e.g. the ideal gas law) to obtain appropriate property data to solve thermodynamics problems*

AHEP4 Mapping with Module outcomes

- C1: Student will understand and knowledge of mathematical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical, tools and notations proficiently in the analysis and solution of engineering problems.
- C2: Student will understand the engineering thermodynamics principles and apply them to analyze the practical problems.
- C3: Student will able to identify, classify and describe the performance of thermodynamic systems and components through the use of analytical methods and modelling techniques.
- C4: Student will understand the use of technical literature and other information sources.
- C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems.

Text Books:

1. Nag, P.K, "Engineering Thermodynamics", Tata McGraw-Hill, 5th Edition. 2013

2. Cengel Y.A and Boles M.A, "Thermodynamics: An Engineering Approach", Tata McGraw Hill, 7th Edition 2011.

Reference Books:

1. Sonntag, R. E, Borgnakke C. and Van Wylen G.J, "Fundamentals of Thermodynamics", John Wiley, 7th Edition. 2009

2. Moran, M. J and Shapiro H. N, "Fundamentals of Engineering Thermodynamics", John Wiley & Sons, 6th Edition. 2010.

ME 19.204 **Fluid Mechanics** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.101

Objective(s):

- *To know properties of fluid.*
- *To calculate hydrostatic forces on submerged surfaces.*
- *To apply Bernoulli equations.*
- *To calculate friction losses in pipes.*
- *To apply conservation of mass, momentum & energy principle.*
- *To apply boundary condition for different conditions.*

1. **Introduction:** Physical properties of fluids, concept of shear stress, Newtonian and Non-Newtonian fluids **[8]**
   Fluid Statics: Pressure-density-height relationships, manometers, force on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform acceleration and uniform rotation about the axis.
2. **Kinematics of Fluid Flow:** Types of fluid flow, stream lines, streak lines, path lines, stream tubes, stream function and velocity potential, flow nets. **[10]**
   Dynamics of Fluid Flow: Euler's equation of motion along a streamline and its integration, Bernoulli's equation and momentum equation. Boundary Layer Analysis, Boundary Layer Thickness, Boundary Layer over a flat plate.
3. **Dimensional Analysis And Hydraulic Similitude:** Dimensional analysis, Buckingham's pi theorem, important dimensionless numbers and their significance, geometric, kinematic and dynamic studies. **[8]**
   Flow Past Immersed Bodies: Lift and drag, expressions for lift and drag.
4. **Flow Through Pipes:** Laminar and turbulent flow in pipes, general equation for head loss-Darcy-Weisbach and Fanning's equations, Moody's diagram, energy losses through pipe fitting, flow through network of pipes, power transmission through pipelines. **[7]**
5. **Fluid Flow Measurements:** Introduction, venturimeter, orifice meter, Pitot tube, notches and weirs. **[7]**
   Introduction To Compressible Flow: Velocity of sound in a fluid, Mach number, propagation of pressure waves in a compressible fluid

Outcome(s):

- *An understanding of fluid mechanics fundamentals, including concepts of mass and momentum conservation.*
- *An ability to apply the Bernoulli equation to solve problems in fluid mechanics.*
- *An ability to apply control volume analysis to problems.*
- *An ability to use potential flow theory to solve problems.*
- *An ability to perform dimensional analysis for problems.*
- *Knowledge of laminar and turbulent boundary layer fundamentals.*

AHEP4 Mapping with Module outcomes	• C2: Student can understand of fluid mechanics principles and the ability to apply them to analyse key engineering processes. • C4: Student can understand of the use of technical literature and other information sources.

Text Books:

1. Som S and Biswas G, "Introduction to Fluid Mechanics and Fluid Machines",Tata McGraw-Hill, 2nd Edition, 2007.

2. Bansal R. K., "Fluid Mechanics and Hydraulic Machines" Laxmi PublicationPvt. Ltd. 2005.

Reference

1. Young D. F, Munson B, Okiishi T. H and Huebsch W. W, "Fundamentals of Fluid

ME 19.205 **Material Science** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): PY 19.101

Objective(s):

- *To acquaint students with the basic concepts of Material Science.*
- *To impart the knowledge on mechanical behaviour of materials.*
- *To acquire knowledge in various class of materials (like Ferrous, Non-Ferrous Alloys and Advanced Materials) and their applications.*
- *To impart knowledge on Heat Treatment, Microstructure and Phase diagrams.*
- *To acquire knowledge in destructive and non-destructive testing of materials.*

1. **Introduction to Engineering Materials & Material Structure:** Introduction to engineering materials, development in materials science, classification of material, crystal structures (BCC, FCC and HCP systems), imperfections in crystals, point defects, line defects, surface and bulk defects, slip, twinning. **[8]**

2. **Phase Diagrams:** Solid solutions, binary alloy system, lever rule, Iron-carbon equilibrium diagram, TTT diagrams**.** **[8]**

3. **Heat Treatment:** Annealing, normalizing, tempering, hardening (case hardening and surface hardening). **[8]**

4. **Engineering Materials:** Ferrous metals, alloy steels, tool steels, stainless steels, cast irons, effect of alloying elements on mechanical properties of steel. Copper and i ts alloys, aluminium and their alloys, bearing materials. Polymers, polymer types, polymer synthesis and processing; ceramics, their crystal structures and properties, composites, particle reinforced composites, fibre reinforced composites, structural composites, nanoparticle composites. **[8]**

5. **Mechanical Properties and Their Testing:** Destructive Testing**,** tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, formability, hardness testing, different hardness tests, Vickers, Rockwell, Brinell, impact test, ductile and brittle fracture, creep, generalized creep behaviour. Non-destructive testing (NDT), visual Inspection, magnetic particle inspection, dye penetrant inspection, ultrasonic inspection, Selection of NDT. **[8]**

Outcome(s):

- *The students will be able to understand the knowledge of materials & their applications.*
- *Students will be able to design the alloy system of ferrous and non-ferrous metals based on their knowledge of phase diagrams and metal characteristics.*
- *The students will also be able to understand the heat treatment processes and destructive and non-destructive testing of materials.*

AHEP4 Mapping with Module outcomes

C1: Student can understand the knowledge of characteristics of particular materials and processes

C2: Student can Understand of engineering principles and the ability to apply them to analyse key engineering processes.

C4: Student can understand of the use of technical literature and other information sources.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

Text Books:

1. V. Raghavan, "Material Science & Engineering", Prentice Hall India Ltd., 6th Edition.
2. A. K. Bhargava, C.P. Sharma. "Mechanical Behaviour & Testing of Materials", PHI Learning Private Ltd., 2014

Reference Books:

1. Avner S. H, "Introduction to Physical Metallurgy", Tata-McGraw Hill Publishing Co., New Delhi, 26th Edition 2009.
2. Dieter G. E, "Mechanical Metallurgy", McGraw Hill Publishing Co., New York, Latest Edition.

ME 19.206 **Design of Machine Elements - I** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.101, ME 19.201

Objective(s):

- *Develop an ability to apply knowledge of mathematics, science, and engineering*
- *To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.*
- *To develop an ability to identify, formulate, and solve engineering problems.*
- *To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice*.

1. **Introduction:** Engineering design - an applied decision theory with respect to functional requirements, aesthetic consideration and ergonomic consideration-traditional design methods-synthesis in design, standardization, preferred numbers, derived series of preferred numbers, types of Fits, tolerance with respect to Indian standard, calculation examples, interchangeability, surface Roughness and its designation on drawing. **[4]**

2. **Design against Static and Fluctuating Load:** Factor of safety, design of simple machine parts, design of Cotter Joint, knuckle Joint and Hooke's Joint, theories of Failures, maximum principal stress theory, maximum shear stress theory, distortion-energy theory of failures. Methods to reduce stress concentration. Fluctuating stresses, fatigue failure, endurance limit, low cycle and high cycle fatigue, notch sensitivity, reversed stress-design for finite and infinite life, cumulative damage in fatigue, Soderberg and Goodman lines, modified Goodman's diagram, Gerber equation, fatigue design under combined stresses. **[11]**

3. **Shaft, Keys and Couplings:** Transmission shafts, shaft design on strength basis, shaft design on torsional rigidity bases, ASME code for shaft design, design of hollow shaft, design of keys, design of couplings- muff coupling, rigid flange coupling, flexible coupling, design of shaft for lateral rigidity, Castigliano's theorem, area moment method. **[6]**

4. **Welded, Riveted and Threaded Joints:** Design of riveted joints and simple welded connections under concentric loads only, eccentric load in plane of weld, welded joints subjected to bending moment, Welded joints subjected to torsional moment, welded joints subjected to fluctuating forces. Basic type of screw fastening, terminology of screw thread, ISO metric screw thread, materials and manufacture, simple analysis of bolted joints, eccentrically loaded bolted joints in shear, eccentric load perpendicular to the axis of the bolt, eccentric load circular base, elastic analysis of bolted joints, bolted joints under fluctuating load. **[9]**

5. **Power Screw and Springs:** Forms of threads, multiple threaded screws, terminology of power screw, torque requirement for lifting of load and for lowering of load, self-locking screw, design of screw jack, differential and compound screws. Types of springs, style of end, stress and deflection equation, series and parallel connections, spring material, design of helical springs, concentric springs, multi-leaf spring, design of load spring. **[10]**

Outcome(s):

- Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.
- Demonstrate knowledge on basic machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.
- Be able to approach a design problem successfully, taking decisions when there is not a unique answer.

AHEP4 Mapping with Module outcomes	• C1: Student will understand and knowledge of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems. • C2: Student can understand of engineering principles and the ability to apply them to analyse key engineering processe. • C4: Student can understand of the use of technical literature and other information sources. • C5: Student can investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems • C12: Student will develop the ability to apply relevant practical skills • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Bhandari, V. B. “Design of machine elements”. Tata McGraw-Hill Education, 2010
2. Gupta, J. K., and R. S. Khurmi. "A textbook of machine design." SI Edition 2005

Reference Books:

1. Norton, Robert L. "Machine design: an integrated approach", Prentice-Hall Inc: NJ, USA, 1996
2. Shigley, Joseph E., and Charles R. Mischke. "Machine Engineering Design.", McGraw-Hill Book Company, 1989
3. Spotts, Merhyle Franklin. “Design of machine elements”. Vol. 730. Englewood Cliffs: Prentice-Hall, 1985.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.208 **Production Technology-I** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.112

Objective(s):

- *To analyze and understand the metal cutting phenomenon.*
- *To study the conventional machining processes such as lathe, drilling, milling, shaping.*
- *To select process parameters and tools for obtaining desired machining characteristic.*

1. **Metal Cutting Theory:** Introduction to manufacturing, classification of manufacturing processes. Tool materials, tool geometry, mechanics of metal cutting, tool failures, tool wear in metal cutting, tool life, cutting forces and power, machinability, cutting fluids. **[10]**
2. **Turning Operations:** Introduction, constructional features of a center lathe, cutting tools, operations performed on a center lathe, taper turning methods, thread cutting methods, special attachments, limitations of a center lathe, capstan and turret lathes, turret indexing mechanism, tool layout of turret and capstan machines, automatic lathes, tool layout for automatic lathes, machining time estimation. **[8]**
3. **Hole Making and Milling Process:** Introduction, constructional features of a drilling, types of drilling machines, drill geometry, reaming, boring, tapping, other hole making operations, machining time estimation, boring machine. Introduction, types of milling machines, constructional features of a milling, cutters, milling operations, dividing head, milling mechanics, machining time estimation, machining center. **[8]**
4. **Other Machining processes:** Introduction to shaper, planner, slotter and broaching. Gears types and gear making, machining of gears, gear finishing. Introduction to jig and fixtures. **[8]**
5. **Abrasive Machining:** Grinding machines, various grinding operations; Grinding wheels, preparation for wheel operation. Lapping, honing, super finishing **[6]**

Outcome(s): *At the end of the course, the student will be able to understand working of lathe, shaper, planer, drilling, and milling and machines. Comprehend speed and feed mechanisms of machine tools. Estimate machining times for machining operations on machine tools. Be able to select proper metal removing processes for the typical application.*(C2, C3, C4, C6, C13)

Text Books:

1. Rao P. N, "Manufacturing Technology", Tata McGraw-Hill, Fourth Edition.
2. Lindberg Roy A, "Processes and Materials of Manufacture", PHI, Fourth edition.

Reference Books:

1. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Fourth Edition, John Wiley & Sons.
2. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, 7th Edition, Pearson.

AHEP4 Mapping with Module outcomes	• C2: Using first principles of mathematics, students can solve problems related to mechanics of machining. • C3: Considering limitations of machining, students can select machining process parameter. • C4: Student can refer literature for appropriate machining parameter for machining different materials. • C6: Student will understand of, and the ability to apply, an integrated or

	systems approach to solving machining related problem. • C13: Student can understand the knowledge of characteristics of particular materials, equipment, processes, or products for machining on different machine tools.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.301 **Dynamics of Machines** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME 19.101, ME 19.202

Objective(s):

- *Understand Kinematics and Dynamics of different machines and mechanisms.*
- *To facilitate students to understand the function of flywheels, the concept of balancing of rotating and reciprocating masses.*
- *To understand the principles in mechanisms used for governing of machines*
- *To give awareness to students on the phenomenon of vibration and its effects.*

1. **Static and Dynamic force analysis:** Constraint and applied forces, static Equilibrium of two and three forces members, principle of virtual work, and friction in mechanisms. Dynamic analysis of 4-bar linkage and slider-crank mechanism, velocity and acceleration of a piston, angular velocity and angular acceleration of connecting rod, Engine force analysis, Dynamically equivalent system, inertia of connecting rod, Inertia force in reciprocating engine, crank shaft torque. **[10]**
   Engine dynamics and flywheel: Turning moment diagram of an I. C engine, Fluctuation of crankshaft-speed, flywheel and its effect on cyclic fluctuation of speed of an engine.

2. **Balancing:** Static balancing & dynamic balancing, Balancing of several masses, rotating in different planes, Balancing of reciprocating mass, Balancing of in-line engine, Balancing of V-engines, Balancing of radial engines. **[8]**

3. **Governors:** Types of governors, analysis of Watt, Porter , Prowell, Hartnell, Hartung governor, Sensitiveness of a governor, hunting, isochronisms and stability of a governor, effect and power of a governor, effect of friction on dynamics of governor. **[8]**

4. **Gyroscope:** Angular velocity, angular acceleration and gyroscopic torque, gyroscopic effect on aeroplanes, naval ships, two wheelers and four wheelers. **[6]**

5. **Mechanical Vibrations:** Types of vibrations, Single degree free & damped vibrations, Logarithmic decrement, Forced vibration of single degree system under harmonic excitation, vibration isolation. **[8]**

Outcome(s):

- Students will have an understanding of static force relationships and inertia forces and their effect that exist in machines.
- Students will demonstrate the dynamics of flywheel and their motion.
- Analyse balancing of rotating masses in a single and several planes.
- Understand concepts of vibrations in various machineries, their harmful effects and remedies.

AHEP4 Mapping with Module outcomes	• C1: Student will apply; integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline. • C2: Student will understand the engineering mechanics principles and apply them to analyze the practical problems.

	• C5: Student can investigate and define the problem, identifying any constraints. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems. • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Rattan S. S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Edition 2014.

2. Shigley J. E and Uicker J.J, "Theory of Machines and Mechanisms", Oxford University Press, 5th Edition 2017.

Reference Books:

1. Thomas B, "Theory of Machines", Pearson Education India, 3rd Edition 2010.

2. Norton R. L, "Kinematics and dynamics of machinery", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1st Edition 2009.

3. Bhave S., " Mechanical Vibrations: Theory and Practice ", Pearson India Ltd., 1st Edition 2010

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.302 **I. C. Engines** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME 19.203, ME 19.204

Objective(s):

- *To teach students the fundamentals, operations, and performance of internal combustion engines and their different types.*
- *To provide students with the theoretical and experimental ability to operate, analyse, and design internal combustion engines.*
- *To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency an demission*

1. **Introduction to I C Engine:** Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, Stratified charge engine, Scavenging in 2 Stroke engines. **[9]**
   Spark Ignition Engines: Spark ignition engine mixture requirements, Carburetion, Theory of carburettor, SP and MPFI, Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control, combustion chamber design for SI engines.
2. **Compression Ignition Engines:** Combustion in CI engine, Ignition delay, Knock and its control, Combustion chamber design of CI engine, Turbocharging, Supercharging. **[6]**
3. **Engine Systems and Components:** Ignition systems- Battery, Magneto and Electronic, Lubrication systems, Engine starting system, Engine cooling system, Intake and exhaust system, Drive train- Cam shaft and Valves. **[7]**
4. **Pollutant Formation Control:** Pollutant, Sources and types, Nox formation, Hydrocarbon emission mechanism, Carbon monoxide formation, Particulate emissions, Effect of pollutant, Emission standards, Catalytic converters and particulate traps, Method of measurement **[12]**
   Alternate Fuels: Methanol, Ethanol, Hydrogen, Natural gas, Biogas, Bio diesel, Liquefied petroleum gas, Properties, suitability, Engine Modifications, Merits and Demerits.
5. **Performance Characteristic and Testing of I C Engine:** Standards for testing of I.C. Engine, Mean effective pressure, Mean effective pressure, indicated power, brake power, friction power, Methods to determine power and efficiencies, Variables affecting performance of engine, characteristic curves, heat balance sheet, Methods of improving engine performance. **[6]**

Outcome(s):

- *Demonstrate a basic understanding of different types of internal combustion engines and their operations.*
- *To analyze the ideal models of engine ecycles.*
- *To understand the effect of supercharging and turbocharging on engine performance.*
- *To understand fuel-metering systems: carburetors and fuel injectors, in SI and CI engines.*

AHEP4 Mapping with Module outcomes	• C2: Student will understand the various principles of engines technology and their applications. • C4: Student can understand of the use of technical literature and other information sources. • C6: Student will apply the various design aspects and system approach in solving engineering problems. • C7: Student will understand the requirement for engineering activities to promote sustainable development of various engines for futuristic aspects. • C15: Student will understand the contexts in which engineering knowledge can be applied (eg. operations and management, application and development of technology, etc).

Text Books:

1. Ganesan V, "Internal combustion Engines", Tata McGraw Hill, 3rd Edition, 2007.

2. Mathur M. L. and Sharma R. P, "Internal Combustion Engines", Dhanpat Rai & Sons, 2005.

Reference Books:

1. Heywood John B, "Internal combustion Engines Fundamentals", McGraw Hill, 2nd Edition, 2018.

Pulkrabek W. W, "Engineering Fundamentals of theInternal Combustion Engine, Pearson Education Limited, 2nd Edition, 2013.

ME 19.303 **Fluid Machinery** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.204

Objective(s):

- *To impart the knowledge on pumps and turbines.*
- *To understand the basic principles of pneumatics and hydraulics.*
- *To identify pneumatic and hydraulic components and their functions*
- *To understand different types of turbine and its applications.*
- *To compute the efficiency of different types of turbine and pumps.*

1. **Introduction:** Introduction, Application of momentum and momentum equation to flow through hydraulic machinery, Euler's fundamental equation. **[6]**
   Impact of Jet: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), effect of inclination of jet with the surface.

2. **Hydraulic Turbines:** Classification of turbines. **[15]**
   Impulse Turbines: Pelton turbine, constructional details, velocity triangles, power and efficiency calculations, governing of Pelton wheel.
   Reaction Turbines: Fransis and Kaplan turbines, constructional details, velocity triangles, power and efficiency calculations, degree of reaction, draft tube, cavitation in turbines, principles of similarity, unit and specific speed, performance characteristics, selection of water turbines.

3. **Centrifugal Pumps:** Classifications of centrifugal pumps, vector diagram, work done by impellor, efficiencies of centrifugal pumps, specific speed, model testing, cavitation and separation, performance characteristics. **[6]**

4. **Positive Displacement Pumps:** Reciprocating pump theory, slip and coefficient of discharges, indicator diagram, effect and acceleration, work saved by fitting air vessels, comparison of centrifugal and reciprocating pumps, positive rotary pumps, Gear and Vane pumps, performance characteristics. **[8]**

5. **Other Machines:** Hydraulic accumulator, Intensifier, Hydraulic press, Lift and Cranes, theory of hydraulic coupling and torque converters, performance characteristics, Hydraulic ram, Jet pumps, Airlift pumps. **[5]**

Outcome(s):

- *Able to identify hydraulic problem.*
- *Able to learn any possible improvements on fluid machinery.*
- *Able to compute efficiency of various fluid machineries.*

AHEP4 Mapping with Module outcomes	• C2: Student can understand of engineering principles of hydraulic machines and the ability to apply them to analyze key engineering processes • C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems.

Text Books:

1. Bansal R. K., "Fluid Mechanics and Hydraulic Machines" Laxmi Publication Pvt. Ltd.,2005.

2. Modi, P. N., and S. M. Seth. Hydraulics and Fluid Mechanics: Including Hydraulic Machines (in SI Units). Standard Book House, 14th ed.,2002.

Reference Books:

1. Sayres A. T, "Hydraulic and Compressible Flow Turbomachines", Tata McGraw Hill,1990.

2. Sawhney G. S. "Thermal And Hydraulic Machines", PHI Learning Pvt. Ltd., 2nd ed., 2011.

ME19.304 **Refrigeration and Air Conditioning** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.203, ME 19.305

Objective(s):

- *To understand the principles of refrigeration and air conditioning.*
- *To calculate the cooling load for human comfort & different applications.*
- *To select the right equipment for a particular application.*
- *To understand the effect of temperature and pressure on moist air.*

1. **Introduction:** Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP). **[6]**
   Air Refrigeration System: Carnot refrigeration cycle; Temperature Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems.
2. **Vapor Compression Refrigeration Systems:** Simple Vapor Compression Refrigeration systems-Limitations of Reversed Carnot cycle with vapor as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP. **[11]**
   Multistage Vapor Compression Refrigeration Systems: Necessity of multistage compression, Compound VC cycle, Inter cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves.
3. **Vapor Absorption Refrigeration Systems:** Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; **[6]**
   Refrigerants: Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants.
4. **Psychrometry:** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer. **[7]**
5. **Air Conditioning:** Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air-conditioning system; year round air conditioning; unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor; Inside design conditions; comfort conditions; components of cooling loads; internal heat gains; system heat gain: external heat gain; Transport air conditioning. **[10]**

Outcome(s):

- *Able to understand basic principles of refrigeration*
- *Able to understand simple and multiple vapour-compression cycle, gas refrigeration cycles and absorption cycles.*
- *Ability to understand the principles of thermal comfort & ventilation*
- *An ability to use refrigerant property tables and psychrometric chart.*

AHEP4 Mapping with Module outcomes	• C1: Student will understand and knowledge of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems. • C2: Student will understand the refrigeration principles and apply them to analyze the practical problems. • C3: Student will understand the assembly of refrigeration systems and air conditioning systems. • C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems. • C7: Student will understand of the requirement for engineering activities to promote sustainable development and ability to apply quantitative techniques where appropriate. • C15: Student will understand the contexts in which engineering knowledge can be applied (eg operations and management, application and development of technology, etc).

Text Books:

1. Stocker W. F. and Jones J.W., "Refrigeration & Air conditioning", Tata McGraw-Hill, New Delhi, 2nd Edition,1982.
2. Arora C. P., "Refrigeration & Air conditioning", Tata McGraw-Hill, New Delhi, 7th Edition, 2006.

Reference Books:

1. Prasad M, "Refrigeration & Air conditioning", New Age International (P) Limited, New Delhi, 3rd Edition,2006.
2. Rajput, R. K. Refrigeration And Air-Conditioning. SK Kataria & Sons, 1st Edition, 2009.

ME 19.305 **Heat and Mass Transfer** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): MA 19.201, ME 19.203, ME 19.204

Objective(s):

- *Identify and understand the various mechanisms of heat and mass transfer that characterize a given physical system.*
- *Formulate models for heat conduction processes. Apply analytical and numerical methods to solve one- and two-dimensional conduction problems.*
- *Analyze and design complex heat transfer applications, such as heat exchangers.*
- *Combine thermodynamics and fluid mechanics principles to analyze heat convection processes.*
- *Integrate radiation aspects into real-world global heat transfer problems.*

1. **Basics Concepts:** Heat transfer in engineering, Mechanisms of heat transfer, temperature field and temperature gradient, conduction, convection and radiation heat transfer, concept of driving potential, combined mechanism of heat transfer. **[10]**
   Fundamental equations of conduction: General different equation of heat conduction in Cartesian, cylindrical and spherical coordinate system, one dimensional steady state heat conduction, systems without internal heat generation, systems with variable thermal conductivity, composite systems, critical radius of insulation, Special one dimensional steady state situations – heat generation, pin fins

2. **Multidimensional steady state conduction:** Introduction, Mathematical analysis of 2-D systems, graphical analysis of 2-D systems, electrical analogy for 2-D systems, Numerical method of solution for 2-D systems, three dimensional systems. **[8]**
   Transient heat conduction: Introduction, systems with negligible internal resistance – lumped parameter method, systems with negligible surface resistance, heat flow in an infinitely thick plate, systems with finite surface and internal resistance.

3. **Fundamental of convective heat transfer:** Introduction, convective heat transfer coefficient, basic equation, boundary layer concept, laminar heat transfer over flat plate, fully developed heat transfer through smooth pipes, the case of contact heat flux and constant wall temperature boundary condition, dimensional analysis, Correlation of heat transfer in turbulent flow, use of hydraulic diameter, free convection heat transfer phenomena. **[12]**
   Heat Exchangers: Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method.

4. **Thermal Radiation:** Basic concept, Theory of thermal radiation, electromagnetic spectrum, Wien's displacement law, Stefan-Boltzmann equation, Concept of black, gray bodies without participating media, radiation shields, View factors, Equivalent emissivity of grooved surfaces electrical network analogies. **[8]**

5. **Mass Transfer**: Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy. **[2]**

Outcome(s):

- *Analyze problems involving steady state heat conduction in simple geometries.*
- *Develop solutions for transient heat conduction in simple geometries.*
- *Understand the fundamentals of convective heat transfer process.*
- *Analyze heat exchanger performance by using the method of heat exchanger effectiveness.*
- *Calculate radiation heat transfer between black body surfaces.*

AHEP4 Mapping with Module outcomes	• C1: Student will apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline. • C2: Student will understand the heat transfer principles and apply them to analyze the practical problems. • C3: Student can identify the analytical approach to solve the heat transfer problems. • C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems.

Text Books:

1. Holman J. P, "Heat Transfer", McGraw Hill Higher Education., 10th Edition 2010

2. Nag P. K, "Heat & mass transfer", Tata McGraw Hill Publishing Company Ltd., 3rd Edition 2005.

Reference Books:

1. Yunus Cengel, "Heat and Mass Transfer: Fundamentals and Application", Tata McGraw Hill Publishing Company Ltd., 4th Edition2011

2.Bergman TL, Incropera FP, DeWitt DP, Lavine AS. "Fundamentals of heat and mass transfer". John Wiley & Sons; 7th Edition 2011

ME 19.306 **Metrology and Quality Control** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): PY 19.101

Objective(s):
- *Describe various instruments and their characteristics.*
- *Solve the problems on angle measurements.*
- *Explain the types of control chart to use, depending on given data.*
- *Solve problems based on quality control and acceptance sampling.*

1. **Introduction to Metrology:** Principles of Engineering metrology, Measurement standards, Types and sources of errors, Accuracy and Precision, introduction to uncertainty in measurement, linear and angular measuring instruments and their applications. **[8]**

2. **Form Measurement:** Principles and Methods of straightness – Flatness measurement – Thread measurement, Gear measurement, Interferometry, Types of Interferometer, Flatness, Roundness measurement - Applications. Control Gauges and Comparators. Surface texture measurement with stylus type instruments, Tomlinson surface meter, Talysurf and profilograph. **[8]**

3. **Advancements in Metrology**: Introduction & applications of: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology, Automatic inspection system, Machine vision for online-offline inspection. **[4]**

4. **Quality Management:** Concept of Quality and quality control, elements of quality & its growth, purpose, setup, policy & objective, factors controlling & quality of design and conformance, balance between cost and quality and value of quality. Specification of quality, planning through trial lots and for essential information. QMS (ISO 9000, TS16949, ISO14000), Quality Audit, FMECA, Zero defects, TPM. Six Sigma. **[10]**

5. **Statistical Quality Control:** Importance of statistical method in quality control, measuring of statistical control variables and attributes. Measurement/inspection, different types of control charts (X Bars, R, P. charts) and their constructions and their application. **[10]**
   Acceptance Sampling: Sampling inspection & percentage inspection, basic concept of sampling inspection, operating characteristic curves, conflicting interests of consumer and producer, producer and consumers risks, AWQL, LTPD, ADGL, single and double sampling plans.

Outcome(s): *After successful completion of this course the student will be able to:*
- *Make various comparative measurements.*
- *Understand fundamentals of gears, thread measurements and measurements of surface finish.*
- *Control chart techniques in quality control.*
- *Purpose and use of sampling and its benefit.*

AHEP4 Mapping with Module outcomes

C1: Student will apply; integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline.
C3: Considering limitation of different techniques, students can apply various measurement techniques.
C4: Student can understand of the use of technical literature and other information sources.
C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

Text Books:

1. Anand Bewoor & Vinay Kulkarni, "Metrology and Measurement", McGraw –Hill, 2009.
2. Mahajan M., "Statistical quality Control",Dhanpat Rai & Sons, Latest Edition.

Reference Books:

1. Jain R. K, "Engineering Metrology", Khanna Publishers, Latest Edition.
2. Gupta I. C, "Engineering Metrology", Dhanpatrai Publications, Latest Edition

ME 19.307 **Production Technology-II** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.205, ME 19.208, ME 19.112

Objective(s):

- *To understand the basic principles of metal forming, welding and casting processes*
- *To know the various types of melting practices*
- *To broaden the understanding of casting design principles*

1. **Metal Forming:** Nature of plastic deformation, deformation mechanism, hot and cold working, rolling principal, rolling stand arrangement, roll passes, sheet metal working processes bending, bend force, press work tool and types of dies. Forging, Extrusion and other Processes: Forging operations, forging design, drop forging die design; Extrusion-principle, forward and backward extrusion, impact extrusion, hydrostatic extrusion, extruding tubes; Wire drawing- rod and tube drawing, tube making, swaging. **[10]**
2. **Metal Fabrication Process:** Introduction to fabrication process, gas welding and cutting. Electric arc welding-principle of arc, arc welding equipment, electrodes, carbon arc welding, TIG GMAW, SAW, arc cutting Resistance welding, Other welding process: Thermit welding, electro slag welding, EBW, laser beam welding, forge welding, friction welding, diffusion welding, explosion welding, Welding design: heat input, heat flow, distortion, metallurgy of welding, defects in welding, brazing, braze welding and soldering **[8]**
3. **Metal Casting Process:** Introduction, Casting terms Patterns: Pattern allowance-pattern materials-types of patterns- colour codes Moulding materials: Moulding sand composition-testing sand properties-sand preparation-moulding sand properties-types of sand moulds-moulding machines Cores: Core sand, types of cores, core prints, chaplets, forces acting on the moulding flasks, Gating system: Elements of gating system, gates, pouring time, sprue, gating ratio, slag trap system, risering design-caine's method, modulus method, chills-feeding aids. **[9]**
4. **Powder Metallurgy & Rapid Prototyping:** Introduction, basic process, powder manufacturing, powder mixing and blending, composting, sintering. Introduction to rapid prototyping, role of rapid prototyping & rapid tooling, features and classifications. **[5]**
5. **Non Traditional Machining:** AJM, WJM, EDM, ECM, USM: working principle, components of set up, field of application, Parameters affecting machining characteristics, Material removal mechanism. **[8]**

Outcome(s): *Student will be able to*

- *Choose forming techniques for various applications*
- *Develop welding techniques for various alloys*
- *Develop welding application concepts*
- *Develop suitable casting techniques for specific applications*
- *Design of gates and risers in castings*

AHEP4 Mapping with Module outcomes

C1: Student can understand the knowledge of characteristics of particular materials, equipment, processes, or products for machining on different machine tools.
C3: Considering limitations of machining, students can select metal forming process.
C4: Student can refer literature for appropriate machining parameter for machining different materials.
C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving metal forming problem.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

Text Books:

1. Rao P. N, "Manufacturing Technology", Tata McGraw-Hill, Fourth Edition.
2. Lindberg Roy A, "Processes and Materials of Manufacture", Fourth edition PHI Latest Edition.

Reference Books:

1. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Fourth Edition, John Wiley & Sons.
2. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, 7th Edition, Pearson.

ME19.308 **Design of Machine Elements -II** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s) ME19.101, ME 19.201, ME 19.206

Objective(s)

- *Develop an ability to apply knowledge of mathematics, science, and engineering*
- *To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.*
- *To develop an ability to identify, formulate, and solve engineering problems.*
- *To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

1. **Design of Gears:** Different types of gears – spur, helical, bevel and worm gears, Beam strength, wear strength, dynamics loads on gears, estimation of module based on beam strength and wear strength, Thermal consideration design of worm gears. **[14]**

2. **Friction Clutches and Brakes:** Different types of clutches, torque transmitting capacity for multidisc clutches, cone clutches, centrifugal clutches, Friction materials for clutches lining, energy equation and thermal considerations. Different types of brakes, Energy equations, Design of block brake, Design of band brake, Design of disc brake, Thermal consideration. **[9]**

3. **Rolling Contact Bearings:** Types of rolling contact bearings, Selection of bearing type, Static load carrying capacity, Equivalent bearing load, Load life relationship, selection of bearing life, Selection of bearing from manufacture's catalogue, Selection of taper roller bearings, Design of cyclic loads and speeds lubrication of bearing contact bearings, Mounting of bearings. **[6]**

4. **Sliding Contact Bearing:** Basic mode of lubrication, Petroff's equation, Mckee's Investigation, Reynold's equation, Raimondi Boyd method, Bearing design- selection of parameters, Bearing materials and construction, selection of lubricant. **[6]**

5. **Miscellaneous Machine Elements:** Engine crank shaft, connecting rod, cylinder head, pressure vessels. **[5]**

Outcome(s)

- Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.
- Demonstrate knowledge on machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.
- Be able to approach a design problem successfully, taking decisions when there is not a unique answer.

AHEP4 Mapping with Module outcomes	• C1: Student will understand and knowledge of mathematical and statistical methods necessary to underpin their education in their engineering discipline and to enable them to apply mathematical and statistical methods, tools and notations proficiently in the analysis and solution of engineering problems. • C3: Student will understand the assembly of systems and components modelling

	techniques. • C5: Student can investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems. • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Bhandari, V. B. "Design of machine elements". Tata McGraw-Hill Education, 2010
2. Gupta, J. K., and R. S. Khurmi. "A textbook of machine design." SI Edition 2005

Reference Books:

1. Norton, Robert L. "Machine design: an integrated approach", Prentice-Hall Inc: NJ, USA, 1996
2. Shigley, Joseph E., and Charles R. Mischke. "Machine Engineering Design.", McGraw-Hill Book Company, 1989
3. Spotts, Merhyle Franklin. "Design of machine elements". Vol. 730. Englewood Cliffs: Prentice-Hall, 1985.

Assessment Diet Theory

Components	Mid Term Examination (Internal)	Class Work	End Term Examination (External)	Total
Weightage	40%	10%	50%	100%

ME 19.309 **Thermal Engineering System** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 19.203

Objective(s):

- *Thermodynamics is an essential part of engineering curricula, and has a broad application area such as transportation vehicles, power generation and cooling systems.*
- *The course will cover the basic principles of thermodynamics and will give students knowledge about how thermodynamics is applied in engineering practice.*

1. **Steam Generator and Draft:** Introduction; classification of boilers; comparison of fire tube and water tube boiler; their advantages; description of boiler; Lancashire; locomotive; Babcock; Wilcox and etc, boiler mountings and accessories; natural draught chimney design; artificial draught; stream jet draught; mechanical draught; calculation of boiler efficiency and equivalent evaporation. Introduction to high pressure boiler **[8]**
2. **Steam & Gas Nozzles:** Flow through nozzle, Variation of velocity, Area and specific volume, Choked flow, Throat area, Nozzle efficiency, off design operation of nozzle, Effect of friction on nozzle, critical pressure ratio for maximum discharge; physical explanation of critical pressure; super saturated flow of steam; design of steam nozzle. **[8]**
3. **Steam Turbines:** Introduction; classification of steam turbine; impulse turbine; working principal; compounding of impulse turbine; velocity diagram; calculation of power output and efficiency; maximum efficiency of a single stage impulse turbine; design of impulse turbine blade section; impulse reaction turbine; working principle; degree of reaction; parsons turbine; velocity diagram; calculation of power output; internal losses in steam turbine; governing of steam turbine. **[10]**
4. **Compressors:** Classification, single and multistage reciprocating compressors, isothermal and volumetric efficiencies, centrifugal and axial flow compressors, surging, choking and stalling. **[6]**
5. **Steam Condensers:** Component of steam condensing plant; types of condensers; air leakage in condensers; Dalton's law of partial pressure; Condenser vacuum, sources of air leakage & its disadvantages, vacuum efficiency; calculation of cooling water requirement; air expansion pump. **[8]**

Outcome(s):

- *Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques,*
  including the use of empirical data and property tables
- *Tto the analysis of representative fluid and thermal energy components and systems.*
- *Apply basic fluid mechanic, thermodynamic, and heat transfer principles and techniques,*
  including the use of empirical data and property tables
- *To the design analysis of auxiliary fluid and thermal energy components and systems representative of the systems encountered in the practice of electrical, industrial, and related disciplines of engineering.*

AHEP4 Mapping with Module outcomes

- C1: Student will get Knowledge and understanding of scientific principles and methodology necessary to underpin their education in their engineering discipline, to enable appreciation of its scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies.
- C2: Student can understand of engineering principles and the ability to apply them to analyze key engineering processes.
- C3: Student can describe the performance of systems and components through the use of analytical methods and modelling techniques.
- C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software.
- C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems.

Text Books:

1. Yadav R, "Steam & Gas Turbines and Power Plant Engineering", Central Publishing House, 7th Edition, 2009.
2. Kearton W. J, "Steam Turbine Theory and Practice", CBS Publisher & Distribution Pvt. Ltd, 2011.

Reference Books:

1. Ballaney P. L, "Thermal Engineering", Khanna Publishers, 24th Edition, 2007.
2. Chattopadhyay P, "Boiler Operation Engineering", Tata McGraw Hill, 11th Edition, 2008.

ME 19.310 **Renewable Energy Technology** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): ME 19.203, ME 19.305

Objective(s):

- *To familiarize students with the various renewable energy sources.*
- *Awareness of the potential of renewable energy technologies, for sustainability in particular.*
- *Suitable applications of solar, wind, biomass, hydro, geothermal and ocean energy.*
- *Awareness and development of suitable social and economic models with implications.*

1. **Importance and applicability of renewable energy sources**: Energy Resources and Their Utilization, Environmental Aspects of Electric Energy Generation. **[8]**
   Technology and economics of solar thermal systems: Solar Radiation and Its Measurement, Solar Thermal Energy Collectors, Solar Thermal Energy Conversion Systems. Solar Photovoltaic System
2. **Technology and economics of wind power:** Types of turbines and their aerodynamics. Theories of wind turbines. WECS components and state of art Feasibility of large wind turbines. Wind Farms. **[10]**
   Technology and economics of small hydro: Types and theories of small, mini, and micro hydro turbines. Hydroelectric systems and advantages at small hydro levels. Conversion apparatus and feasibility.
3. **Technology and economics of geothermal, wave and tidal energy systems:** Geothermal Energy, Wave and tidal turbines. Harnessing wave energy, applicability and feasibility, Electric Power Generation by Ocean Energy. **[8]**
4. **Technology and economics of biogas and biopower:** Biofuel production and gasification. Biopower generation methods with technical details: steam, combined cycle, cogeneration. **[6]**
5. **Fuel Cells, Hydrogen and Hybrid systems:** Fuel Cells, Hydrogen Energy System, Hybrid Systems. **[8]**
   Environmental Impact: Environmental impacts of renewable energy sources and remedial measures. Global Climate Change.

Outcome(s): *Upon successful completion of this course, the student will be able to:*

- *Identify appropriate renewable technology for application.*
- *Implement concepts of clean development mechanism (CDM) and carbon credits.*
- *Utilize energy management and renewable energy systems in everyday life.*
- *Select eco-friendly, cost effective, energy efficient alternatives to unsustainable practices.*

Text Books:

1. Rai, G. D., "Non-Conventional Energy Sources", Khanna Publication, First Edition, 2010.
2. Tiwari, G. N. and Ghosal, M. K., Renewable energy resources: basic principles and applications. Alpha Science International, First Edition, 2005.

Reference Books:

1. Khan, B.H., "Non-Conventional Energy Resources", Tata McGraw-Hill, First Edition, 2006.
2. Kothari DP, Singal KC, Ranjan R. Renewable energy sources and emerging technologies. PHI Learning Pvt. Ltd.;2nd Edition 2011.

ME 19.311 **CAD/CAM** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s) ME 19.101, ME 19.206, CS 19.101

Objective(s)

- *Understand the applications and benefits of CAD*
- *Understand geometric transformation.*
- *Understand various representations of curves and surfaces.*
- *Understand the various concepts and characteristics in geometric modelling.*
- *Understand the basic concepts of CAM. Analyze the components and systems of NC and CNC machine tools. Understand and apply various programming methods for specific jobs.*
- *Classify various CAPP systems.*
- *Understand FMS and CIMS with reference to components, advantages and applications.*

1. **Fundamentals of CAD**: Introduction: Design Process: Application of computers in design: Creating manufacturing database: benefits of CAD. Computer Hardware; Graphic input devices; display devices; Graphics output devices; Central processing unit (CPU). CAD software and Database: Software configuration of a graphics system: functions of a graphics package: geometric modeling: Database structure and control; Graphics standard: GKS and IGES. **[4]**

2. **Geometric Transformations, Curves and Surfaces**: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrices. Application of geometric transformations. Polygon, meshed and ruled surfaces: Bezier curves; B-spline curves. **[10]**

3. **Geometric Modeling**: Wireframe model: solid modeling: representation, volumetric properties, surface modeling, concepts of hidden-line removal and shading: Kinematics analysis and simulation. Application of CAD techniques to finite Element Mesh Generation. Computer Aided Manufacturing (CAM) **[8]**

4. **Introduction of CAM**: Basic concepts of manufacturing system and CAD/CAM. NC/CMNC Machine Tools; NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system. **[12]**

5. **Computer Aided Process Planning and Automation**: Introduction and benefits of CAPP. Types of CAPP systems, machinability data selection systems in CAPP. Introduction to Automation **[6]**

Outcome(s)

- *Understand the capabilities of general Computer Aided Designing Systems and CAD Systems for designing mechanical parts and elements in 2D and 3D dimensions.(C1, C2, C4)*
- *Use effectively CAD / CAM systems in order to produce the final NC code for the manufacturing of various mechanical parts and carry out exchange of data between CAD and CAM systems.(C5,C6, C12)*
- *Describe the principles of various manufacturing processes, manufacturing technology (C17)*

AHEP4 Mapping with Module outcomes	• C1: Student will apply quantitative and computational methods in order to solve engineering problems and to implement appropriate action. • C2: Student can understand of engineering principles and the ability to apply them to analyse key engineering processes. • C4: Student will apply their skills in problem solving, communication, information retrieval, working with others and the effective use of general IT facilities like modeling software. • C5: Student can define the problem, identifying any constraints including environmental and sustainability limitations; ethical, codes of practice and standards. • C6: Student will understand of, and the ability to apply, an integrated or systems approach to solving engineering problems • C12: Student will develop the ability to apply relevant practical skills • C17: Student can demonstrate or communicate their work to technical and non-technical audiences.

Text Books:

1. Groover, Mikell P. "Automation, production systems, and computer integrated manufacturing". Prentice Hall Press, 2007.
2. Zeid Ibrahim, "CAD/CAM : Theory & Practice", Tata Mc Graw Hill Publication, 1998

Reference Books:

1. Rao, Posinasetti Nageswara. "CAD/CAM: principles and applications". Tata McGraw-Hill Education, 2004.
2. Radhakrishnan, Pezhingattil, S. Subramanyan, and V. Raj "CAD/CAM/CIM". New Age International, 2008.
3. Leondes, Cornelius T. "Computer aided and integrated manufacturing systems: a 5-volume set". Vol. 5. World scientific, 2003.

Assessment Diet Theory

Components	**Mid Term Examination (Internal)**	**Class Work**	**End Term Examination (External)**	**Total**
Weightage	40%	10%	50%	100%

UC 19.101 **Social and Professional Ethics** **Total Lectures: 26**

2-0-0-2

Objective: To create an awareness on professional ethics and human values, To instill moral and social values and loyalty and to appreciate the rights of others.

1. **Basic Human Values:** Morals, Values and Ethics – Truth, Rights Conduct (Righteousness), Love, non-violence and peace, Humility and character. Core areas of ethics: Social ethics, Personal ethics Integrity and Trustworthiness, Honesty, Loyalty, Courage, Prudence, Confidence, Confidentiality. **[5]**

2. **Theories of Ethics:** Kohlberg and Gilligan's analysis of moral development, - Deontology, Utilitarianism, Virtue Theory Rights Theory, Casuist Theory of Consequentialism – Robert Nozick's Theory of Entitlement and Property Rights. **[4]**

3. **Professional Ethics:** Introduction, meaning of work ethics, professional ethics for Journalists, Physicians, Lawyers, Engineers and Accountants. Intellectual property Rights, scope of ethics, code of conduct, business values and inner consciousness, Ethics at the workplace cybercrime, plagiarism, misconduct, fraudulent use of institutional resources, etc. **[7]**

4. **Corporate Social Responsibility:** Evolution of Corporate Social Responsibility (CSR) in India, CSR models, CSR to different stakeholders, Corporate Social Responsibility Initiatives of Major Companies of India, Promoting value based governance in organization. Whistle blower policy. **[6]**

5. **Ethics and Environment:** Introduction to environmental Issues- Industry and Environmental Pollution, Ethics of Controlling environmental pollution – Impact of environmental pollution on human health – Rights, Duties and care in environmental protection - Sustainable development. **[4]**

Outcome: The students will understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories.

Text Books:

1. B.N Ghosh "Business Ethics and Corporate Governance", McGraw Hill Education, Chennai, 2016
2. John R Boatright, "Ethics And The Conduct Of Business", Pearson Education, New Delhi, 2013.

Reference Books:

1. Raju Ramachandran, "Professional Ethics: Changing Profession and Changing Ethics", LexisNexis, Butterworths, 2nd Edition 2014.
2. Andrew Crane and Dirk Matten, "Business Ethics", Oxford University Press, 2nd Edition, 2015.
3. S.K Mandal "Ethics in Business and Corporate Governance" McGraw Hill Education, New Delhi, 2013.
4. R. Subramanian "Professional Ethics", Oxford University Press, 2015.

MA 19.101 **Mathematics I** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: (10+2) Higher Secondary Mathematics

1.	**Differential Calculus I:** Review of basic concepts, partial differentiation, Euler's theorem on homogeneous functions, Maclaurin's and Taylor's series (one and two variables) and Jacobians.	[06]
2.	**Differential Calculus II:** Maxima and minima of functions of two variables, asymptotes, Tracing of simple cartesian curves and standard polar curves.	[06]
3.	**Integral Calculus:** Basics of Beta and Gamma functions, Length of plane curves(cartesian and polar), area bounded by the curves(cartesian and polar), multiple integrals (double and triple integrals, change of order of integration), volumes, conversion from cartesian to polar form, physical interpretations and applications.	[12]
4.	**Matrix Theory**: Rank of matrix, linear dependence and independence of vectors, solution of system of simultaneous linear equations, Eigen values, Eigen vectors of a matrix, statement of Cayley-Hamilton theorem (without proof) , reduction of a matrix to diagonal form, quadratic forms, linear transformation of a quadratic form, and applications.	[08]
5.	**Three-dimensional Geometry:** Direction cosines and direction ratios of a straight line, equation of a plane, plane passing through intersections of two planes, equations of straight line, shortest distance between two skew lines, equation of a sphere, intersection of plane and sphere.	[08]

Outcome: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. Shanti Narayan and Mittal, Analytical Solid Geometry, S. Chand, 2018.

Reference Books:

1. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Pal and Bhunia, Engineering Mathematics, Oxford University Press, 2015.
3. Dass and Verma, Higher Engineering Mathematics, S.Chand, 2019.

PY19.101 **Engineering Physics** **Total Lectures: 40**

Pre-requisite: Fundamental knowledge of Basic Physics **3-0-0-3**

Objective:

1. To provide students with a basic understanding of the Physics that may be required by engineers in the course of their careers
2. To enhance knowledge related to lasers and its different components to make it suitable for various purposes
3. To introduce most important concepts of superconductivity, crystallography and fiber optics to the students
4. To introduce the learners to the basics of modern physics and Quantum Mechanics

1.	**Modern Physics**: Introduction to Black body radiation spectrum, Photo-electric effect, Compton effect. Wave particle Dualism. de Broglie hypothesis – de Broglie wavelength, extension to electron particle. Davisson and Germer Experiment. Matter waves and their Characteristic properties, Phase velocity, group velocity and Particle velocity, Relation between phase velocity and group velocity, Relation between group velocity and particle velocity. Expression for deBroglie wavelength using group velocity.	**[8]**
2.	**Quantum Mechanics:** Heisenberg's uncertainity principle and its physical significance. Application of uncertainty principle (Non-existence of electron in the nucleus, explanation for decay and kinetic energy of electron in an atom). Wave function, Properties and physical significance of wave function, Probability density and Normalization of wave function. Setting up of one dimensional time independent Schrodinger wave equation. Eigen values and Eigen functions. Application of Schrodinger wave equation – Energy Eigen values for a free particle. Energy Eigen values and Eigen functions for a particle in a potential well of infinite depth.	**[7]**
3.	**Electrical Conductivity in Metals**: Free–electron concept. Classical free-electron theory – Assumptions. Drift velocity, Mean collision time and mean free path. Relaxation time. Expression for drift velocity. Expression for electrical conductivity in metals. Effect of impurity and temperature on electrical resistivity of metals. Quantum free-electron theory – Assumptions. Fermi – Dirac Statistics. Fermi-energy, Fermi factor. Density of states (No Derivation). Expression for electrical resistivity / conductivity. Temperature dependence of resistivity of metals. electron in a periodic potential, origin of the energy gap, band theory of solids, distinction of solids into metals, semi-conductors and insulators.	**[8]**
4.	**Dielectric & Magnetic Properties of Materials**: Dielectric constant and polarization of dielectric materials. Types of polarization. Equation for internal field in liquids and solids (one dimensional). Ferro and Piezo electricity. Frequency dependence of dielectric constant. Important applications of dielectric materials. Classification of dia, para and ferro-magnetic materials. Hysterisis in ferromagnetic materials. Soft and Hard magnetic materials. Applications.	**[7]**
5.	**Lasers and Optical Fibers**: Einstein's coefficients (expression for energy density). Requisites of a Laser system. Condition for laser action. Principle, Construction and working of CO2 laser and semiconductor Laser. Applications of Laser – Laser welding, cutting and drilling. Measurement of atmospheric pollutants. Holography–Principle of Recording and reconstruction of images, applications of holography. Propagation mechanism in optical fibers. Angle of acceptance. Numerical aperture. Types of optical fibers and modes of propagation. Attenuation. Applications–Block diagram discussion of point to point communication.	**[10]**

Outcome: The student will be able to understand many modern devices and technologies based on lasers and optical fibers. Student can also appreciate various material properties which are used in engineering applications and devices.

Text Books:

1. S. O. Pillai, "Solid State Physics", New Age International, Sixth Edition, 2009
2. V. Rajendran, "Engineering Physics," TMH, Fifth Edition , 2013

Reference Book:

1. G. K. Shivkumar, "Engineering Physics," Prism Book Pvt. Ltd.
2. Stephen T. Thornton, "Modern Physics for Scientists and Engineers",Cengage Learning, 4th ed.,2013

CY 19.102 **Environmental Studies** **Total Lectures: 52**

Prerequisite(s): NIL **Credit: 3-1-0-4**

Objective(s):
- To teach the principal resources, renewable energy systems and biosphere.
- To explore the environmental impact of various energy sources and also the effects of different types of pollutants.

1. **Multidisciplinary nature of environmental studies:** Definition, scope and importance, Need for public awareness. [2]

2. **Natural Resources:** Renewable and non-renewable resources: Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. [8]
Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.
Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

3. **Ecosystems & Biodiversity:** [14]
Ecosystems: Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow and nutrient cycling in the ecosystem. Food chains, food webs and ecological pyramids. Ecological succession
Structure and function of the following ecosystem - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).
Biodiversity and its conservation: Introduction – Definition, genetic, species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic values. Biodiversity at global, national and local levels. Hot-sports of biodiversity. India as a mega-diversity nation, Threats to biodiversity: habitat loss, illicit poaching, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

4. **Environmental Pollution:** Definition, cause, effects and control measures of : Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. [8]
Role of an individual in prevention of pollution. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides.

5. **Social Issues, Human Population and the Environment:** From Unsustainable to Sustainable development: Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people: its problems and concerns. Global Climate Change, global warming, acid rain, ozone layer depletion. Wasteland reclamation. Population growth, variation among nations. Population explosion – Family Welfare Programme. Environment and human health. Human Rights. Value Education. HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies.Environment Protection Act 1986. Air (Prevention and Control of Pollution) Act 1981., Water (Prevention and control of Pollution) Act 1974, Wildlife Protection Act 1972., Forest Conservation Act 1980. [13]

Field work [7]
- Visit to a local area to document environmental assets river/forest/grassland/hill/mountain
- Visit to a local polluted site-Urban/Rural/Industrial/Agricultural
- Study of common plants, insects, birds.
- Study of simple ecosystems-pond, river, hill slopes, etc.

Outcome(s): Upon successful completion of the course, students should be able to:
- Measure environmental variables and interpret results
- Evaluate local, regional and global environmental topics related to resource use and management
- Propose solutions to environmental problems related to resource use and management
- Interpret the results of scientific studies of environmental problems
- Describe threats to global biodiversity, their implications and potential solutions.

Text Books:

1. ErachBharucha “Environmental Studies”, University Grants Commission, 2004.
2. G. Boyle, Renewable energy: Power for a sustainable future’. Oxford University press. 2004.

Reference Books:

1. C. William, P. Saigo, B Woodworth, “Environmental Science: A Global Concern”, Sixth Edition McGraw-Hill Higher Education, 2001.
2. R.T. Wright, D.F. Boorse, “Environmental Science” 11th Edn, PHI, 2010.

EE 19.101 **Elements of Electrical Engineering** **Total Lectures: 40**

3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

Pre-requisite: Nil

1.	**DC Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation using mesh and nodal method. Network Theorems - Superposition, Thevenin, Norton and Maximum power transfer Theorems. Time-domain analysis of first-order RL and RC circuits.	**[8]**
2.	**AC Circuits:** Basic terminologies, representation of sinusoidal waveforms, average, rms and peak values of a.c. quantities, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel).	**[8]**
3.	**Three Phase A.C. Circuits:** Three phase supply, phase sequence, star connection, delta connection, relationship between phase and line quantities in 3-phase circuits, measurements of three phase power under balanced condition.	**[6]**
4.	**Transformers:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, Transformer testing: open circuit and short circuit test, losses in transformers, regulation and efficiency. Basics of auto-transformer and three-phase transformer connections.	**[10]**
5.	**Electrical Machines:** DC Machines – construction, functions of each part, working principle, EMF and torque equations, types of dc machines. AC machines – classification of a.c. machines, construction, operating principles of ac machines.	**[8]**

Outcome: At the end of this course, students will demonstrate the ability to

- To understand and analyse basic electric and magnetic circuits.
- To study the working principles of electrical machines.

Text Books:

1. Kothari, D. P., and I. J. Nagrath, "Theory and Problems of Basic Electrical Engineering," PHI Learning Pvt. Ltd., 1998.
2. Fitzgerald, Arthur Eugene, David E. Higginbotham, and Arvin Grabel, "Basic electrical engineering," McGraw-Hill Series in Electrical Engineering, Auckland: McGraw-Hill, 1981, 5th ed.(1981).

Reference Books:

1. H.Cotton, "Advanced Electrical Technology," CBS Publication. 1967.
2. Vincent Del Toro, "Electrical Engineering Fundamentals," 2nd Edition PHI Publication. 1972.

Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", PHI Publication, 1st Edition, 2007.

CS 19.101 **Programming Language** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): NIL

Objective(s):

1. To learn principles of programming by the structured native language 'C'.
2. To comprehend the rudiments, constructs, syntax, and statements with essentials of efficient compiling, running and debugging processes.

1.	**Introduction:** The role of programming languages, programming paradigms, language description and syntax structure, basics of structured and object-oriented programming, functional programming, logic programming, concurrent programming.	[10]
2.	**Fundamentals of 'C' language**: Character set, variables data types constants, arithmetic,relational and logical operators, type conversion,increment,decrement, bitwise and assignment operators, conditional expressions, statements and blocks, *if-else*,*switch*, loops-*do-while*, *while*, *for*;*break*, *continue* and *goto* statements, labels.	[10]
3.	**Functions, pointers and Arrays**: Basics of functions, automatic, external, static and register variables, scope rules, and header files, recursion and C preprocessor, arrays, pointers and addresses, pointers and arrays address arithmetic, character pointers and functions, pointer arrays, pointers to functions, pointers and multidimensional arrays, command line arguments.	[10]
4.	**Structures and unions:** Basics of structures and functions, arrays of structures, pointers to structures, self-referential structures, unions.	[5]
5.	I/O and File Processing: Concept of files, standard input and output, formatted output, file access in different modes, reading from and writing to a file.	[5]

Outcome(s): Students would be able to apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner.

Text Books:

1.Brain W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second edition, Pearson Education, 2013,

2.Ravi Sethi&K.V.Viswanatha, Programming Languages-Concepts, and Constructs, Second edition, Pearson Education,2013,

Reference Books:

1.Herbert Schildt, C: The Complete Reference, Fourth Edition, McGraw-Hill Education, 2017

2.E Balagurusamy, Programming in ANSI C, Tata McGraw - Hill Education,6th edition,2012

PY 19.111 **Physics Laboratory** **0-0-2-1**

Pre-requisite: Nil

Objective:
1. To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
2. To apply the analytical techniques and graphical analysis to the experimental data.

List of Experiments:

1. To study of material constant, temperature coefficient of current and planck's constant.
2. To determine the specific resistance of a given wire by using the Carey Foster's bridge.
3. To determine the ballistic constant, K of a moving coil ballistic galvanometer with a standard capacitor of known capacity.
4. To determine the high resistance by the method of leakage of a condenser with the help of ballistic galvanometer.
5. To study the variations of resistivity with temperature and hence determines the energy band gap of the given semiconductor with help of four probe method.
6. To convert a galvanometer into a voltmeter of a given range.
7. To convert a galvanometer into an ammeter of a given ranges.
8. To plot graph showing the variation of magnetic field with distance along the axis of a circular coil carrying current and to estimate from it the radius of the coil.

Outcome: Students will be convergent with operation of equipments and verify the principle of Physics by doing the experiments. Students will be able to apply the analytical techniques and graphical analysis for finding out the experimental results.

EE 19.111 **Electrical Laboratory** **0-0-2-1**

Objective: The objective is to provide a basic exposure of installation and operation of electrical equipment.

Prerequisite: Nil

Perform any ten of the list.

1. To Study of the various apparatus used in Electrical Engineering.
2. To perform residential house wiring using fuse, indicator, switch, Socket, plug and lamp.
3. To design a Stair case wiring for illuminating a lamp.
4. To design Tunnel wiring for illuminating three lamps.
5. To construct a fluorescent tube and to measure voltage across tube rod, voltage across choke and current.
6. To conduct the polarity test on the given transformer.
7. To conduct the open circuit & short circuit tests on the given single phase transformer and to determine equivalent circuit parameters.
8. To control the speed of DC machine by field current control method.
9. To control the speed of DC machine by Armature Voltage control method.
10. To measure three phase power by using two wattmeter methods.
11. To verify Superposition Theorem using resistive circuit.
12. To verify Thevenin's Theorem using resistive circuit.

Outcome: Students will be convergent with installation and operation of electrical equipment.

Text Books:

1. J.B. Gupta, Theory and Performance of Electrical Machines, S.K. Kataria and Sons, 3rd Edition, 2002.
2. Kothari, D. P., and I. J. Nagrath. Theory and Problems of Basic Electrical Engineering. PHI Learning Pvt. Ltd., 1998.

Reference Books:

1. P.S. Bimbhra, "Electrical Machinery", Khanna Publishers, 5th Edition, 2013.
2. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", PHI Publication, 1st Edition, 2007.

CS 19.151 **Programming Language Laboratory** **Total Hours:26**
Credit: 0-0-2-1

Prerequisite(s): NIL

Objective(s):

- To make students familiar with syntax and structure of C-programming.
- To learn problem solving techniques using C programs implementation.

List of Practicals

1. Implement the logic of Data Types & Operators.
2. Implement the logic of Type Conversions.
3. Implement the logic of Arithmetic, Relational, and logical operators.
4. Implementation of Bitwise, unary, assignment operators.
5. Implementation of Increment and Decrement operators.
6. Implementation of Conditional operators.
7. Implement the logic of Increment and Decrement operators.
8. Implement programs in order to cover Control Structure, If-Else statements, Nested If-Else statements, Switch-case statement, Loops- For, While, Do-While, Break Continue, Go-To Statements, and Labels.
9. Implement programs in order to cover processing an array, passing arrays to functions, Multidimensional arrays.
10. Implement programs to cover all possible String operations.
11. Implement programs in order to cover Function prototypes and passing arguments to a function, Recursion.
12. Implement programs in order to cover Pointers declaration, operations on pointers, Array of pointers, pointers to arrays.
13. Implementation of structure and union programs.
14. Implement the use of Storage classes in C programming.
15. Implement programs for Reading and writing from/to a file.

Outcomes On completion of this course student will be able to:

- Apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner

UC 19.102	Communication Skills	Total Lectures: 26
		2-0-0-2

Objective:	This Course aims to develop and enhance the linguistic and communicative competence of the students. The students will be exposed to various forms of personal and professional communication. The self-learning tasks designed will facilitate to enhance effective communication skills.	
1.	**Introduction to Communication:** Need for Effective Communication, The Process of Communication, Use of language in communication; Barriers to Communication: Types of barriers (Semantic, Intrapersonal, Interpersonal, And Organizational); Miscommunication; Noise; Overcoming measures. **Technology-based Communication:** Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software.	[5]
2.	**Listening and Reading Skills:** Listening as an active skill; Types of Listeners; Listening for general content; Listening to fill up information; Intensive Listening; Listening for specific information; Developing effective listening skills; Barriers to effective listening skills. **Reading Skills**: Previewing techniques; Skimming; Scanning; Understanding the gist of an argument; Identifying the topic sentence; recognizing coherence and sequencing of sentences; Improving comprehension skills.	[6]
3.	**Writing Skills**: Sentence formation; Use of appropriate diction; Paragraph and Essay Writing; Coherence and Cohesion. Common Errors. **Letter Writing:** Formal, informal and demi-official letters; **Job Application:** Cover letter, Differences between bio-data, CV and Resume. **Report Writing**: Basics of Report Writing; Structure of a report; Types of reports.	[6]
4.	**Non-verbal Communication and Body Language:** Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language.	[3]
5.	**Interview Skills:** Types of Interviews; Ensuring success in job interviews; Appropriate use of non-verbal communication. **Group Discussion:** Differences between group discussion and debate; Ensuring success in group discussions. **Presentation Skills:** Oral presentation and public speaking skills.	[6]

Outcome:	The students would hone the skills of reading, writing, listening, and speaking and become adept at communicating in the current modern context.
Text Books:	1. Raman, M., & Singh, P. (2017). Business Communication (2nd edition.). New Delhi: Oxford University Press.
	2. Lesikar, Raymond V and Marie E. Flatley. Basic Business Communication: Skills for Empowering the Internet Generation: Ninth Edition. New Delhi: Tata McGraw-Hill,
Reference Books:	1. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Publishing Company Limited
	2. Bonet, Diana. The Business of Listening: Third Edition. New Delhi: Viva Books, 2004.

MA 19.102 **Mathematics II** **Total Lectures: 40**

3-1-0-4

Objective: To acquire fundamental knowledge of Mathematics and apply in engineering disciplines.

Pre-requisite: Mathematics I

1.	**Computational Methods:** Introduction and importance of numerical analysis, calculus of finite differences, interpolation schemes for equal and unequal intervals (Newton's forward and backward interpolation formulae), divided difference, interpolation for unequal intervals (Newton's divided difference and Lagrange interpolation formulae), Solution of algebraic and transcendental equations by Newton-Raphson method. Applications to Engineering.	[12]
2.	**Ordinary Differential Equations I:** First order and first degree differential equations (variable separable, homogeneous and non-homogeneous, linear, Bernoulli's equation, and exact equations).	[06]
3.	**Ordinary Differential Equations II:** Linear differential equations of second order with constant and variable coefficients (complementary functions and particular integrals), and applications.	[06]
4.	**Partial Differential Equations:** Formation of partial differential equations, Lagrange's multipliers method for solution of first order differential equations, separation of variables for nonlinear differential equations and applications.	[06]
5.	**Vector Calculus:** Vector and scalar point functions, conservative fields, gradient of scalar point functions, divergence and curl of vector point functions (Solenoidal and irrotational vectors), directional derivative of scalar point functions, work done along a curve, Integration of vectors, line integral (work done), surface integral, volume integral, physical interpretations and applications.	[10]

Outcome: After completion of the course, students would be able to apply mathematical knowledge in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. Grewal, B.S. and Grewal, J.S., Higher Engineering Mathematics, Khanna Publishers, Daryaganj, New Delhi, 40th Edition, 2007.

Reference Books:

1. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Pal and Bhunia, Engineering Mathematics, Oxford University Press, 2015.
3. Dass and Verma, Higher Engineering Mathematics, S.Chand, 2019.

CY 19.101 **Engineering Chemistry** **Total Lectures: 39**

Prerequisite(s): NIL **Credit: 3-0-0-3**

Objective(s):

- To purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers their preparation, properties and uses.
- To develop the basics of protecting engineering materials from the natural forces.
- To understand the present day up-to-date knowledge of the contemporary energy sources.
- To build up the basis of the future Engineering materials like superconductors, conducting organic polymers, Nano materials etc.

1.	**Water treatment:** Hardness, types of hardness, degree of hardness and its estimation (EDTA methods). Numerical problems on degree of hardness.Boiler troubles: sludge and scale formation, Prevention of sludge and scale formation in boilers. Softening of hard water (Lime-Soda, Permutit, Ion Exchange and calgon methods). Numerical problems based on water treatment (Lime-Soda process).	[8]
2.	**Polymers:** Classification, Functionality, Types of polymerization, Mechanism of Addition polymerization. Plastics: thermoplastic and thermosetting resins. Preparation, Properties and Uses of Polyamides, Bakelite, Polyesters, Rubber, Vulcanization of Rubber, Synthetic Rubber viz. Buna-S, Buna-N, Butyl and Neoprene rubbers. Silicones-polysiloxanes and sulphur based polymers.	[8]
3.	**Electrochemistry and Corrosion:** Electrochemical Changes, Electrochemical cell and its classifications (Galvanic cell, electrolytic cell). Types of electrodes. Origin of electrode potential, Electrochemical Series. Electromotive force, Nernst equation of electrode potential. **Corrosion:** Definition and its significance, Theories of corrosion, Mechanism of corrosion, types of corrosion, Corrosion control (Corrosion inhibitors, Cathodic protection - sacrificial anodic and impressed current cathodic protection).	[8]
4.	**Fuels and Lubricants:** Introduction - Importance of fuels in Industries. Classifications of fuels, Comparison of solid, liquid & solid fuels, Calorific value of a fuel. Determination of calorific value by Bomb calorimeter. Refining and cracking of petroleum, knocking. Octane Number and Cetane Number. L.P.G., Coal gas and Producer gas.**Lubricants:** Introduction and Classification of Lubricants. Properties of Lubricants, Lubricant Oil, Grease, Emulsions.	[9]
5.	**New Engineering Materials:** Introduction: Superconductors, high and low temperature superconductors, organic electronic materials, Fullerenes and Nano materials, Industrial applications of fullerenes and Nano materials.	[6]

Outcome(s): The student will be able to understand the basis of the future Engineering materials like of lubricants, superconductors, conducting polymers, Nano materials etc and purification of the most valuable natural resource of the future-water.

Text Books:

1. Jain and Jain, "Engineering Chemistry," 16th Edition, Dhanpat Rai Publishing Company, 2015.
2. S.S. Dara, "A Text Book of Engineering Chemistry," 12th Edition, S. Chand & Company Limited, 2014.

Reference Books:

1. Peter Atkins, Julio de Paula, and James Keeler, "Atkins' Physical Chemistry" Eleventh Edition, Oxford University Press, 2017.
2. William D. Callister, "Materials Science and Engineering: An Introduction, Eighth Edition, John Wiley & Sons, Inc., 2010.

ME-19.101 **Applied Mechanics** **Total Lectures: 40**
3-1-0-4

Prerequisite Basic Mathematics and Physics

Objectives:
1. This course will help the student to acquire knowledge of basic engineering mechanics concepts and enhance their ability to solve open ended engineering problems.
2. To provide the student with a clear and thorough understanding of the theory and applications of engineering mechanics, covering both statics and dynamics.
3. To provide the student with a thorough understanding of the concept, drawing, and the use of free-body diagrams.
4. To be able to determine the Centre of Gravity and Moments of Inertia of simple geometric shapes and understand the physical applications of these properties.
5. To understand the use and be able to perform calculations related to friction forces in engineering applications.

1.	**Introduction:** Idealization of Mechanics, concept of Rigid Body, External Forces (Body forces & surface forces), Laws of Mechanics. **Force Systems and Equilibrium:** Introduction to vector, Statically Equivalent Force systems, Free Body Diagram, Equations of equilibrium and their applications to various system of forces.	**[10]**
2.	**Distributed Forces and Moment Of Inertia:** Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, Principle axes and Principle Moment of Inertia.	**[6]**
3.	**Friction:** Introduction of friction, Laws of friction, wedge, screw, belt, rolling friction.	**[6]**
4.	**Tension, Compression and Shear:** Normal stress and strain, Linear elasticity, Hooke's Law and Poisson's Ratio, Shear stress and shear strain, Relationship between modulus. **Beams:** Different support & load conditions, SFD, BMD	**[9]**
5.	**Kinematics of Particles:** Introduction, Rectilinear motion, Plane curvilinear motion, Rectangular coordinates, Tangential and normal coordinates, polar coordinates, Relative motion (Translating Axes), constrained motion of connected particles. **Kinetics of Particles:** Introduction, Force, Mass and acceleration, Newton's second law of motion, Equation of motion and solution of problems, Work and Energy, Impulse and Momentum.	**[9]**

Outcome: The students shall develop the ability to identify, formulate, and solve engineering problems related to forces and motion.

Text Books:
1. Hibbeler, Gupta R. C., "Engineering Mechanics," 11th ed., Pearson India, 2010.
2. Merian, J.L, Kraige, L.G., "Engineering Mechanics Vol I & II," 5th edition, Wiley India 2010.

Reference Books:
1. Timoshenko, S, Young, D.H, Rao, J.V, "Engineering Mechanics," 4th edition TMH, 2010.
2. Irving. H. Shames, "Engineering Mechanics," Prentice Hall Book Company, 1966.

EC 19.101 **Basics of Electronics Engineering** **Total Lectures: 40**

3-1-0-4

Prerequisite Basic Knowledge of Engineering and Applied Physics

Objective: To learn the fundamental principle and applications of electronics and communication engineering and devices.

1.	**Introduction:** Brief history of major inventions in ECE, Electronic test and measurement equipments, Specifications for electronic components.	**[3]**
2.	**Semiconductors**: Material and its properties, Formation of energy band diagram, Currents in semiconductors, Fermi-Dirac energy distribution, Types of semiconductors – Intrinsic and Extrinsic, Mass action law, Hall effect.	**[5]**
3.	**Diodes**:Introduction, Characteristic of ideal and real diode, Current components in diode, load characteristics, Breakdown in diode, Zener diode, Varactor diode, Tunnel diode, Clippers and Clampers, Rectifiers – Half and Full-wave rectifiers.	**[8]**
4.	**Transistors:** Introduction to pnp and npn transistors, current components, active, cutoff and saturation regions, CC, CB and CE configuration, Operating point, Biasing circuits, Bias Stability, Thermal runway and thermal stability.	**[8]**
5.	**Signals**: Definition, Classification of signals – Analog and Digital, Deterministic and Random signals, Power and Energy of signals, Bandwidth, Bit and Baud rate.	**[4]**
6.	**Basics and Applications of Communication**: Definition, Block representation of communication system, Modulation – Definition, Need of modulation, Frequency translation, Types of modulation - Analog and Digital, Multiplexing – TDM and FDM. Introduction to - Optical Fiber, Transmission line, Waveguides, Satellite communication and RADAR.	**[12]**

Outcome: Students will be able to understand the basic concepts of Electronic and Communication Engineering and devices .They are able to implement mini projects based on concepts of ECE.

Text Books:

1. George Kennedy, Bernard Davis, “Electronics Communication Systems”, Tata McGraw-Hill, 3rd Edition, 2007.
2. Behrouz Forouzan, “Data Communication and Networking”, McGraw-Hill, 4th Edition, 2006.

Reference Books:

1. David A. Bell, “Electronics Devices and Circuits”, PHI, 4th edition, 2008.
2. Wayne, Tomasi, “Advanced Electronic Communication Systems”, PHI, 6th edition, 2013.
3. Robert L. Boylestad, Louis Nashelsky, “Electronics Devices and Circuits Theory”, Prentice Hall, 10th Edition, 2009.

ME-19.111 **Computer Aided Engineering Drawing** **0-0-4-2**

Objective:

1. To improve the visualization skills.
2. To enable the students with various concepts like dimensioning, conventions and standards related to working drawings in order to become professionally efficient.
3. To impart the knowledge on understanding and drawing of simple engineering products.

1.	**Introduction to Computer Aided Sketching:** Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and free hand practice. Board Drawing vs. Computer- Aided Drawing. Introduction to Solid works Environments. Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP &LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, dimensioning, line conventions, material conventions and lettering.	[8]
2.	**Orthographic Projections**: Horizontal planes, Vertical planes, Front view, Top view, Side view, Projections, First and Third angle of projection, Projections of points, Principles of orthographic projections, Sketching of different views of given objects. Introduction to sketching in Solid works : 2-Dimenional Sketching, Sketching in Solidworks, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity.	[12]
3.	**Projections of Lines, Planes and Solids:** Lines inclined to both the principal planes, projection of Lamina inclined to both principal planes, Projections of solids: Axis inclined to both the reference planes and Intersection of solids. Introduction to part module in Solidworks: Extrude, Revolve, Sweep, Hole, Filleting, and Chamfering features.	[12]
4.	**Sections of solids and sectional orthographic views:** Sectional orthographic projections - Full, Half, Partial, revolved and removed surfaces. Introduction to drawing module in Solidworks: Standard 3 views, Auxiliary view, Section View, Projected view.	[12]
5.	**Isometric Projection:** Terminology, Isometric scale, Box method, Coordinate or offset method, Four-center method, isometric projection of arcs. Solid models practice using Solidworks part module.	[8]

Outcomes:

1. Students will be able to improve their visualization skills so that they can apply these skills in developing new products.
2. Students will be able to know and understand the conventions and the methods of engineering drawing using Solidworks.
3. Students will be able to prepare simple drawings of engineering products.

Text Books:

1. N.D. Bhatt, "Engineering Drawing", Charotar Publishing House, 2013.
2. Prof. Sham Tickoo, SandeepPremDass “Solid works 2013 for Engineers and Designers” Wiley Publication, 2013.

Reference Books:

1. Randy H. Shih, “Solid works 2013 and Engineering Graphics: An Integrated Approach”, SDC Publications. 2013

CY 19.111 **Engineering Chemistry Laboratory** **Total Hours:26**
Credit: 0-0-2 - 1

Prerequisite(s): NIL

Objective(s):

- To introduce students to water chemistry and purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers, lubricants, fuel and their properties and uses.

LIST OF EXPERIMENTS

Choice of 10-12 experiments from the following

1. To determine the temporary and permanent hardness in the given water sample by complexometric titration using EDTA as standard solution.
2. To determine the percentage of Available Chlorine in the given sample of Bleaching powder. Iodometrically.
3. To determine the alkalinity of water sample.
4. To prepare urea formaldehyde resin.
5. To determine the strength of given HCl solution by titrating it against NaOH solution using pH meter.
6. To determine the strength of given acid solution by titration it against sodium hydroxide solution using conductometer.
7. To determine molecular weight of a polymer using Ostwald viscometer.
8. Determination of viscosity of given lubricating oil by Redwood viscometer.
9. Determination of cloud and pour point of given lubricating oil.
10. Determination of the flash and fire point of given lubricating oil.
11. Determination of acid value of given lubricating oil.
12. To determine the calorific value (HCV) of a sample of fuel.
13. Proximate Analysis of Coal.
14. Determination of the percentage of Fe in the given steel sample.

Outcomes The students will learn to:

- Estimate the Hardness of water, alkalinity of water.
- Familiar with the important practical applications of electrochemistry, lubricants, solids, their properties and applications, and the polymer materials.

ME-19.112 **Mechanical Workshop** **0-0-2-1**

Objectives:

1. Practice on manufacturing of components using workshop trades including fitting, carpentry, sheet metal and welding.
2. Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping.
3. Study and practice on machine tools and their operations.

List of Jobs:

1. **Fitting Shop:** Prepare job that contain various fitting operation like filing, marking, measuring, cutting, drilling etc.
2. **Carpentry Shop:** Making of carpentry joint (T, L joint etc).
3. **Sheet Metal Shop:** Making job from sheet (funnel, tray etc).
4. **Machine Shop:** Perform various operations like, turning, step turning, facing, chamfering, knurling etc on Lathe.

Outcomes:

At the end of the course, the student will be able to:

1. To acquire skills in basic engineering practice.
2. To identify the hand tools and instruments.
3. To acquire measuring skills.
4. To provides the knowledge of job materials in various shops.
5. Students will be able to analyze the material on the basis of their properties and thus assigning different weight age to their use for technical purposes.

Text Books:

1. Hajara Chaudhary, Workshop Technology Vol I & II, Media Promoters and Publishers PVT. LTD, Mumbai.
2. B.S. Raghuvanshi, Workshop Technology, Dhanpat Rai & Sons. New Delhi.

Reference Books:

1. H S Bawa, Workshop Technology, TMH. New Delhi.

EC 19.111 **Electronics Lab** **0-0-2-1**

Pre-requisite: Nil

Objective:
1. To gain practical knowledge by applying the experimental methods to correlate with the theory of Electronics Engineering.
2. To apply the analytical techniques and graphical analysis to the experimental data.
3. To enable the students to simulate and test the Electronics circuits using Multisim software.

Practical to be performed on Hardware:

1. To plot V-I characteristics of junction diode and Zener diode.
2. To design a half wave rectifier with and without filter circuit and find the ripple factor.
3. To design a full wave rectifier with and without filter circuit and find the ripple factor.
4. Study of clipper and clamper circuits and their implementation on breadboard.
5. To plot the characteristics of Transistor under Common Emitter configuration
6. To plot the characteristics of Transistor under Common Base Configuration
7. To plot the characteristics of Transistor under Common Collector configuration
8. To perform soldering and de-soldering to make banana probe, BNC probe and connection on PCB.

Practical to be performed using Multi-Sim Software:

9. An Introduction to Electronic Circuit Simulation using Multi-Sim Software.
10. To verify Ohm's law and Kirchhoff's law.
11. To Simulate half wave and full wave bridge rectifier.
12. To plot V-I characteristics of junction diode.

Outcome: Student will be able to understand the operation of electronic test equipment and hardware/software tools to characterize the behavior of devices and circuits.

CS 19.201 **Discrete Mathematics** **Total Lectures: 40**

Credit:3-1-0-4

Prerequisite(s): None

Objective(s):

- To Introduce fundamental concepts and applications of discrete structure in the field of computer science

1.	**Sets, Relations and Functions**: Set theory, combination of sets, multi-sets, ordered pairs, set identities, relations, operations on relations, properties of relations, composite relations, equality of relations, order of relations, functions, classification of functions, operations on functions, recursively defined functions.	[8]
2.	**PartiallyOrderedSets:**Definition,combinationofpartialordersets,Hassediagram,lattices:definition,propertiesof lattices: bounded, complemented, modular and complete lattice, orphisms of lattices.	[6]
3.	**Algebraic Structures & Counting:** Groups, subgroups and order, cyclic groups, cosets, Lagrange's theorem, normal subgroups, permutation and symmetric groups, group homomorphism's, rings, fields, basics of linear algebra, integers modulo n.Counting principles, permutations, combinations, summations, principle of inclusion and exclusion, pigeon-hole principle, generating functions and recurrence relations.	[10]
4.	**Propositional Logic:** Proposition, well-formed formula, truth tables, tautology, satisfiability, contradiction, algebra of proposition, theory of inference, natural deduction, predicate logic: first order predicate, well-formed formula of predicate, quantifiers, and inference theory of predicate logic.	[8]
5.	**Graph Theory:** Graphs, types of graphs, sub graphs, Eulerian chains and cycles, Hamiltonian chains and cycles, graph traversal algorithms, chromatic number, plannar graph.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:

- Understand the theory and techniques of logic, graphs and trees, and algebraic systems.
- Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.

Text Books:

1. Bernard Kolman, Robert C., BusbSharon, Cutler Ross, Discrete Mathematical Structures, PHI, 6thEdition, 2009.
2. Kenneth H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, 7th Edition, 2011.

Reference Books:

1. SwapanKumarChakraborty,BikashKantiSarkar,DiscreteMathematics,OxfordHigher Education,2011
2. C.L.Liu, D. P. Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, Tata Mcgraw-Hill, 3rdEdition, 2008.
3. Seymour Lipshutz, Marc Lipson, Discrete Mathematics, 3rd edition, 2010

CS-19.202 **Objected Oriented Programming** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 19.101(Programming Language)

Objective(s): The objective of this courseis to:

- Cover issues related to the definition, creation and usage of classes, objects and methods.
- Discuss the principles of inheritance and polymorphism.
- Provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- Cover the basics of API and to explore the java abstract programming interface.

1.	**Overview:** Introduction to OOP, OOP concepts, interactive Development Environments: Eclipse/Net Beans, basics of OOP, importance of Java Primitive datatypes, typecasting, arrays, Array List, operators and control structures, identifiers, constants and literals.	[9]
2.	**Classes and Inheritance:** Class fundamentals, objects, constructors, this keyword, garbage collection, the finalize () method, overloading methods, understanding static & final, exploring the string class. Inheritance basics, using super, multilevel hierarchy, constructor inhierarchy, method overriding, dynamic method dispatch, the object class, using abstract classes, interface.	[10]
3.	**Package, and Exception Handling:** Packages, access protection, importing packages,interfaces,exception-handlingfundamentals,exceptiontypes,usingtry and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, user defined exception, assertions	[10]
4.	**Multithreaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managing threads, thread class built-in functions.	[4]
5.	**I/O and String Handling:** I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer.	[7]

Outcome(s): Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP practices(e.g., interfaces and APIs) and proper program structuring(e.g.,by using access control identifies, automatic documentation through comments, error exception handling).
- Use of development environment like Eclipse for collaborative programming

Text Books:

1. Herbert Schildt, Java The Complete Reference, Herbert Schildt, 8th Edition, 2011.
2. Bert Bates and Kathy Sierra, Head First Java, O'Reilly,2005

Reference Books:

1. AllenB. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
2. Paul Deitel, Harvey Deitel, Java How To Program (Early Objects), 10thEdition, 2014.
3.E. Balaguruswamy, Programing with Java A Primer, Tata Mc. Graw Hill, 2007

CS-19.203 **Data Structures** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS 19.101 (Programming Language)

Objective(s):
- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems, and to promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1.	**Introduction:** Basic terminology, elementary data organization, algorithm, efficiency of an algorithm, time and space complexity, asymptotic notations, time-space trade-off, abstract data types.	[4]
2.	**Array& Linked list:** Definition, single and multidimensional arrays, representation of arrays: row major order, and column major order, application of arrays, sparse matrices and the irrepresentations. Singly linked lists, doubly linked list, circular linked list, insertion, deletion, traversal, polynomial representation and addition, generalized linked list.	[10]
3.	**Searching & Sorting:** Sequential search, binary search, comparison and analysis, hash function, collision resolution strategies, insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, radix sort.	[10]
4.	**Stack & Queue:** Primitive stack operations: push and pop array and linked list implementation of stack, application of stack: prefix and postfix expressions, evaluation of postfix expression, recursion, and tower of Hanoi problem. Queue operations, circular queues, array and linked list implementation of queues, dequeue and priority queue	[8]
5.	**Tree:** Binary trees, binary tree representation, tree traversal algorithms: in order, pre order and post order, threaded binary trees, Huffman algorithm, binary search trees AVL trees.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:
- Be knowledgeable of certain abstract data types (ADT)
- Be able to make a critical assessment of different implementations of an ADT
- Be familiar with a number of fundamental computational problems, and beware of real world instances of those problems

Text Books:
1.Lipschutz, "Data Structures" Schaum's Outline Series, TMH, Revised Edition Feb. 2014
2. Horowitzand Sahani, Fundamentals of Data Structures, University Press, 2ndEdition, 2008.

Reference Books:
1.AaronM.Tenenbaum,YedidyahLangsamandMosheJ.Augenstein,DataStructures Using and C++, PHI, 2nd Edition, 2012.
2. D. Samanta, Classic Data Structures, PHI, 2nd Edition, 2009
3. JeanPaulTrembleyandPaulG.Sorenson,AnIntroductiontoDataStructures With applications, McGraw Hill, 2nd Edition, 2003.

CS-19.204 **Database Management Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS 19.203 (Data Structures).

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS & RDBMS in the organization.

1.	**Introduction & Relational Data Model:** database system concepts and architecture, data modeling using theentity-relationship (ER) model, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model.	[10]
2.	**Structured Query Language (SQL)**: SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views.	[6]
3.	**Database Design:** Functional dependencies and normalization of relational databases, first normal form (1NF), 2NF, 3NF, boyce-coddnormal form (BCNF), multivalued dependency, 4NF, join dependency, 5NF.	[8]
4.	**Transaction Processing:** Introduction, properties, recoverability, serializability, concurrency control techniques: two phase locking protocol, concurrency control based on time-stamp ordering, database recovery techniques: recovery concepts, recovery techniques based on deferred and immediate update, the ARIES recovery algorithm.	[8]
5.	**Database Security:** Vulnerabilities in database, authentication, SQL injections, Encryptions & public Key infrastructures, privacy issues and preservation process	[8]

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.

Text Books:

1. Ramez Elmasri & Shamkant B. Navathe, Fundamentals of Database Management Systems, Edition, Pearson Education, 2013.
2. Raghu Ramakrishnan, Database Management Systems, 3rd Edition, Tata McGraw Hill, 2008.

Reference Books:

1. G.W. Hansen, and J.V. Hansen, Database Management and Design, 2nd Edition, Prentice Hall India, 2000.
2. Korth and Schilberschatz, Database System Concepts, 5th Edition, Tata McGraw Hill, 2006.
3. C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CS19.205 **General Purpose Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CS 19.101 (Programming Language)

Objective(s): Python is a general-purpose, versatile and popular programming language. It's great as a first language because it is concise and easy to read, and it is also a good language to have in any programmer's stack as it can be used for everything from software development and scientific applications.

1.	**Introduction**: The basic elements of python, python syntax, python operators, basic input, branching programs, control structures, strings, tuples, lists, sets, dictionaries and input iteration, Mutability with deferent types, Ranges and iterators	[7]
2.	**Functions and Module**: Functions and scoping flow of execution, specifications, recursion, global variables, eval&exec , variable arguments, default arguments, system functions and parameters, input and output, modules , making your own module, importing modules.	[7]
3.	**Classes and Object-Oriented Programming**: Abstract data types and classes, class attribute, instances, constructor, self, inheritance, encapsulation and information hiding, polymorphism, getter & setter	[8]
4.	**Testing and Debugging**: Exceptions and assertions, types of testing – black-box and glass-box, debugging, handling exceptions, assertions.	[6]
5.	**Advance Python:** Regular expressions – REs and Python, plotting using mat plot lib and Multithreaded Programming, GUI & event handling programming using Tkinter & pygame. Introduction to machine learning and deep learning	[12]

Outcome(s): Upon completion of this course students will be

- Familiar with Python syntax.
- Able to use python to implement a given logic.

Text Books:

1. John V Guttag, Introduction to Computation and Programming using Python, Prentice Hall of India, 2nd Edition, 2013.
2. Martin C. Brown, Python: The Complete Reference,McGraw Hill, 2018

Reference Books:

1. Zed A. Shaw, Learn Python the hard way: a very simple introduction to the terrifyingly beautiful world of computers and code, 3rd edition, 2014.
2. Richard L. Halterman, Learning to Program with python, 2011.
3. Allen Downey, Think Python How to Think Like a Computer Scientist, Version 2.0.17, Green Tea Press Needham, Massachusetts, 2012.

CS19.206 **Theory of Computation** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): CS14.201(Discrete Structures)

Objective(s): The goal of this course is to

- Provide students with an understanding of basic concepts in the theory of computation.
- To understand variety of issues in the mathematical development of computer science theory, particularly finite representations for languages and machines, as well as gain a more formal understanding of algorithms and procedures.

1.	**Finite Automata and Regular Expression:** Finite state systems, basic definitions, regular languages and regular expression, finite automata ,Equivalence of DFA and NDFA , Kleen's theorem, pumping lemma for regular sets, regular expression with algebraic method Using Arden's Theorem, closure properties of regular sets, minimization of finite automata, Mealy and Moore machine - conversion of Mealy machine into Moore machine and vice versa.	[11]
2.	**Context-Free Grammars:** Context-free grammars, union, concatenation of CFG, derivation trees, simplification of context-free grammars, Chomsky normal form, Greibach Normal form, ambiguous context-free grammar.	[9]
3.	**Context-Free Languages and Pushdown Automata:** Pushdown automata and context-free languages, pumping lemma for CFL, closure properties of CFL, decision, algorithms for CFL.	[8]
4.	**Turing Machine:** Turing machine model, techniques for Turing machine construction, Turing machines as language acceptor, combining Turing machines, properties of recursive and recursively enumerable languages, universal Turing machine.	[8]
5.	**Chomsky Hierarchy of Languages:** Regular grammars, unrestricted grammars and Turing machines, context-sensitive grammars and linear bounded automata.	[4]

Outcome(s):

- Be able to prove the equivalence of languages described by finite state machines and regular expressions.
- Be able to construct pushdown automata and the equivalent context free grammars.
- Be able to prove the equivalence of languages described by pushdown automata and context free grammars.
- Be able to construct Turing machines and Post machines.
- Be able to prove the equivalence of languages described by Turing machines and Post Machines.

Text Books:

1.Peter Linz, An Introduction to Formal Languages and Automata, Third Edition, Jones and Bartlett, 2016.

2. Hopcroft, Motwani, Ullmann, Introduction to Automata Theory, Languages and Computation, Pearson Education, 2nd Edition, 2005.

Reference Books:

1. Daniel I. A. Cohen, Introduction to Computer Theory, Prentice-Hall, 2nd Edition, 1997.

2. Martin, Introduction to Languages and the theory of Computation, Tata Mcgraw Hill, 3rd Edition, 2006

3. Michael Sipser, Introduction to the Theory of Computation, 3rdEdition, Cengage Learning,2013

CS 19.208 **Computer Organization and Architecture** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): EC 19.202 (Digital Electronics) (Optional)

Objective(s):

- To have a thorough understanding of the basic structure and operation of a digital computer.
- To discuss in detail the operation of the arithmetic unit including the algorithms &
- Implementation of fixed-point and floating-point addition, subtraction, multiplication & division.
- To study the different ways of communicating with I/O devices and standard I/O interfaces. To study the hierarchical memory system including cache memories and virtual memory.

1.	**Introduction:** Von-Neuman architecture, register transfer and micro operations: register transfer language, arithmetic micro-operations, logic micro-operations, shift micro-operations, bus and memory transfers, computer organization and design: instruction cycle, computer registers, common bus system, computer instructions, addressing modes, design of a basic computer. General register organization, stack organization, instruction formats, data transfer and manipulation, program control, RISC, CISC	[10]
2.	**Computer Arithmetic:** Hardware implementation of addition and subtraction, multiplication algorithms, Booths multiplier, array multiplier, division algorithms, floating point arithmetic: floating point representation, add, subtract, multiplication, division.	[8]
3.	**Memory & I/O Organization:** Memory hierarchy, RAM, ROM chips, memory address map, memory connection, associative memory, cache memory and virtual memory: paging and segmentation, auxiliary memory: magnetic disks, magnetic tapes, Input-output interface, Asynchronous data transfer, modes of transfer, priority interrupt, DMA, IOP.	[8]
4.	**Hardwired and Micro programmed Control:** Hardwired control, micro programmed control: micro instruction, micro program sequencing, wide-branch addressing, microinstruction with next-address field, prefetching microinstruction.	[7]
5.	**Pipelining & Parallel Processing: P**ipeline and vector processing: pipeline structure, speedup, efficiency, throughput and bottlenecks, arithmetic pipeline and instruction pipeline. Flynn's Classification performance matrices for parallel system	[7]

Outcome(s): On the successful completion of the course, the student will be able to:

- Understand basic structure of a digital computer.
- Perform arithmetic operations of binary number system.
- Know the organization of the control unit, arithmetic and logical unit and I/O memory unit

Text Books:

1. M. Morris Mano, Computer System Architecture, Pearson Education, 3rd edition, 2008.
2. Carl Hamacher, Zvonko Vranesic and SafwatZaky, Computer Organization, Tata McGraw Hill, 5thedition, 2002.

Reference Books:

1. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/ Software interface, Elsevier, 3rd edition, 2005.
2. William Stallings, Computer Organization and Architecture–Designing for Performance, Pearson Education, 6thedition, 2000.
3.Kai Hwang, Advance Computer Architecture, Tata Mc Graw Hill,18th edition,2008

EC 19.202 **Digital Electronics** **Total Lectures: 40**

Pre-requisite: Basics of Electronics Engineering **3-0-0-3**

Objective: The aim of this course is to present the principles and techniques of combinational and sequential digital logic design and optimization at a gate level. The use of transistors for building gates is also introduced.

1. **Number Systems and Boolean Algebra:** Introduction to number systems, weighted and non-weighted codes, 1's complement, 2's complement, complement arithmetic, Postulates and theorems of Boolean algebra, Boolean functions, canonical and standard form, simplification of Boolean function using Boolean laws and theorems. [5]
2. **Logic Gates and Simplification of Boolean Functions:** Basic Logic gates, Universal gates, K-map representation, incompletely specified functions, simplification realization with gates, Quine-McCluskey method. [5]
3. **Combinational Logic:** Analysis and design of combinational circuits, half adder and full adder, half subtractor and full subtractor, binary serial and parallel adder, BCD adder, binary multipliers, magnitude comparator, decoders, encoders, multiplexers, de-multiplexers. [10]
4. **Sequential Circuits and Programmable Logic:** Latches, flip-flops, triggering of the flip-flops, master-slave flip-flop, excitation tables, conversion of the flip-flops, analysis and design of clocked sequential circuits, shift registers, counters, PAL, PLA. [10]
5. **Introduction to Verilog HDL:** Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis, Functional Verification, System Tasks, Programming Language Interface (PLI), Module, Simulation and Synthesis Tools. Gate Level Modeling: Introduction, AND Gate Primitive, Module Structure, Other Gate Primitives, Illustrative Examples, Tri-State Gates, Array of Instances of Primitives, Design of Flip-flops with Gate Primitives, Delays, Strengths and Construction Resolution, Net Types, Design of Basic Circuits. [10]

Outcomes: Upon successful completion of this course, students should be able to:

1. Gain fundamental knowledge of the basic logic gates such as AND, OR, NAND NOR, EX-OR and their implementation in Logic Circuits.
2. Design multipliers, Combinational Circuits and registers.

Text Books:

1. Mano, M. M. and Ciletti, M.D., "Digital Design", Pearson Education, Patparganj, Delhi, 4thEdition, 2009.
2. Floyd, T. L. and Jain, R.P., "Digital Fundamental", Pearson Education, Patparganj, Delhi, 8thEdition, 2009.

References

1. Puri, V. K., "Digital Electronics: Circuits and Systems", Tata McGraw-Hill, Patel Nagar, New Delhi, 4thEdition, 2001.
2. Jain, R. P., "Modern Digital Electronics", Tata McGraw-Hill, Patel Nagar, New Delhi, 4th Ed.

MA 19.201 **Mathematics III** **Total Lectures: 40**

3-1-0-4

Pre-requisite: Mathematics I and Mathematics II

Objective: To acquire fundamental knowledge of linear programming, numerical methods, complex analysis and integral transform and apply in engineering disciplines.

1.	**Linear Programming:** Introduction with formulation; Graphical method; Simplex method, Artificial variable technique (Two phase method, Big –M method); Assignment problem (Hungarian method); Transportation problem (Vogel's approximation method).	[12]
2.	**Numerical Methods:** Solution of system of equations (Gauss elimination and Gauss - Seidel methods);Solution of algebraic and transcendental equations (Bisection, Ramanujan's and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector, Runge-Kutta method of order four).	[08]
3.	**Complex Analysis:** Function of complex variable, analytic function, Cauchy- Riemann equations(without proof); Integration of complex functions, line integrals in the complex plane, Cauchy integral theorem(without proof), Cauchy integral formula(without proof), zeros and singularities of complex functions, residues.	[08]
4.	**Integral Transform I**: Basics of Laplace transform and inverse Laplace transform; First and Second Shifting theorems; Convolution theorem (without proof); Laplace transform of Unit Step function, Dirac Delta function and periodic function.	[06]
5.	**Integral Transform II**: Solution of ordinary differential equations with initial conditions by Laplace transforms; Fourier series of periodic functions, even and odd functions, Fourier half-range series; Basics of Fourier transforms with properties.	[06]

Outcome: After completion of the course, students would be able to apply the knowledge of linear programming, numerical methods, complex analysis and integral transforms in engineering and solve curriculum problems.

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books:

1. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.
3. Jain R.K. and S.R.K. Iyenger Advanced Engineering Mathematics, Narosa Publishing House, 2003.

MA 19.202 **Statistics and Probability Theory** **Total Lectures: 40**

3-1-0-4

Pre-requisite: Mathematics I, Mathematics II, and Mathematics III

Objective: To acquire fundamental knowledge of Statistics and Probability and apply in engineering disciplines.

1.	**Introductory Ideas:** Recapitulation of basics of permutation, combination and probability theory; Law of addition and law of multiplication; Conditional probability; Total probability; Bayes' theorem (with proof)and it's applications.	[08]
2.	**Random Variables and Distribution:** Discrete and continuous random variables; Types of distributions with basic properties; Probability mass and density functions; Cumulative distribution function; Mean, variance and standard deviation of distributions; Discrete types (Binomial and Poisson) and Continuous types (Normal, Uniform and Exponential); Applications of basic ideas of these distributions.	[10]
3.	**Sampling and Testing of Hypothesis:** Sampling distribution of mean and variance; Central limit theorem; Simple and Composite hypothesis; Type I and Type II errors with graphical interpretations; Level of significance and tests of significance for large and small samples with applications.	[08]
4.	**Correlation and Regression:** Simple, partial and multiple correlations; Linear regression with applications.	[06]
5.	**Queuing Theory and Queuing Models:** Birth and death process; Pure birth and pure death process; Classification of queuing models: $[(M/M/1):(FCFS/\infty/\infty)]$, $[(M/M/1):(SIRO/\infty/\infty)]$, $[(M/M/1):(FCFS/N/\infty)]$, $[(M/M/C):(FCFS/\infty/\infty)]$; Applications of queuing models.	[08]

Outcome: After completion of the course, students would be able to apply the knowledge of Statistics and Probability theory in engineering and solve curriculum problems.

Text Books:

1. S.Palaniammal, Probability and Random Processes, PHI, 2013.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books:

1. Papoulis, Probability, Random Variables and Stochastic Processes, TMH, 2018.
2. Gupta & Kapoor, Fundamental of Mathematical Statistics, SCS Publisher, 2002.
3. Dass and Verma, Higher Engineering Mathematics, S. Chand, 2019.

UC 19.201 **Introduction to Management and Leadership** **Total Lectures: 26**
2-0-0-2

Objective: This Course, Management and leadership focus on understanding seminal and contemporary leadership theories and principles. To provide a basis of understanding to the students with reference to the working of the business organization through the process of management.

Pre-requisite:

1.	**Introduction to Management :** Nature of Management, Meaning, Definition, it's nature purpose, importance & Functions, Management as Art, Science & Profession- Management as social System Concepts of management-Administration-Organization	**[4]**
2.	**Evolution of Management Thought:** Contribution of F.W.Taylor, Henri Fayol, Elton Mayo, Chester Barhard& Peter Drucker to the management thought. Various approaches to management (i.e. Schools of management thought) Indian Management Thought.	**[5]**
3.	**Functions of Management:** Planning - Meaning - Need & Importance, type's levels - advantages & limitations. Organizing - Elements of organizing & processes, Delegation of authority - difficulties in delegation – Decentralization, Staffing - Meaning & Importance, Controlling - Process & Techniques, Coordination - Need – Importance.	**[6]**
4.	**Introduction to Leadership**: Leadership styles, qualities of a good leader, role of a leader, trait approach to leadership, behaviour approaches to leadership; Situational theories; Transformational Leadership transactional leadership, Neutralizers and substitutes to leadership.	**[6]**
5.	**Emerging Challenges to Leadership**: Leadership in changing workplace, Leader's role in fostering teamwork, Overcoming traditional thinking Methods to enhance creative problem solving, Climate for creative thinking, Leadership practices for innovation, Ethical leadership development, Cultural sensitivity, intelligence, and global leadership skills.	**[5]**

Outcome: On successful completion of the course, students will be able to Work effectively and collaboratively with others in diverse management contexts.

Text Books:

1. Dr. L.M.Parasad, "Principles & practice of management", Sultan Chand & Sons - New Delhi, 2015
2. Stephen P.Robbins "Organizational Behavior" Pearson Publisher, 16th Edition, 2014

Reference Books:

1. Principles of Management, By Tripathi, Reddy Tata McGraw Hill, 2012
2. Essential of Business Administration - K.Aswathapa Himalaya Publishing House, 2014
3. Hughes, R., Ginnett, R., &Curphy, G. Leadership: Enhancing the lessons of experience, McGraw Hill, 7th Edition, 2017
4. Northouse, P. G. "Leadership: Theory and Practice" Sage Publications, New Delhi, 7th Edition 2015.

UC 19.202 **Business Environment** **Total Lectures: 26**

2-0-0-2

Objective: To familiarize the students about the background of the spectrum of business and its environment (internal and external).

Pre-requisite: Good General knowledge.

1.	**Dimensions of Business Environment**: Nature and characteristics of contemporary business; Types of business environment - general and task environment, Internal (Value system, Organization structure, Human Resource, Company image and brand value, Physical assets) and external Environment (micro and macro), Environmental analysis and strategic Management.	[5]
2.	**Social Environment**: Concept and salient features of Indian culture and values, Impact of culture on business, Cultural resources, Ethics and social responsibility of business, Consumerism.	[5]
3.	**Political and legal Environment*:*** Impact of competing political ideologies and role of government, Political Stability and Instability on Business Activities, Legal framework for establishing a business unit in India, Competitive Conditions, Foreign Direct Investment in India.	[5]
4.	**Economic Environment**: Economic systems – Market, Planned and Mixed economy; Indian economy – overview; Economic reforms in India; Economic policies – Determinants of National Income, Privatization, Fiscal policy and Monetary policy.	[6]
5.	**Technological Environment:** Features of technology; Impact of technology; Management of technology; status of technology in India; Policy for research and development in India.	[5]

Outcome: Understanding real life situations vis-à-vis economic, social, legal, political and technological systems in the country and analyzing the impact of changes on different industries and trends in different sectors of the economy and society.

Text Books:

1. Business Environment, Francis Cherunilam, 1st Edition, 2018.
2. Essentials of Business Environment, K Aswathappa, HPH, 12th Edition, 2014.

Reference Books:

1. Business Environment, BN Ghosh, OUP, 2015
2. Business Environment: Text & Cases (3rd Edition), Justin Paul, McGraw Hill, 2016.
3. Business Environment, AC Fernando, Pearson, 2016

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

BCA

CA 19. 101 **Computer Fundamentals** **Total Lectures: 40**
Credits : 3-0-0-3

Prerequisite(s): NIL
Objective(s): To understand the fundamentals of computers like basic working and structure of computer, data representation, and office automation and networking.

1	**Introduction to Computers**: Definition, Block Diagram, characteristics, Applications in Modern Society, History, Classification of computers and Generation of computers.	[6]
2	**Functional Units of Computer Processing System**: Hardware, CPU, Memory and secondary storage devices, Input devices, Output Devices, Information Concept and Processing: Data, Information, Knowledge and Wisdom.	[8]
3	**Data representation**: Representation of Data, Bits and Bytes, Number System: Decimal, Binary, Octal, Hexadecimal, Conversions b/w number system, Arithmetic Operations in Binary Number, ASCII, EBCDIC and BCD Codes.	[8]
4	**Software Concepts**: Types of Software, Generation of Programming Language: Machine Language, Assembly Language, High Level Language, Translator: Assembler, Interpreter, Compiler, Operating System: Functions, types of operating system: Batch Processing, Multiprogramming, Multiprocessing, Multitasking, Time Sharing and Real Time System, MS-DOS, MS-Windows.	[9]
5	**Data Communication and Computer Networks**: The Basic Communication System, Data Transmission Modes, Network types, Network Topologies, Internet and its Applications: E-mail, World Wide Web, Intranet, Extranet, Computer Threats: Virus, Worm, Trojan horse, Malware.	[9]

Outcome(s): After completion of the course, students would be able to:

- Understand the concept of input/output devices of Computers and how it works.
- Learn the working of computer network and web communication.

Text Books:

[1]. P.K.Sinha ,P.Sinha, Computer Fundamentals, 6th ed., BPB Publications, 2015.
[2]. R. Thareja, Fundamentals of Computers, 2nd ed., Oxford University Press India, 2016.

Reference Books:

[1]. ITL Education Solutions Limited, Introduction to Computer Science, 2nd ed., Pearson Education, 2011.
[2]. V. Rajaraman, Fundamentals of Computers, 6th ed., PHI, 2015

CA 19. 102 **Operating System** **Total Lectures: 40**
Credits: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- Understand the fundamental operating system abstractions like processes, threads, files, semaphores, IPC and deadlocks.
- Understand operating system from user's perspective as well as from system's perspective.
- Understand the principles of concurrency and synchronization.
- Understand basic resource management techniques.
- Understand different theoretical principles in depth through hands on high level programming.

1	**Introduction:** Definition and types of operating systems, Batch Systems, multi programming, time sharing, distributed and real-time systems, Operating system structure, Operating System Components and Services, System calls, System Programs, Virtual Machines.	**[6]**
2	**Process Management:** Process and Thread Concept, Process States, Process Control Block, Operations with examples from UNIX (fork, exec) and/or Windows, Inter-process communication (shared memory and message passing), Scheduling Algorithms, Performance Evaluation.	**[9]**
3	**Process synchronization and Deadlocks:** critical section problems, semaphores, classical Inter process communication problems. Deadlocks-System model, Characterization, Deadlock prevention, Avoidance and Detection, Recovery from deadlock, Combined approach to deadlock handling.	**[9]**
4	**Memory Management:** Logical and Physical Address Space, Swapping, Contiguous Allocation, paging and segmentation, demand paging, virtual memory page replacement algorithms.	**[8]**
5	**File and I/O Management:** Directory systems, File System Implementation issue, access methods, Allocation Methods, Free Space Management, Disk Structure, Disk Scheduling, Disk Management, Control of Various Devices, Device Drivers, Interrupt Driven and Poll Driven Data Transfer.	**[8]**

Outcome(s): By learning the course, the students will be able to,

- describe, contrast and compare differing structures for operating systems
- understand and analyse theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files

Text Books:

[1]. P. B. Galvin, A. Silberschatz, G. Gagne, Operating System Concepts, 9th ed., Wiley India, 2015.
[2]. Andrew S. Tanenbaum, Modern Operating Systems, 4th ed.,Prentice-Hall Inc., 2015.

Reference Books:

[1]. Deitel, Operating Systems,3rd ed., Pearson Education,2012
[2]. Stallings, Operating Systems: Internals and Design Principles, 7th ed., Pearson education, 2013.

CA 19.103

C- Programming **Total Lectures: 40**
Credits :3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To learn the basics of programming skills through C-Programming language.
- To understand the fundamentals concepts like syntax, and statements with essentials of efficient compiling, running and debugging processes.

1	**Introductory Concepts:** Introduction to computers, Computer characteristics, Types of programming languages, Introduction to C, identifiers and keywords,Data types: declaration and definition, Type conversion.	[8]
2	**Operators:** Arithmetic, relational, logical, bitwise, unary, assignment, Increment and Decrement operators, conditional operators and their hierarchy, associativity,Data input/output.	[6]
3	**Control Structure and Array:** Introduction, Conditional Statements; Simple If-Else; Nested Statements, switch, Loops- For, While, Do-While; Break, Continue, Go-To Statements, Labels, printf, scanf function. Defining an array, processing an array, passing arrays to functions, Multidimensional arrays, Arrays and strings.	[13]
4	**Function and Pointer:** A brief overview, Defining a function, accessing a function, function prototypes, passing arguments to a function, recursion, Pointers: Declaration, operations on pointers, array of pointers, pointers to arrays.	[7]
5	**Advance C Concepts:** Structure, Union, storage classes in C, Concept of files, file access in different modes, reading from and writing into a file, Library Functions.	[6]

Outcome(s): At the end of the course student will be able to:

- Describe the process of problem solving through C.
- Write a justifiable C program for a given algorithm.
- Trace the certain C program manually.

Text Books:

[1]. Y. Kanetkar, Let us C, 16th ed. BPB Publication, 2018.
[2]. B. W. Kernighan and D. M. Ritchie, The C Programming Language, 2nd ed., Pearson Education, 2013.

Reference Books:

[1]. H. Schildt, C: The Complete Reference, Fourth edition, McGraw- Hill Education, 2000.
[2]. E. Balagurusamy, Programming in ANSI C, 4th ed., TMH Education, 2008.

CA 19. 104 **Data Structures** **Total Lectures:40**
Credits 3-0-0-3

Prerequisite(s): CS-19.103 (C- Programming)

Objective(s):
- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems,
- To promote an analytical and empirical appreciation of the behavior of algorithms using data structures

1.	**Introduction:** Overview of data structure, types of data structures and operations. Applications of data structures.	[4]
2.	**Pointer and dynamic memory allocation:** Pointer declaration and initialization, accessing a variable through its pointer, meaning and advantages of dynamic memory allocation, Memory allocation functions.	[9]
3.	**Array, Sorting and Searching Techniques:** Representation of single and multidimensional array. Insertion Sort, Selection Sort, Merge Sort, quick sort, Linear Search, Binary Search.	[9]
4.	**Stack & Queue:** Definition and representation of stack, operations on stack, Infix, Postfix, Prefix Expressions, Conversion from Infix to Postfix (Algorithms only). Types of queues, Primitive Operations on Queues.	[9]
5.	**Linked List & Tree:** Introduction to Linked List, implementation of Linked List, operations on linked list: creation, deletion, search and display, Tree introduction, Traversal of Binary Trees.	[9]

Outcome(s): On the successful completion of the course, the student will be able to:
- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:
[1]. Lipschutz, Data Structures, Schaum's Outline Series, TMH, Revised ed. Feb. 2014.
[2]. Horowitz and Sahani, Fundamentals of Data Structures, 2nd ed., University Press, 2008.

Reference Books:
[1]. Langsam , Augenstein and Tannenbaum, Data Structure Using C and C++, 3rd ed., PHI, 1996.
[2]. M. A. Weiss, Data Structures and Algorithm analysis in C++, 3rd ed., Addison Wesley,

CA 19. 106 System Analysis and Design

Total Lectures:40
Credits : 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To introduce the concept of system analysis for managing the projects
- To analyze and document systems, design new systems and implement their plans.

1	**Introduction to system:** Definition, characteristics and elements of system, types of system, System development life cycle, Role of system analyst.	**[6]**
2	**System Planning and Initial Investigation:** Introduction, bases for planning in system analysis, initial investigation, fact finding, information gathering, information gathering tools, fact analysis, determination of feasibility.	**[7]**
3	**Structured Analysis and Feasibility Study:** Tools of structured analysis: DFD, data dictionary, flow charts, Gantt charts, decision tree, decision table, structured English, pros and cons of each tool. Feasibility Study Objective, types, Steps in feasibility analysis, feasibility report, oral presentation, cost and benefit analysis, classification of costs and benefits.	**[10]**
4	**Designing:** System Design Objective, logical and physical design, design methodologies, structured design, form-driven methodology (IPO charts), and structured walkthrough. Input/ Output and Form Design: Objectives of input and output design, form design, classifications of forms, requirements of form design.	**[9]**
5	**System Testing and Implementation:** Objectives of testing test plan, testing techniques/types of system tests, quality assurance goals in system life cycle, System implementation.	**[8]**

Outcome(s): By learning the course, the students will be able to,

- Describe different approaches to systems analysis and design.
- Describe the five phases of the systems development life cycle (SDLC).
- Describe in detail the systems planning, systems analysis, systems design, systems implementation, and systems operation and support phases of the SDLC.

Text Books:

[1]. A wad Elias M, System Analysis and Design,,2nd ed., Galgotia Pub.(P) Ltd., 2008

Reference Books:

[1]. H. Igor, Introduction To System Analysis and Design, 5th ed., PHI, 2001
[2]. M. Lejk and D. David , An Introduction to System Analysis Techniques, 1st ed., PHI, 1998

CA 19. 107 **Foundation course in Mathematics** **Total Lectures: 40**
Credits :3-1-0-4

Prerequisite(s): Nil

Objective(s):

- To acquire fundamental knowledge of (10+02) higher Mathematics and apply in science and engineering disciplines.

1	**Matrix:** Addition, Subtraction and Multiplication of matrices, column matrix, row matrix, unit matrix, diagonal matrix, zero matrixes.	[6]
2	**Determinants:** Definition, Properties of Determinants, multiplication of Determinants, Value of Determinants up to third order, Minors and Co-factors.	[8]
3	**Algebra:** Factorial Functions, Permutations and Combinations.	[7]
4	**Calculus:** Differentiation, Integration of Standard functions, Definite Integrals.	[11]
5	**Statistics:** Frequency Distribution, Mean, Median, Mode, and Standard Deviation and Variance.	[8]

Outcome(s): After completion of the course, students would be able to apply fundamentals of (10+02) higher mathematical knowledge in science and engineering and also solve curriculum problems.

Text Books:

[1]. R.D. Sharma, 11th and 12th Mathematics, Dhanpatrai Publication, 2018.
[2]. Dass and Verma, Higher Engineering Mathematics, S.Chand, 2019.

Reference Books:

[1]. Majumder, Engineering Mathematics , Volume I, Central,1995.
[2]. Ramana B.V., Higher Engineering Mathematics, TMH, 2006.

CA 19.108 **Python Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): C Programming (CA 19.103)

Objective(s): Python is a general-purpose, versatile and popular programming language. It's great as a first language because it is concise and easy to read, and it is also a good language to have in any programmer's stack as it can be used for everything from web development to software development and scientific applications.

1.	**Basics of Python Programming**: History of python, installation of python , execution of python program, python character set, token, data type, inbuilt functions in python, operators and expressions, translating mathematical formulae into equivalent python expressions.	[7]
2.	**Python Program Flow Control** : Conditional blocks using if, else and elif, simple for loops in python For loop using ranges, use of while loops in python Loop, nested loops, break and continue	[8]
3.	**Functions:** syntax and basics of a function, parameters and arguments in a function, local and global scope of a variable, return statement, recursive function and lambda function	[8]
4.	**Strings and Lists:** Basic inbuilt python functions for string, immutable strings, strings operators and operations, creating and accessing the elements of the list, python inbuilt functions for lists.	[9]
5.	**Tuples, sets and dictionary:** creating tuples, inbuilt functions for tuples, operations on tuples, creating sets and set operations, creating dictionary, simple program on dictionary	[8]

Outcome(s): Upon completion of this course students will be

- Familiar with Python syntax.
- Able to use python to implement a given logic.

Text Books:

1. John V Guttag, Introduction to Computation and Programming using Python, Prentice Hall of India, 2nd Edition, 2013.
2. Swaroop C H. , A Byte of Python, URL: https://python.swaroopch.com

Reference Books:

1. Zed A. Shaw ,Learn Python the hard way: a very simple introduction to the terrifyingly beautiful world of computers and code, Third edition, 2014.
2. Richard L. Halterman,Learning to Program with python, 2011.
3. Allen Downey ,Think Python How to Think Like a Computer Scientist, Version 2.0.17, Green Tea Press Needham, Massachusetts,2012.

CA 19. 133 Office Automation Laboratory

Total Hours: 26

0-0-4-2

Prerequisite(s): NIL

Objective(s): To familiarize the students in preparation of documents and presentations with office automation tools like, MS Word, MS Excel, MS PowerPoint and MS Access.

MS Word Exercise:

1. Working with Documents., Formatting Documents.
2. Setting Page style.
3. Creating Tables.
4. Drawing.
5. Mail Merging and Printing Documents.

MS Excel Exercise:

6. Spread Sheet & its Applications, Opening Spreadsheet, Menus.
7. Entering & Deleting Data.
8. Setting Formula.
9. Formatting Spreadsheets.
10. Working with sheets.
11. Creating Charts.
12. Using Tools.

MS Access Exercise:

13. Starting Access, Access Screen, Creating a New Database.
14. Creating Tables and Working with Forms.
15. Creating queries.
16. Finding Information in Databases.
17. Creating Reports.
18. Types of Reports.
19. Printing & Print Preview – Importing data from other databases viz. MS Excel etc.

MS Power Point Exercise:

20. Creating a presentation.
21. Formatting a Presentation.
22. Adding Effects to the Presentation.
23. Printing Handouts.

Outcome(s): By learning the course, the students will be able

- to perform documentation
- to perform accounting operations
- to perform presentation skills

CA 19.134 **Data Structure Laboratory** **Total Hours: 26**

0-0-4-2

Prerequisite(s): CS-19.135 (C Programming Laboratory)

Objective(s):

- To develop skills to design and analyze simple linear and nonlinear data structures
- To Strengthen the ability to identify and apply the suitable data structure for the given real
- world problem
- To Gain knowledge in practical applications of data structures

1. Implement the logic of One Dimensional Array.
2. Implement the logic of Two Dimensional Array.
3. Implement the logic of Linked List and its various operations.
4. Implementation of stack using array and Link List.
5. Implement various stack operations.
6. Implementation the logic of Queue using array.
7. Implement various operations on queue.
8. Implement all the types searching algorithms (minimum 4 programs are desired)
9. Implement all types of sorting algorithms (minimum 5 programs are desired)

Outcome(s): At the end of this course, the student will

- Be able to design and analyze the time and space efficiency of the data structure.
- Be capable to identity the appropriate data structure for given problem.
- Have practical knowledge on the application of data structures.

CA 19.135 **C Programming Laboratory** **Total Hours: 26**

0-0-4-2

Prerequisite(s): NIL

Objective(s):

- To make students familiar with syntax and structure of C-programming.
- To learn problem solving techniques using C programs implementation.

1. Implement the logic of Data Types & Operators.
2. Implement the logic of Type Conversions.
3. Implement the logic of Arithmetic, Relational, and logical operators.
4. Implementation of Bitwise, unary, assignment operators.
5. Implementation of Increment and Decrement operators.
6. Implementation of Conditional operators.
7. Implement the logic of Increment and Decrement operators.
8. Implement the 10 programs in order to cover Control Structure, If-Else statements, Nested If-Else statements, Switch-case statement, Loops- For, While, Do-While, Break Continue, Go-To Statements, and Labels.
9. Implement the 8 programs in order to cover processing an array, passing arrays to functions, Multidimensional arrays.
10. Implement the 5 programs to cover all possible String operations.
11. Implement the 4 programs in order to cover Function prototypes and passing arguments to a function, Recursion.
12. Implement the 5 programs in order to cover Pointers declaration, operations on pointers, Array of pointers, pointers to arrays.
13. Implementation of structure and union programs.
14. Implement the use of Storage classes in C programming.
15. Implement 4 programs for Reading and writing from/to a file.

Outcome(s): On competition of this course student will be able to:

- Apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner.

CA-19.136 **Python Programming Laboratory** **Total Hours:26**

Credit:0-0-4-2

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Prerequisite: (CS 19.135) C Programming Laboratory

Objectives: The objective of this course is to:

- Become comfortable with Python programming, starting from basics of data types to deep learning.
- Provide the foundation of to explore any expansions of Python whether it is machine learning, deep learning, web development or gaming. It will also put focus to learn various skills to design object-oriented software.

Contents:

- Code different data types and operations on list, dictionaries, sets, String etc
- Code basic programs like factorial, Fibonacci etc. to understand functions and recursions.
- Implement different built-in functions in Python like eval, exec, map, lambda etc.
- Implement the concept of class, objects, inheritance and polymorphism
- Implement constructor and self
- Code programs to implement exceptions and assertions
- Implement regular expressions

CA 19. 201 **Computer Organization** **Total Lectures:40**
Credits 3-1-0-4

Prerequisite(s): NIL

Objective(s):

- To understand the basics of combinational as well as sequential logic.
- To get familiar for analyzing the performance of digital circuits

1	**Boolean Algebra:** Laws and theorems of Boolean algebra. De-Morgan's theorem, XOR and XNOR gates, Half and Full Adder and Subtractor circuits.	**[5]**
2	**Fundamental Concepts:** Products, Sum of products and Product of sums, Form of Boolean expressions, Truth Tables and Karnaugh maps and Karnaugh simplification. Multiplexers, decoders, characteristics of digital integrated digitals.	**[8]**
3	**Design of Simple Computer:** Micro Operation, Macro Operation, Bus and Memory Transfers, Arithmetic and Logic Micro Operations, Shift Micro Operation, Instruction and Instruction Types	**[8]**
4	**Instruction Cycle:** Timing and Control Instruction Cycle, Memory Reference Instructions, Input Output and Interrupts, Machine Language Instructions	**[8]**
5	**I/O and Memory Organization:** Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Programmed I/O, Interrupt I/O Direct Memory Access. Memory Hierarchy, Main Memory, Auxiliary Memory, Associative, Cache Memory, Virtual Memory and Memory Management Hardware	**[10]**

Outcome(s): After successful completion of the course, student will be able to

- Develop a digital logic and apply it to solve real life problems.
- Analyze, design and implement combinational logic circuits.
- Classify different semiconductor memories.
- Analyze, design and implement sequential logic circuits.

Text Books:

[1]. M. Mano, Digital Design, 4th ed., Prentice Hall of India, 2008
[2]. R. P. Jain, Modern Digital Electronics, 3rd ed., TMH, 2003.
[3]. W. Stallings, Computer Organization and Architecture, 9th ed., Pearson,2013

Reference Books:

[1]. J. F.Wakerly, Digital Design, 4th ed, Pearson, 2008.
[2]. C.H.Roth. Fundamentals of Logic Design, 6th ed., Thomson Learning, 2013.

CA 19.203 **Database Management System** **3-0-0-3**

Total Lectures:40

Prerequisite(s): Nill

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS & RDBMS in the organization.

1.	**Introduction**: An Overview of Database Management System, Comparison of Database System and File System, Characteristics of Database Approach, DBMS Architecture, Data Models, Schema and Instances, Data Independence. Data Modeling Using Entity Relationship Model: Entity, Entity Types, Entity Set, Notation for ER Diagram, Attributes and Keys, Concepts of Composite, Derived and Multivalued Attributes, Super Key, Candidate Key, Primary Key, Relationships, Relation Types, Weak Entities, Inheritance, Specialization and Generalization.	**[10]**
2.	**Relational Data Model:** Relational Model Terminology: Domains, Attributes, Tuples, Relations, Characteristics of Relations, Relational Constraints: Domain Constraints, Key Constraints, Relational Database Schema, Relational Database Design By ER To Relational Mapping. Introduction to SQL.	**[11]**
3.	**Normalization:** Functional Dependencies, Armstrong's Inference Rule, Normal Form up to Boyce Codd Normal Form.	**[4]**
4	**Relational Algebra:** Selection, Projection, Set Theoretic Operations Union, Intersection, Set Difference And Division, Inner, Outer, Left Outer, Right Outer and Full Outer Join.	**[8]**
5.	**Transaction Processing And Concurrency Control:** Definition of Transaction, Desirable ACID Properties, Serializable And Non Serializable Transactions, Concurrency, Lost Update, Dirty Read, Concurrency Control Techniques: Locking, 2PL	**[7]**

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.

Text Books:

[1] R. Elmasri & S. B. Navathe, Fundamentals of Database Management Systems, 7th ed., Pearson Education, 2016.

[2] R. Ramakrishnan, Database Management Systems, 3rd ed., Tata McGraw Hill, 2008.

Reference Books:

[1] Korth and Schilberschatz, Database System Concepts, 6th ed., Tata McGraw Hill, 2011.

[2] C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CA 19. 204 **Computer Networks** **Total Lectures: 40**
Credits: 3-1-0-4

Prerequisite(s): Nill

Objective(s):

- To become familiar with layered communication architectures (OSI and TCP/IP).
- To understand the client/server model and key application layer protocols.
- To understand fundamentals of computer networks and major routing protocols.

1	**Basic concepts of networks and Layered Architecture:** Computer networks introduction, network topologies, protocols and standards, Client-Server transactions, Network devices: repeaters, bridges, gateway, Routers; categories of networks- LAN, WAN and MAN. Layers and their function, OSI reference model, TCP/IP model, Comparison of models.	**[9]**
2	**Physical layer:** Transmission Media, guided and unguided; Attenuation, Distortion, Noise, Switching.	**[7]**
3	**Data Link Layer:** Functionality, Framing, Encoding Techniques, Design Issue, Error Detection & Correction Codes, MAC.	**[7]**
4	**Network & Transport Layer:** Routing Algorithms (Distance Vector & Link State), IPv4 and IPv6, Connection Oriented and Connection Less services, Sliding Window Protocols.	**[8]**
5	**Application Layer :** Network Security & Privacy, Data Compression & Cryptography, Electronic Mail (SMTP, POP3, IMAP), DNS, FTP, HTTP, telnet etc.	**[9]**

Outcome(s): On successful completion of this course, students will be able to

- Analyze computer network component and devices.
- Synthesize how communication works in a network and internet.
- Formulate the concept of topologies and their applications.
- Analyze protocol at different layers and how they play important role in network implementation.
- Enumerate the layers of OSI and TCP/IP models.

Text Book: [1]. B. A. Forouzan, Data Communications and Networking, 5th ed., Tata McGraw Hill, 2013.

Reference Book: [1]. A. S. Tanenbaum, Computer Networks, 4th ed., Prentice-Hall of India, 2002.

CA 19. 206 **Computer Graphics** **Total Lectures: 40**
3-1-0-4

Prerequisite(s): CS-19.103 (C Programming)

Objective(s):

- To introduce the students with the graphics mode, with the help of basic algorithms and methodologies.
- The objective of the course is to equip students with fundamental knowledge and basic technical competence in the field of computer graphics.
- Provide an understanding of how a computer draws the fundamental graphics primitives.
- To learn Computer Graphics methodologies/Algorithms and techniques.

1	**Basic Concepts:** Application Areas of Computer Graphics, Graphical User Interface, RGB Color model, CMY color models, Advantages of Computer Graphics.	**[8]**
2	**Graphics Hardware:** Random Scan Displays, Raster Scan Display (with Introduction to Flickering, Interlacing, American Standard Video), Color CRT Monitors, Flat Panel Display (Plasma Panel, Liquid Crystal Display, Electroluminescent Display).	**[7]**
3	**Raster Graphics Algorithms:** Line Drawing Algorithms-DDA, Bresenham's Algorithm, Circle and Ellipse Drawing Algorithms, Filling (Scan-Converting Polygon Filling, Inside Outside Tests Boundary Fill and Area Fill Algorithm). Cohen- Sutherland Algorithm of clipping.	**[12]**
4	**Transformations:** 2-D Transformations (Rotation, Reflection,Shearing, Scaling), Homogeneous Coordinate Representation, and Translation.	**[8]**
5	**Animation Introduction:** Conventional and Computer-Assisted Animation, Animation languages, methods of controlling Animation, basic rules of Animation.	**[5]**

Outcome(s): On successful completion of this course, students will be able to

- Understand basic concepts of computer graphics.
- Acquire knowledge about drawing basic shapes such as lines, circle ellipse, polygon.
- Perform processing of basic shapes by various processing algorithms /techniques.
- Implement two dimensional transformations.

Text Books:

[1]. D. D. Hearn and M. P. Baker, Computer Graphics, 3rd ed., Prentice Hall India, 2011.
[2]. A. Kalbag, Computer graphics & animation, 1st ed., Usborne, 1999.

Reference Books:

[1]. J. D. Foley, A. V. Dam, S. K. Feiner, J. F. Hughes, Computer Graphics Principles and Practice, 2nd ed., Addison Wesley, 1995.
[2]. D. F. Rogers, Procedural Elements for Computer Graphics, 2nd ed., Tata McGraw Hill Publications, 2001.

CA 19. 207 **C++ Programming** **Total Lectures: 40**
Credits: 3-0-0-3

Prerequisite(s): CS-19.103 (C Programming)

Objective(s):

- To get a basic knowledge of object-oriented concepts.
- To master in programming related to classes inheritance using C++.

1	**Introduction to Object Oriented Programming and C++:** Basic concepts of object–oriented programming, Structured versus object- oriented programming, merits and demerits of object oriented methodology. C++ Preprocessor directives, Variables, data types, constants, operators, scope resolution operator, memory management operators, decision and loop control structures, arrays, strings, functions.	**[8]**
2	**Classes and Objects:** Class definition, Structure versus class, accessing member functions within a class, data hiding, arrays within a class, static data and member functions, objects, friend functions and friend classes, constant member functions, pointers to members, constructors and destructor.	**[9]**
3	**Overloading and Exception Handling:** Definition, unary operator overloading, binary operators overloading, overloading of new and delete operators, manipulation of string using operators, type conversion, overloading with friend functions, function overloading, error and exception handling.	**[9]**
4	**Inheritance and Overriding:** Derived and base classes, type of inheritance, derived class constructors and destructor, overriding member functions, public and private inheritance, virtual base classes, abstract classes, this pointer, virtual functions and pure virtual functions, static and dynamic bindings.	**[8]**
5	**Introduction of I/O Streams and the Standard Library:** Header files, I/O stream library, stream I/O for objects, file I/O.	**[6]**

Outcome(s): On the successful completion of the course, the student will be able to:

- To gain the basic knowledge on object oriented concepts.
- To understand the role of inheritance, polymorphism, dynamic binding and generic structures in building reusable code.

Text Books:

[1]. R. Lafore, Object-Oriented Programming in C++, 4th ed.,Pearson Education, 1997.
[2]. Balagurusamy E., Object Oriented Programming With C++, 6th ed., Tata McGraw Hill Publishing Co. Ltd., 2013.

Reference Books:

[1]. Stroustrup Bjarne,Programming -Principles and Practice Using C++, 4th ed.Addison-Wesley, 2013
[2]. Schildt Herbert, “C++: The Complete Reference”, 4th ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2003.

CA 19. 208 **Electronic Commerce** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Computer Fundamental

Objective(s): A comprehensive overview of how firms compete in today's environment with a focus on strategic choices and the infrastructures affecting e-commerce including technology, capital, media, and public policy.

1	**Electronic Commerce**: Overview and Scope, Traditional Commerce vs.ElectronicCommerce,ImpactofE-Commerce,Electronic Markets,InternetCommerce,e-commerceinperspective,ApplicationofE Commerce inDirect Marketingand Selling,advantagesand disadvantages,and futureof E-commerce	**[6]**
2	**BusinessstrategyinanElectronicAge:**ValueChains,Supplychain,Porter's value chain Model, Inter Organizational value chains, Strategic Business unit chains and industryvalue chains.	**[8]**
3	**Business toBusiness E-Commerce**: Inter-organizational Transitions, Credit TransactionTradeCycle,avariety oftransactions.Electronic DataInterchange (EDI):Introduction,BenefitsofEDI,EDITechnology,EDI standards,EDI Communication, EDI Implementation, EDIagreement, EDIsecurity.	**[8]**
4	**Electronic Payment System:** Introduction, Online Payment System, Prepaid Electronic Payment System, Post Paid Electronic System, E-Cheques, Credit Cards, Smart Cards, E-Purses, DebitCards,LegalRisk of E-Payment System.	**[9]**
5	**Securing NetworkTransaction:** Security Policy, Procedures and Practices, Transaction Security, Cryptography Algorithm, Public Key Algorithm,AuthenticationProtocol,Digital Signature, E-Mail Security. Different case studies of E commerce	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Illustrate management's role in the networked economy.
- Identify strategies involved in running an e-commerce company.
- Identify factors of successful implementation of an online strategy.
- Compare metrics used to evaluate progress of an e-commerce strategy.
- Summarize the effect of laws and regulations on e-commerce and Internet business.

Text Books:

[1]. Whitely David, "E-commerce Strategy, Technology and application", Tata McGraw Hill Publications, New Delhi,2005.

Reference Books:

[1]. Kalakota ,R. and Whinston, A. B. "Readings in Electronic Commerce", Addison Wesley.2006
[2]. Schneider, Gary P. and Perry ,Jame, "Electronic Commerce" Thomson Publication.2003
[3]. P.T. Joseph, S.J., "E-Commerce :An Indian Perspective", PHI.

CA 19. 209 **Discrete Mathematics** **Total Lectures: 40**
3-1-0-4

Prerequisite(s): Nill

Objective(s):
- To Introduce fundamental concepts and applications of discrete structure in the field of computer science

1	**Set Theory:** Definition of Sets, Subsets, Cardinality of Sets, types of sets: Equal Sets, Universal Sets, Finite and Infinite Sets, proper set, power sets, Operations on Sets: Union, Intersection, Complement of Sets, set difference, Cartesian Product, Venn Diagrams, and Algebra of sets, duality, counting principle.	**[10]**
2	**Relations and Functions:** Definition, types of relation, Ordered Pairs, properties of relation, equivalence relations, partial ordering relation. Function: Domain and Range, Onto, Into, and One to One Function, Composite and Inverse Functions.	**[8]**
3	**Algebraic Structures:** Definition of a group, properties of group, different types of group, subgroup, finite, infinitely, countable and Cyclic Groups.	**[8]**
4	**Prepositional Calculus:** Propositions, Logical Connectives: conjunction, disjunction and negation, Truth Tables, Tautologies and Contradictions, Conditional and Bi-conditional statements.	**[8]**
5	**Counting:** Basic principles, permutations, combinations, summations, principle of inclusion and exclusion, pigeon-hole principle.	**[6]**

Outcome(s): On the successful completion of the course, the student will be able to:
- Understand the theory and techniques of logic, graphs and trees, and algebraic systems.
- Apply the knowledge and skills obtained to investigate and solve a variety of discrete mathematical problems.

Text Book:
[1]. B. Kolman, C. Robert , S. Busb, C. Ross, Discrete Mathematical Structures, 6th ed., PHI, 2009.
[2]. H. R. Kenneth, Discrete Mathematics and Its Applications, 7th ed., TMH, 2011.

Reference Book:
[1]. Swapan Kumar Chakraborty, BikashKanti Sarkar, Discrete Mathematics, Oxford Higher Education, 2011
[2]. C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics A Computer Oriented Approach, Tata Mcgraw-Hill, 3rd Edition, 2008.

CA 19. 210 **Java Programming** **Total Lectures: 40**
3-1-0-4

Prerequisite(s): Nill

Objective(s): The objective of this course is to:

- Cover issues related to the definition, creation and usage of classes, objects and methods.
- Discuss the principles of inheritance and polymorphism.
- Provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.

1	**Basics of Java Programming:** Importance of Java, Java Byte code, Java and HTML, the Java buzzwords, using blocks of code, lexical issues, Java Class Libraries. Constants, Variables, Data Types, Operators, Type Conversion in Expression, Mathematical Functions, Decision Control Structure, Loop Control Structure, Arrays.	**[10]**
2	**Class and Inheritance:** Class fundamentals, declaring objects, assigning object reference variables, introducing methods, constructors, the this keyword, garbage collection, the finalize () method, overloading methods, using objects as parameters, returning objects, recursion, introducing access control, understanding static, introducing final, arrays revisited, introducing nested and inner classes, Wrapper Classes. Inheritance: Multilevel hierarchy, method overriding, Abstract classes, Final classes, String Class.	**[10]**
3	**I/O and String Handling:** I/O basics, reading console input, writing console output, the PrintWriter class, reading and writing files, String and StringBuffer class, Various Types of string operations related to both the classes.	**[6]**
4	**Package, Interfaces and Exception Handling:** Packages, importing packages, interfaces, exception-handling fundamentals, exception types, uncaught exceptions, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, Java's built-in exceptions, creating your own exception subclasses, using exceptions.	**[7]**
5	**Applet Programming:** Applet life cycle, creating executable application, Designing a web page, Applet Tag, Parameter passing in applets, Graphic Class, lines, rectangles, circle and ellipse, polygons.	**[7]**

Outcome(s): Upon completion of this course, students are able to:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identify classes, objects, members of a class and the relationships among them needed for a specific problem.
- Develop programs using the in-built Java API and the Java standard class library.
- Create Java application programs using sound OOP practices (e.g., interfaces and APIs) and proper program structuring (e.g., by using access control identifies, automatic documentation through comments, error exception handling).

Text Book:
[1]. H. Schildt, Java The Complete Reference, 8th ed., Herbert Schildt, 2011.
[2]. J. Jukowski, Mastering Java J2SE 1.4, SYBEX, 2002.

Reference Book:
[1]. A. B. Downey, Think Java: How to Think Like a Computer Scientist, 2011.
[2]. P. Deitel, H. Deitel , Java How To Program, 10th ed., Deitel publication, 2014.

CA 19. 231 **Management Information System** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Computer Fundamental

Objective(s): To understand how to leverage information systems to effectively operate and grow an enterprise. The course provides a foundation in the theory and practical application of information systems within an organization. Managing, analyzing, designing, and implementing an MIS will be the focus of the course

1	**Introduction:** Elements, characteristics, objectives and importance, relationshipbetween MIS and Computer, role of MIS in the functions of management.	**[6]**
2	**Information:** Classification of information, levels of information,techniques of data collection, quality aspect of information, value of Information	**[8]**
3	**Decision Making:** Decision making concepts, rationality in decision making,decision support system, MIS as a technique for programmed decisions, structured v/s Un-structured decisions, formal vs. informal systems, model of decision making, methods, MIS and role of decision making.	**[8]**
4	**Manager and Computers:** Database concept, database models, database design,RDBMS, MIS and RDBMS, network topology, LAN, MAN, WAN and data communication.	**[9]**
5	**Development and Application of MIS:** Strategic and project planning for MIS, conceptual systemdesign, detailed design, implementation, evaluation and maintenance of the MIS, pitfalls of MIS. MIS for marketing, financial, production management,human resource management.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- understand and articulate fundamental concepts of information technology management.
- assess and apply IT to solve common business problems.
- suggest and defend effective solutions to business problems, and design a database application to solve a business problem.
- discuss the ethical aspects of information technology use in the organization and its governance issues.

Text Books:

[1]. Jawadekar,W. S. “Management Information System”, Tata McGraw- Hill Publishing Co. Ltd., New Delhi, 2004

Reference Books:

[1]. Murdick, R, G, Ross J E and Clagget, J,R, “Information Systems for Modern Management”, PHI, New Delhi.,2003
[2]. Sadagopan, “Management Information System”, PHI, New Delhi.2010.
[3]. Parker, Case Thomas, “Management Information System: Strategies and Action”, Tata McGraw- Hill Publishing Co. Ltd., New Delhi

CA 19.232 **Enterprise Resource Planning** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Computer Fundamental and Networking

Objective(s): This course will enable student understanding of issues and decisions that must be made when embarking upon a ERP selection and implementation journey. It will also lead to an understanding the challenges associated with managing extant ERP systems.

1	**Overview:** Definition, ERP & Business, Evolution of ERP, Need of ERP, Features of ERP, Motivation behind ERP, Technologies & Infrastructure required for ERP, Demerits of ERP, benefits & application, BPR & ERP,ERP Market.	**[6]**
2	**Data Mining & Data Warehousing:** Foundation of Data Mining, scope of Data Mining, Mechanism, Data Mining methods & Algorithms, Relevance of Data Mining to BPR, Database marketing by Data mining. Data warehouse Management System, Business Intelligent system architecture, features, Application, Necessity of Data warehousing, critical factors for the failure of Data warehouse.	**[8]**
3	**Implementation Issues:** Implementation Methodologies, Post Implementation Issue, Hidden Costs of ERP (Training, Testing, Dirty Data), Role of consultant	**[8]**
4	**ERP Module :** BAAN, SAP, ORACLE, People soft, Comparison of major ERP packages	**[9]**
5	**ERP & E-commerce:** Electronic Data Interchange, Advantage of EDI with respect to business, ERP fitness with E-commerce, Post ERP work with E-commerce, ERP & Internet.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Understand and gain insight into process views of organizations and tools and techniquesused to model both as-is and to-be models.
- Apply the process modeling techniques in one or more modeling environments.
- Know and be able to apply key technical terminology in enterprise information systems asthey apply in different ERP products and development methods
- Understand key differences between the major ERP applications (such as SAP R/3, andOracle/PeopleSoft/Sibel) and issues specific to these applications their configuration andmanagement.
- Analyze a current architecture and perform an effective gap analysis before an ERP implementation
- Be able to map enterprise architectural resources to a contemporary Enterprise Architecturemapping tool.

Text Books:

[1]. Luvai F. Motiwalla, Jeff Thompson, Enterprise Systems For Management, Pearson Education., 2nd Ed., 2011
[2]. Ravi Shankar, S.Jaiswal, Enterprise Resource Planning, Galgotia Publication Pvt. Ltd., 2nd Ed., 2005.

Reference Books:

[1]. Monk, E. F., Wagner, B. J., Concepts in Enterprise Resource Planning, Course Technology CengageLearning,3rd Ed. 2009.
[2]. Chuck Munson, Supply Chain Management Casebook : The Comprehensive Coverage and Best Practices in SCM, Pearson FT Press 2013.
[3]. Ferran, C., and Salim, R., Enterprise Resource Planning for Global Economics: Managerial Issues and Challenges, Information Science References, 2008.

CA 19.237 **Software Project Management** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): (System Analysis and Design)

Objective(s):

- To introduce the concepts of Software Project Management to the students.
- To make the students understand the requirement for project evaluation.
- To make the students understand the requirement for Software quality assurance and project management along with its tools.

1	**Introduction to Software Project Management (SPM) : S**oftware Engineering problem and software product, software product attributes, definition of a Software Project (SP), SP vs. other types of projects activities covered by SPM, categorizing SPs, Project Management cycle, SPM framework, types of project plan	**[10]**
2	**Project Evaluation:** Strategic assessment, technical assessment, cost benefit analysis, cash flow forecasting, cost benefit evaluation techniques, risk evaluation	**[8]**
3	**Activity Planning**: Objectives, project schedule, sequencing and scheduling activities, network planning models, forward pass, backward pass, activity float, shortening project duration, activity on arrow networks.	**[8]**
4	**Managing people and Organizing teams:** Introduction, understanding behaviour, organizational behavior, working in groups, becoming a team, decision making leadership, organizational structures.	[7]
5	**Software Quality Assurance and Testing:** Testing principles and objectives, test plan, types and levels of testing, test strategies, program verification and validation, software quality, SEI-CMM,SQA activities, QA organization structure, SQA plan	**[7]**

Outcome(s): After completion of the course, students would be able to:

- Identifying the essential skills required to be an excellent project manager
- Analyzing the main factors influencing project management outcome

Text Books:

[1]. Bob Hughes, Mikecotterell, "Software Project Management", Fourth Edition, Tata McGraw Hill, 2009.

[2]. AshfaqueAhmed,"Software Project Management: A Process-Driven Approach",CRC Press, 2016.

Reference Books:

[1]. Ramesh, Gopalaswamy, "Managing Global Projects", Tata McGraw Hill,2nded. 2005.

[2]. Royce, "Software Project Management", Pearson Education, 1999

[3]. Walker Royce Software Project Management,, Addison Wesley, 1998.

CA 19. 263 **System Software** **Total Lectures: 40**

3-0-0-3

Prerequisite(s): Basic concepts of Unix-like systems. Shells and scripting. System-level programming in the C language. Software development tools and techniques.

Objective(s): This course provides an introduction to computer systems and explores the design and implementation issues of System programs that play an important role in program development.

1	**Overview:** Language processors, data structures for language processors, assemblers,macrosandmacroprocessors,compilers,interpreters, linkers and loaders.	**[6]**
2	**Operating System:** Functions of Operating System, Kernel, Shell, Process, Process state diagram, System Calls	**[8]**
3	**Assemblers:** Design of an assembler ,one pass and two pass Assembler, Databases of Assemblers,tableprocessing	**[8]**
4	**MacroProcessors:**Importance of Macro, MacroDefinition,Macro call,Macro Expansion,ConditionalMacroexpansion,Nesting ofMacros,FunctionsofMacro Processor .	**[9]**
5	**Loaders, Linkers and Compilers:**FunctionofLoaders, loaderschemes-compileandgo, general,absolute,subroutinelinkages,relocating loaders,directlinkingloaders, binders, linkingloaders,overlays, dynamicbinders,TypesofCompilers,Phases of compilerdesign,recursion,calland return statements.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Apply knowledge of mathematics, science, and engineering
- Design a system, component, or process to meet desired needs within realistic constraints.
- Identify, formulate, and solve engineering problems Understand the concept of input/output devices of Computers and how it works.

Text Books:

[1]. Donovan J.J., “Systems Programming”, New York, Mc-Graw Hill, 3rd Ed 1993.

Reference Books:

[1]. Leland L Beck,”System Software, An Introduction to System Programming”, Pearson Education, 13th Indian Reprint, New Delhi,2003

[2]. Dhamdhere, D.M., “Introduction to Systems Software”, Tata Mc-Graw Hill 1996.

CA 19. 265 **Internet Technologies** **Total Lectures: 40**
Credits 3-0-0-3

Prerequisite(s): Computer Fundamental

Objective(s): Internet Technologies presents the student with an introduction to the Internet and its services, applications and tools

1	**Introduction:** Layering, TCP/IP Layering, Internet Addresses, The Domain Name System,Client ServerModel, PortNumbers,Implementations andApplication, Programminginterfaces.	**[6]**
2	**IP**:TheLinkLayerEthernetandIEEE802EncapsulationTrailerEncapsulation,**SLIP:**SerialLineIP, Compressed SLIP,**PPP**: Point-to-Point Protocol. TheInternetProtocolIPHeader,IPRouting,SubnetAddressing,SubnetMask, Special CaseIPAddresses.	**[8]**
3	**Introduction toARP**: Address Resolution Protocol and RARP: Reverse Address Resolution Protocol, ARP Packet Format, ProxyARP, RARPPacketFormat.	**[8]**
4	**ICMP**:InternetControlMessageProtocolIntroduction,ICMP,MessageTypes,ICMP Address, Mask Request and Reply , IP Routing RoutingPrinciples, Introduction to Dynamic Routing; . UDP: User Datagram Protocol UDP Header, UDP Checksum; DNS: The Domain Name System DNS Basics, DNS Message Format, security	**[9]**
5	**TCP**: Transmission Control Protocol TCP Services, TCP Header TCP Connection, Establishment and Termination, TCP Timeout and Retransmission, Repacketization; Telnet and Rlogin Remote Login Rlogin Protocol, SMTP Protocol; FTP: File Transfer Protocol and SMTP: Simple Mail Transfer Protocol.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Understand different types of networks, various topologies and application of networks.
- Understand types of addresses, data communication.
- Understand the concept of networking models, protocols, functionality of each layer.
- Learn basic networking hardware and tools.

Text Books:

[1]. Tannenbaum A. S., “Computer Networks”, Prentice-Hall India., New Delhi
[2]. ForouzanBehrouz A, “Data Communication and Networking”, TMH, New Delhi

Reference Books:

[1]. Sybex ,“Networking Complete”, BPB Publication, New Delhi
[2]. Stallings Willam, “Data and Computer Communication”, Pearson Education, New Delhi

CA 19.267 **Network Security** **Total Lectures: 40**
Credits 3-0-0-3

Prerequisite(s): Computer Fundamental and Networking,
Basic Mathematics.

Objective(s): Students will learn the basic concepts in computer security including software vulnerability analysis and defense, networking and wireless security, applied cryptography, as well as ethical, legal, social and economic facets of security.

1	**Introduction:** Attacks, Services and Mechanisms, Security Attacks, Security Services, Integrity check, digital Signature, authentication, has algorithms	**[6]**
2	**Secret Key Cryptography:** Block Encryption, DES rounds, S-Boxes IDEA: Overview comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB CBC, OFB, CFB, Multiple encryptions DES, Hash Functions and Message Digests: Length of hash, uses, algorithms (MD2, MD4, MD5, SHS) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages,digest computation.) SHS: Overview, padding, stages	**[8]**
3	**Public key Cryptography:** Algorithms, examples, Modular arithmetic (addition,multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption.Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures	**[8]**
4	**Authentication:** Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs offline guessing, storing. Cryptographic Authentication:passwords as keys, protocols, KDC's Certification Revocation, Interdomain, groups, delegation. Authentication of People: Verification techniques, passwords, length of passwords, password distribution, smart cards, biometrics, Kerberos: purpose, authentication, serer and ticket granting server, keys and tickets, use of AS and TGS, replicated servers. Kerberos V4: names, inter-realm authentication,Key version numbers. Kerberos V5: names, realms, delegation, forwarding and proxies, ticket lifetimes, revoking tickets, multiple Realms	**[9]**
5	**Network Security:** Electronic mail security, IP security, Network management security.Security for electronic commerce: SSL, SET. System Security: Intruders and Viruses, Firewalls, Intrusion Detection	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Identify the security goals of an information system, point out contradictory goals and suggest compromises.
- Understand of the principles underlying cryptography and cryptanalysis and have a technical understanding of the main cryptographic concepts and technologies.
- Understand the purpose of security protocols and be witness to the difficulties of their verification.

Text Books:

[1]. AtulKahate," Cryptography and Network Security", TMH, New Delhi
[2]. Kaufman, C., Perlman, R., and Speciner, M., "Network Security, Private Communication in a public world" , PHI

Reference Books:

[1]. Stallings, W., "Cryptography and Network Security: Principles and Practice", Prentice Hall.
[2]. BehrouzAForouzan, "Cryptography and Network Security"; McGraw Hill.

CA 19. 373 **Software and CASE Tools** **Total Lectures: 40**

3-0-0-3

Prerequisite(s): Computer Fundamental, Computer programming

Objective(s):

- To introduce the concept of software crisis, managing complexity, requirements specification, architectural and detailed design, testing and analysis, software process, and tools and environments.
- Explores concepts and techniques for design and construction of reliable and maintainable software systems in modern high-level languages; program structure and design; program-correctness approaches, including testing; and event-driven programming

1	**Software Engineering Fundamentals :** Definition of software product and process, Software Characteristics, Components, Applications, Layered Technologies, Processes and Product, Methods and Tools, Generic View of Software Engineering, Software Crisis and Software development paradigms	**[6]**
2	**Software Requirements Analysis & Specification:** System specification, Software requirements specification (SRS) standards, Analysis Modeling: Difference between Data and Information, ER Diagram, Dataflow Model, Control Flow Model, Control and Process Specification, Data Dictionary	**[8]**
3	**Software Design:** Software architecture, Modular design - cohesion and coupling, Process-oriented design, Data-oriented design, User-interface design, Real-time software design, introduction to Object Oriented Design	**[8]**
4	**CASE Tools, Coding and Testing:** Computer-aided software engineering, Introduction to CASE, Building Blocks of CASE, Integrated Case Environment, Characteristics of good Programming languages, Introduction to Testing Process, Testing Activities like Unit, Integration & System Testing.	**[9]**
5	**Reengineering, Quality and Metrics:** Business Process Reengineering, Reverse Engineering, Software re-engineerin. SQA-Software Quality Assurance, Software Reliability, Software quality metrics, SQA plan, ISO 9000 and 9001 Quality Standards.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Make independent and critical assessments,
- Identify, formulate and solve problems autonomously, and
- Deal with changes in working life.
- Stay abreast of the development of knowledge, and
- Communicate their knowledge to others, including those who lack specialist knowledge in the field.

Text Books:

[1]. Pressman R.S. , "Software Engineering", TMH 7th Ed 2014.

[2]. PankajJalote,"An Integrated Approach to Software Engineering", NAROSA, 2005.

Reference Books:

[1]. Designing Flexible Object Oriented systems with UML - Charles Ritcher

[2]. Fairely, R.E., "Software Engineering Concepts", McGraw-Hill

[3]. Object-Oriented Analysis and Design: using UML Mike O'Docherty Wiley Publication

ET 19.362 **Mobile Apps Development** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CA 19.210 (Java Programming)

Objective(s):
- To learn how mobile apps are different from others traditional apps by learning those aspects of mobile programming that make it unique from other platforms
- Program mobile applications for the Android operating system that use basic and advanced phone features
- Deploy applications to the Android marketplace for distribution.

1	**Getting started with Mobility:** Mobility landscape, mobile platform, mobile apps development, overview of android platform, setting up the mobile app development environment along with an emulator, a case study on mobile app development.	[8]
2	**Building blocks of mobile apps: Apps user:** Interface designing-mobile UI resources (Layout,UI elements, Draw-able,Menu), activity-states and life-cycle, interaction amongst activities. app-functionality beyond user interface- threads, async task, service –state and life cycle, notification, broad cast receivers, telephony and smsapis native data handling-on device file I/O, shared preferences, mobile database such as SQLite, and enterprise data access(via Internet/Intranet)	[15]
3	**Sprucing up mobile apps:** Graphics and animation- custom views, canvas, animation APIs, multimedia-audio/video playback and record, location awareness, and native hardware access (sensor such as accelerometer and gyroscope).	[8]
4	**Testing mobile apps:** Debugging mobile apps, whiteboxtesting,blackbox testing, and test automation of mobile app, JUnit for Android, Robotium, Monkey Talk.	[6]
5	**Taking apps to market:** Versioning signing and packaging mobileapps, distributing apps on mobile market place.	[3]

Outcome(s): On successful completion of this course, students will be able to
- Understand the android operating system in details
- Create mobile application for various screens
- Deploy on play store market
- Use various sensors available in mobile

Text Books:
[1]. Barry Burd, Android Application Development All in One for Dummies, Johen Wiley & Sons Inc., Edition I , 2011.
[2]. AnubhavPradhan ,Anil V Deshpandy, Mobile App Development, Edition

Reference Books:
[1]. Lauren Darcey, Shane Conder,"Teach Yourself Android Application Development in 24 Hours",Sams Publishing, 2012, 2nd Edition , 2012.

ET 19.471 **Cloud Computing (Infosys)** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Computer Fundamental and Networking
Object Oriented Design and Programming

Objective(s): This course covers a series of current cloud computing technologies, including technologies for Infrastructure as a Service, Platform as a Service, Software as a Service, and Physical Systems as a Service.

1	**Overview of Cloud Computing:** Brief history and evolution - History of Cloud Computing, Evolution of Cloud Computing, Traditional vs. Cloud Computing. Why Cloud Computing, Cloud service models (IaaS, PaaS&SaaS). Cloud deployment models (Public, Private, Hybrid and Community Cloud), Benefits and Challenges of Cloud Computing. Introduction to AWS Public Cloud Vendor. Cost optimization in AWS.	**[6]**
2	**Virtualization**: Basics of virtualization, Virtualization technologies, Server virtualization, VM migration techniques, Role of virtualization in Cloud Computing. Introduction to EC2 service of AWS.	**[8]**
3	**WWoWorking with Private Cloud**: Private Cloud Definition, Characteristics of rivate Cloud, Private Cloud deployment models, Private Cloud Vendors - CloudStack, OpenStack, Eucalyptus Microsoft, Private Cloud – Benefits and Challenges. Private Cloud implementation in Amazon EC2 service.	**[8]**
4	**Working with Public Clouds:** What is Public Cloud, Why Public Cloud, When to opt for Public Cloud, Public Cloud Service Models, and Public Cloud Players. Infrastructure as a Service Offerings, IaaS Vendors, PaaS offerings, PaaS vendors, Software as a Service. Demonstrating public cloud with AWS – Storage and Database services. Private vs. Public Cloud – When to choose.	**[9]**
5	**Overview of Cloud Security:** Explain the security concerns in Traditional IT, Introduce challenges in Cloud Computing in terms of Application Security, Server Security, and Network Security. Security reference model, Abuse and Nefarious Use of Cloud Computing, Insecure Interfaces and APIs, Malicious Insiders, Shared Technology Issues, Data Loss or Leakage, Account or Service Hijacking, Unknown Risk Profile, Shared security model between vendor and customer in IAAS/PAAS/SAAS, Implementing security in AWS. Migration paths for cloud, Selection criteria for cloud deployment, Issues/risks in cloud computing, Future technology trends in Cloud Computing.	**[9]**

Outcome(s): After completion of the course, students would be able to:

- Understand the concepts of cloud computing
- Understand the advantages and limitations of different cloud architectures.
- Understand the enabling technologies for building cloud systems.
- Understand the concept of security in cloud computing.

Text Books:

[1]. Cloud Computing: Principles and paradigms By Raj Kumar Buyya, James Broberg, AndrezeiM. Goscinski, 2011
[2]. Cloud Computing, By Michael Miller, 2008.
[3]. Cloud Computing for dummies, By Judith Hurwitz, Robin Bllor, Marcia Kaufman, Fern Halper, 2009.

Reference Books:

[1]. Rittinghouse, John, W. Cloud computing: Implementation, management and security
[2]. Rhoton, John, Cloud Computing Architected: Solution Design Handbook.
[3]. Krutz, Ronald L.; Vines, Russell DeanKalakota ,R. and Whinston, A. B.,"Cloud Security: A comprehensive Guide to Secure Cloud Computing", Addison Wesley.

UC 19.101 **Social and Professional Ethics** **Total Lectures: 26**
2-0-0-2

Objective: To create an awareness on professional ethics and human values, To instill moral and social values and loyalty and to appreciate the rights of others.

Pre-requisite:

1.	**Basic Human Values:** Morals, Values and Ethics – Truth, Rights Conduct (Righteousness), Love, non-violence and peace, Humility and character. Core areas of ethics: Social ethics, Personal ethics Integrity and Trustworthiness, Honesty, Loyalty, Courage, Prudence, Confidence, Confidentiality.	**[5]**
2.	**Theories of Ethics:** Kohlberg and Gilligan's analysis of moral development, - Deontology, Utilitarianism, Virtue Theory Rights Theory, Casuist Theory of Consequentialism – Robert Nozick's Theory of Entitlement and Property Rights.	**[4]**
3.	**Professional Ethics:** Introduction, meaning of work ethics, professional ethics for Journalists, Physicians, Lawyers, Engineers and Accountants. Intellectual property Rights, scope of ethics, code of conduct, business values and inner consciousness, Ethics at the workplace cybercrime, plagiarism, misconduct, fraudulent use of institutional resources, etc.	**[7]**
4.	**Corporate Social Responsibility:** Evolution of Corporate Social Responsibility (CSR) in India, CSR models, CSR to different stakeholders, Corporate Social Responsibility Initiatives of Major Companies of India, Promoting value based governance in organization. Whistle blower policy.	**[6]**
5.	**Ethics and Environment:** Introduction to environmental Issues- Industry and Environmental Pollution, Ethics of Controlling environmental pollution – Impact of environmental pollution on human health – Rights, Duties and care in environmental protection - Sustainable development.	**[4]**

Outcome: The students will understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories.

Text Books:

1. B.N Ghosh "Business Ethics and Corporate Governance", McGraw Hill Education, Chennai, 2016
2. John R Boatright, "Ethics And The Conduct Of Business", Pearson Education, New Delhi, 2013.

Reference Books:

1. Raju Ramachandran, "Professional Ethics: Changing Profession and Changing Ethics", LexisNexis, Butterworths, 2nd Edition 2014.
2. Andrew Crane and Dirk Matten, "Business Ethics", Oxford University Press, 2nd Edition, 2015.
3. S.K Mandal "Ethics in Business and Corporate Governance" McGraw Hill Education, New Delhi, 2013.
4. R. Subramanian "Professional Ethics", Oxford University Press, 2015.

UC 19.102 Communication Skills **Total Lectures: 26**

2-0-0-2

Objective: This Course aims to develop and enhance the linguistic and communicative competence of the students. The students will be exposed to various forms of personal and professional communication. The self-learning tasks designed will facilitate to enhance effective communication skills.

Pre-requisite:

1.	**Introduction to Communication:** Need for Effective Communication, The Process of Communication, Use of language in communication; Barriers to Communication: Types of barriers (Semantic, Intrapersonal, Interpersonal, And Organizational); Miscommunication; Noise; Overcoming measures. **Technology-based Communication:** Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software.	[5]
2.	**Listening and Reading Skills :** Listening as an active skill; Types of Listeners; Listening for general content; Listening to fill up information; Intensive Listening; Listening for specific information; Developing effective listening skills; Barriers to effective listening skills. **Reading Skills**: Previewing techniques; Skimming; Scanning; Understanding the gist of an argument; Identifying the topic sentence; recognizing coherence and sequencing of sentences; Improving comprehension skills.	[6]
3.	**Writing Skills**: Sentence formation; Use of appropriate diction; Paragraph and Essay Writing; Coherence and Cohesion. Common Errors. **Letter Writing:** Formal, informal and demi-official letters; **Job Application:** Cover letter, Differences between bio-data, CV and Resume. **Report Writing**: Basics of Report Writing; Structure of a report; Types of reports.	[6]
4.	**Non-verbal Communication and Body Language:** Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language.	[3]
5.	**Interview Skills:** Types of Interviews; Ensuring success in job interviews; Appropriate use of non-verbal communication. **Group Discussion:** Differences between group discussion and debate; Ensuring success in group discussions. **Presentation Skills:** Oral presentation and public speaking skills.	[6]

Outcome: The students would hone the skills of reading, writing, listening, and speaking and become adept at communicating in the current modern context.

Text Books:

3. Raman, M., & Singh, P. (2017). Business Communication (2nd edition.). New Delhi: Oxford University Press.
4. Lesikar, Raymond V and Marie E. Flatley. Basic Business Communication: Skills for Empowering the Internet Generation: Ninth Edition. New Delhi: Tata McGraw-Hill,

Reference Books:

1. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Publishing Company Limited
2. Bonet, Diana. The Business of Listening: Third Edition. New Delhi: Viva Books, 2004.

UC 19.201 **Introduction to Management and Leadership** **Total Lectures: 26**
2-0-0-2

Objective: This Course, Management and leadership focus on understanding seminal and contemporary leadership theories and principles. To provide a basis of understanding to the students with reference to the working of the business organization through the process of management.

Pre-requisite:

1.	**Introduction to Management :** Nature of Management, Meaning, Definition, it's nature purpose, importance & Functions, Management as Art, Science & Profession- Management as social System Concepts of management-Administration-Organization	**[4]**
2.	**Evolution of Management Thought:** Contribution of F.W.Taylor, Henri Fayol ,Elton Mayo , Chester Barhard & Peter Drucker to the management thought. Various approaches to management (i.e. Schools of management thought)Indian Management Thought.	**[5]**
3.	**Functions of Management:** Planning - Meaning - Need & Importance, types levels - advantages & limitations. Organizing - Elements of organizing & processes, Delegation of authority - difficulties in delegation – Decentralization, Staffing - Meaning & Importance, Controlling - Process & Techniques, Coordination - Need – Importance.	**[6]**
4.	**Introduction to Leadership**: Leadership styles, qualities of a good leader, role of a leader, trait approach to leadership, behaviour approaches to leadership; Situational theories; Transformational Leadership transactional leadership, Neutralizers and substitutes to leadership.	**[6]**
5.	**Emerging Challenges to Leadership**: Leadership in changing workplace, Leader's role in fostering teamwork, Overcoming traditional thinking Methods to enhance creative problem solving, Climate for creative thinking, Leadership practices for innovation, Ethical leadership development, Cultural sensitivity, intelligence, and global leadership skills.	**[5]**

Outcome: On successful completion of the course, students will be able to Work effectively and collaboratively with others in diverse management contexts.

Text Books:

1. Dr. L.M.Parasad, "Principles & practice of management", Sultan Chand & Sons - New Delhi, 2015
2. Stephen P.Robbins "Organizational Behavior" Pearson Publisher,16th Edition, 2014

Reference Books:

1. Principles of Management, By Tripathi, Reddy Tata McGraw Hill, 2012
2. Essential of Business Administration - K.Aswathapa Himalaya Publishing House, 2014
3. Hughes, R., Ginnett, R., & Curphy, G. Leadership: Enhancing the lessons of experience, McGraw Hill, 7th Edition, 2017
4. Northouse, P. G. "Leadership: Theory and Practice" Sage Publications, New Delhi, 7th Edition 2015.

UC 19.202 **Business Environment** **Total Lectures: 26**
2-0-0-2

Objective: To familiarize the students about the background of the spectrum of business and its environment (internal and external).

Pre-requisite: Good General knowledge.

1.	**Dimensions of Business Environment**: Nature and characteristics of contemporary business; Types of business environment - general and task environment, Internal (Value system, Organization structure, Human Resource, Company image and brand value, Physical assets) and external Environment (micro and macro), Environmental analysis and strategic Management.	[5]
2.	**Social Environment**: Concept and salient features of Indian culture and values, Impact of culture on business, Cultural resources, Ethics and social responsibility of business, Consumerism.	[5]
3.	**Political and legal Environment*:*** Impact of competing political ideologies and role of government, Political Stability and Instability on Business Activities, Legal framework for establishing a business unit in India, Competitive Conditions, Foreign Direct Investment in India.	[5]
4.	**Economic Environment**: Economic systems – Market, Planned and Mixed economy; Indian economy – overview; Economic reforms in India; Economic policies – Determinants of National Income, Privatization, Fiscal policy and Monetary policy.	[6]
5.	**Technological Environment:** Features of technology; Impact of technology; Management of technology; status of technology in India; Policy for research and development in India.	[5]

Outcome: Understanding real life situations vis-à-vis economic, social, legal, political and technological systems in the country and analyzing the impact of changes on different industries and trends in different sectors of the economy and society.

Text Books:

3. Business Environment, Francis Cherunilam, 1st Edition, 2018.
4. Essentials of Business Environment, K Aswathappa, HPH, 12th Edition, 2014.

Reference Books:

5. Business Environment, BN Ghosh, OUP, 2015
6. Business Environment: Text & Cases (3rd Edition), Justin Paul, McGraw Hill, 2016.
7. Business Environment, AC Fernando, Pearson, 2016

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech CS

CS 19.506 **Distributed Operating Systems** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite: Operating System

Objective(s):

- To learn the operating system and distributed computing environment
- To learn remote procedure call and Remote method invocation.
- To learn the principles of distributed shared memory
- To learn distributed file system..

1	**Introduction and distributed computing environment**: Definition, Evolution of distributed computing system, Distributed computing system models- Minicomputer model, workstation model, workstation –server model, processor –pool model, hybrid model. Advantages of distributed operating system. Design issues of distributed operating system- Transparency, Reliability, concurrency, scalability, heterogeneity, openness, security.	[8]
2	**Message Passing:** Introduction, issues in IPC by message passing, Synchronization, buffering –null buffer, single message buffer, unbounded capacity buffer, finite bound buffer. Multi datagram message, encoding and decoding of message data. Process addressing, failure handling, group communication.	[6]
3	**Remote Procedure call and Remote Method Invocation:** RPC model, Transparency of RPC, Implementing RPC mechanism, Stub generation, RPC Messages, Parameter passing, semantics, call semantics. Communication protocols for RPC-request protocol, request/reply protocol, request/reply/acknowledge protocol, RPC heterogeneous environment, Light weight RPC. Remote Method Invocation(RMI) : Introduction, communication between distributed objects, design issues for RMI implementation of RMI , clock synchronization, logical clock- Lamport time stamps, deadlock, election algorithms- Bully algorithm, Ring algorithm , distributed transactions.	[15]
4	**Distributed shared memory:** Introduction, message passing vs DSM, implementation approaches to DSM, design and implementation issues- Structure and synchronization model. Granularity, Structure of shared memory space, consistency model, replacement strategy, thrashing.	[8]
5	**Distributed File System:** Design, implementation, trends in distributed file system.	[7]

Outcome(s): On successful completion of this course, students will be able to

- Understand the primary functionalities of operating system.
- Understand Message passing efficiently in an operating system environment
- Develop new operating systems as well as work on existing ones to develop them further

Text Books:

[1] Pradeep K. Sinha, "Distributed Operating Systems: Concepts and Design", Prentice-Hall of India, 3rd Printing, October 2001 .

[2] Andrew S. Tanenbaum and Maarten van Steen, " Distributed Systems", PHI, second Printing, July 2003.

Reference Books:

[1] G. Coulorius, J. Dollimore and T. Kinderberg, "Distributed Systems: Concepts and Design", fourth edition, Addison Wesley, May 2005.

CS 19.508 **Soft Computing Paradigms** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite: Artificial Intelligence

Objective(s):

- To familiarize with soft computing concepts
- To introduce the idea of artificial neural networks, fuzzy logic and use of heuristics based on human experience
- To introduce the concept of genetic algorithm and its applications to soft computing using some applications

1. **Artificial Neural Networks:** Definition, benefits of Artificial Neural Networks, terminology, neuron models, activation function, network architectures, learning process, types of learning: Hebbian, competitive, error-correction, Boltzmann learning. [8]

2. **Types of Neural Networks:** Feed forward neural network: Single layer perceptron, limitations, multi layer perceptron, back propagation algorithm, practical considerations, radial basis function network. Recurrent networks: Hopfield network, NARX model, state space model, recurrent multi layer, perceptron, second order networks. Self-organizing map, and principal component analysis. [12]

3. **Fuzzy Logic and applications :** Basic concepts of fuzzy logic, crisp sets and fuzzy sets, operations and properties of crisp sets and fuzzy sets, crisp and fuzzy relations, fuzzy rules, fuzzification and defuzzification. Pattern recognition, control engineering, image processing, neuro fuzzy application. [10]

4. **Genetic Algorithms:** Basic concepts, working principles, genetic operators, genetic programming, parsing trees and mathematical foundation of genetic algorithm. . Other optimization methods: Swarm Intelligence, ant colony optimization. [6]

5. **Hybrid Systems:** Neuro genetic systems, fuzzy genetic systems and neuro fuzzy genetic systems, applications. [4]

Outcome(s): On successful completion the students will be able to:

- Identify and describe soft computing techniques and their roles in building intelligent machines
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems
- Apply genetic algorithms to combinatorial optimization problems
- Apply neural networks to pattern classification and regression problems
- Evaluate and compare solutions by various soft computing approaches for a given problem

Text Books:

[1] Li Min Fu, "Neural Networks in Computer Intelligence", Tata McGraw Hill Edition, 2008.

[2] S.N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", Wiley India, 2008.

Reference Books:

[1] S. Rajsekaran, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Application", Prentice Hall, 2010.

[2] Simon S. Haykin , "Neural Networks- A Comprehensive Foundation", Prentice Hall, 2009

[3] D.E. GoldBerg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, 2009.

[4] S. Rajsekaran, G. A. Vijayalaxmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Application", Prentice Hall, 2010

CS 19.510 **Digital Image Processing and Analysis** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite: Computer Programming, Computer Graphics

Objective(s):

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the image segmentation and representation techniques
- To study the image representation in form of features and descriptors

1. **Image Representation:** Sampling, Quantization, Image Basis Function, Image Types, Fourier Transform, Discrete Cosine Transform, Walsh- Hadamard Transform, Wavelet Transform, Principal Component Analysis [6]

2. **Image Enhancement and Restoration:** Contrast Stretching, Histogram Specification, Histogram Equalization, Enhancement Using Arithmetic/Logic Operations, Smoothing Sharpening, Low-Pass Filters, High-Pass Filters, Bandpass Filters, Homomorphic Filtering, Restoration Process Model, Noise Models, Inverse Filtering , Minimum Mean-Square Error Restoration. [8]

3. **Image Morphology**: Introduction, Logic Operations Involving Binary Images, Dilation and Erosion, Opening And Closing, Boundary Extraction, Region Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening. [5]

4. **Image Segmentation:** Region Extraction, Pixel-Based Approach, Thresholding, Edge And Line Detection, Pattern Fitting Approach, Hough Transform, Radon Transform, Edge Linking And Edge Following, Edge, Corner Detection**.** [6]

5. **Pattern Recognition , Compression and Feature Extraction** [15]
Recognition: Deterministic Methods, Clustering, Neural Network, Template Matching, Statistical Classification, Syntactic Recognition, Tree Search, Graph Matching.Image Compression: Information Content of an Image, Lossless and Lossy Compression Algorithms, Compression Standards. Feature Extraction: Representation, Topological Attributes, Geometric Attributes, spatial Moments, Texture, Boundary Based Description, Region Based Description, Intensity Based and Relational Description.

Outcome(s): On successful completion of this course, students will be able to

- Discuss digital image fundamentals.
- Apply image enhancement and restoration techniques.
- Use image compression, segmentation and features extraction Techniques.

Text Books:

[1] Gonzaloz R. C. and Woods R.E., “Digital Image Processing”, Prentice Hall 2002.

[2] Jain A.K., “Fundamentals of Digital Image Processing”, Prentice Hall 1989.

Reference Books:

[1] William K. Pratt, “Digital Image Processing”, John Wiley, 2001.
[2] B. Chanda and D. Dutta Majumder ,” Digital Image Processing and Analysis”,PHI, 2002

CS 19.511 **Ad hoc Sensor Networks** **Total Lectures: 40**

Prerequisite: Computer Networks **Credit: 3-1-0-4**

Objective(s):

- To learn the Ad hoc networks and related protocols
- To learn QoS parameters of Ad hoc network
- To learn the basic principles of sensor networks
- To understand the functionality of wireless sensor network and respective securities issues

1	**Ad hoc Networks:** Introduction and Definitions, Ad hoc Network Applications, Design Challenges. Routing in Mobile Ad hoc Networks: Introduction, Flooding, Proactive Routing, On Demand Routing, Proactive Versus on demand Debate, Location based Routing.	[7]
2	**Multicasting and Transport layer Protocols in Ad hoc Networks:** Introduction, Classifications of Protocols, Multicasting Protocols, Broadcasting. Protocol Comparisons, Overarching Issues. Transport layer Protocols in Ad hoc Networks: Introduction, TCP and Ad hoc Networks, Transport Layer for Ad hoc Networks: Overview, Modified TCP, TCP-aware Cross-layered Solutions. Ad hoc Transport Protocol.	[9]
3	**QoS Issue in Ad hoc Networks:** Introduction, Definition of QoS, Medium Access Layer, QoS Routing, Inter- Layer Design Approaches. Security in Mobile Ad hoc Networks: Vulnerabilities of Mobile Ad hoc Networks, Potential Attacks, Attack Prevention Techniques. Intrusion Detection Techniques.	[8]
4	**Overview of Wireless Sensor Networks (WSNs)**: Introduction, Constraints and Challenges, Advantages of Sensor Networks, Sensor Network Applications' Routing Protocols: Geographic, Energy-Aware Routing – Unicast Geographic Routing, Routing on a Curve, Energy-Minimizing Broadcast, Energy-Aware Routing to a Region; Attribute-Based Routing – Directed Diffusion, Rumor Routing.	[10]
5	**Security in WSNs:** Introduction: IEEE 802.11b Security Mechanisms, WEP Security Issues, WEP Improvements, Wireless Security Threats and Risks: Types of Security Threats, Physical Security of Wireless Devices, WLAN Attacks. Risk Mitigation and Countermeasures: Basic Countermeasures, AAA Infrastructure Solutions, Additional Enhancements.	[6]

Outcome(s): On successful completion of this course, students will be able to
Understand the basic working of sensor networks
Understand security aspects of WSN

Text Books:

[1] Prasant Mohapatra and Srihanamurthy, "Ad Hoc Networks Technologies and Protocols", Springer, Springer International Edition, 2009.

[2] Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks", John Wiley & Sons, Inc., Pub!ication, 2007.

Reference Books:

[1] A.Boukereche, "Handbook of Algorithms for Wireless Networking and Mobile Computing", Chapman and Hall/CRC Computer and Information Science Series, 2007.
[2] Zhao, Guibas, "Wireless Sensor Networks" , Elsevier, 2004.

CS 19.512 **Advances in Database Management Systems** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite: Database Management System

Objective(s): The objectives of this Course are :

- To learn object relational databases
- To learn query processing and optimization
- To learn database recovery and database security
- To learn distributed databases

1. **Object and Object-Relational Databases:** Introduction, Object relational features, Object database extensions to SQL, ODMG object model and the object definition language (ODL) [8]

2. **Query Processing and Optimization:** Translating SQL queries into relational algebra. Algorithms for external sorting, select, join, project and set operations. Implementing aggregate operations and outer joins. Combining operations using pipelining, heuristic query optimization, selectivity and cost estimates in query optimization, semantic query optimization. [8]

3. **Database Recovery:** Recovery concepts, no-undo/redo recovery based on deferred update, recovery techniques based on immediate update, shadow paging, ARIES algorithm, recovery in multi database systems, database backup and recovery from catastrophic failures. [8]

4. **Database Security:** Security issues, granting and revoking privileges, role based access control for multilevel security, SQL injection, statistical database security, flow control, encryption and public key infrastructures, privacy issues and preservation, challenges of database security**.** [8]

5. **Distributed Databases:** Distributed database architecture, fragmentation, and query processing and optimization management in distributed databases. Database concepts, types, distributed distribution and allocation techniques, in distributed databases, transaction [8]

Outcome(s): After completion of the course, students will be able to:

- Understand object and object relational databases.
- Understand Structured Query Language (SQL) with query optimization.
- Understand issues in database recovery and database security

Text Books:

[1] Elmasri, Navathe, "Fundamentals of Database systems", Addison Wesley, sixth ed, 2010.

[2] Raghu Ramakrishnan, Gehrke, "Database Management systems", McGraw Hill, third ed, 2009.

Reference Books:

[1] Thomas m. Connolly, Carolyn E. Begg, "Database Systems", Pearson education, fifth ed, 2009.

CS 19.515 **Machine Learning** **Total Lectures: 40**

Credit:3-1-0-4

Prerequisite: Artificial Intelligence

Objective(s):

- To learn the Machine learning concepts.
- To learn different models of Machine learning.

1. **Foundations of Learning:** Components of learning, learning models, geometric models, probabilistic models, logic models, grouping and grading, learning versus design, supervised learning, unsupervised learning, reinforcement learning , theory of learning, feasibility of learning, error and noise, training versus testing, theory of generalization, generalization bound, approximation generalization trade off, bias and variance, learning curve. [8]

2. **Linear Models:** Linear classification, univariate linear regression, multivariate linear regression, regularized regression, logistic regression, perceptron, multilayer neural networks, learning neural networks structures, support vector machines, soft margin SVM, going beyond linearity, generalization and overfitting, regularization, validation. [8]

3. **Distance-based Models:** Nearest neighbour models, K-means clustering, hierarchical clustering, k-d trees, locality sensitive hashing, non-parametric regression, ensemble learning, bagging and random forests, boosting, meta learning. [8]

4. **Tree and Rule Models:** Decision trees, learning decision trees, ranking and probability estimation trees, regression trees, clustering trees, learning ordered rule lists, learning unordered rule lists, descriptive rule learning, association rule mining, first-order rule learning. [8]

5. **Reinforcement Learning:** Passive reinforcement learning, direct utility estimation, adaptive dynamic programming, temporal-difference learning, active reinforcement learning, exploration, learning an action utility function, generalization in reinforcement learning, policy search, applications in game playing, applications in robot control. [8]

Outcome(s): Students will be able to

- Compare and apply Machine learning models for different problems.
- Carry out research in the area of Machine learning.

Text Books:

[1] T. M. Mitchell, Machine Learning, McGraw Hill, 1997.
[2] P. Flach, Machine Learning: The art and science of algorithms that make sense of data, Cambridge University Press, 2012.

Reference Books:

[1] M. Mohri, A. Rostamizadeh, and A. Talwalkar, Foundations of Machine Learning, MIT Press, 2012.

[2] S. Russel and P. Norvig, Artificial Intelligence: A Modern Approach, Third Edition, Prentice Hall, 2009.

CS 19.521 **Big Data Analytics** **Total Lectures: 40**

Credit:3-1-0-4

Prerequisite: Data Mining, Database Management Systems

Objective(s):

- To learn Big Data characteristics
- To learn Hadoop architecture and functioning of Map-Reduce.
- To learn other Big data tools like HIVE, HIVEQL and HBASE.

1. **INTRODUCTION: D**istributed file system – Big Data and its importance, four Vs, drivers for Big data, Big data analytics, Big data applications, algorithms using map reduce, matrix-vector multiplication by Map Reduce. [8]

2. **Introduction to HADOOP:** Apache HADOOP & HADOOP ecosystem , moving data in and out of Hadoop , understanding inputs and outputs of MapReduce , data serialization [8]

3. **HADOOP Architecture:** HADOOP architecture, HADOOP storage: HDFS, common HADOOP shell commands , anatomy of file write and read., namenode, secondary namenode, and datanode, HADOOP MapReduce paradigm, map and reduce tasks, job, task trackers ,cluster setup, SSH & HADOOP configuration, HDFS administering, monitoring & maintenance. [8]

4. **HADOOP Ecosystem and YARN**: HADOOP ecosystem components, schedulers, fair and capacity, HADOOP 2.0 new features, namenode, high availability, HDFS federation, mrv2, YARN, running mrv1 in YARN. [8]

5. **HIVE and HIVEQL, HBASE**: HIVE architecture and installation, comparison with traditional database, hiveql, querying data, sorting and aggregating, map reduce scripts, joins & subqueries, Hbase concepts, advanced usage, schema design, advance indexing - Pig, Zookeeper - how it helps in monitoring a cluster, Hbase uses Zookeeper and how to build applications with Zookeeper. [8]

Outcome(s): The students will be able to carry out research in Big Data using the latest tools.

Text Books:

[1] Chris Eaton, Dirk deroos et al., Understanding Big data , McGraw Hill, 2012.

[2] Tom White, HADOOP: The definitive Guide , O Reilly 2012.

Reference Books:

[1] Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, Professional Hadoop Solutions, Wiley, 2015.

[2] Jy Liebowitz, Big Data and Business analytics, CRC press, 2013.

CS 19.523 **Operations Research** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite: Engineering Mathematics
Objective(s): To learn major Operations research techniques.

1. **Introduction to Operation Research:** Origins of or, nature, impact and phases of OR, solving the OR Model , operation research as tool for decision support system, productivity improvement, overview of OR research techniques. [6]

2. **Linear Programming Extensions:** Formulation of linear programming problem, linear programming models, assumptions of linear programming, graphical method of solving LP problem, Simplex method for solving LP problem, special cases in Simplex method application. Formulation of transportation problem, types of transportation problems, methods of initial feasible solution, methods of optimum solution, unbalanced transportation problem, assignment problem, transshipment model. [14]

3. **Decision, Game & Queueing Theory:** Formulation of two person, zero-sum games, solving simple games, mixed strategies, non-zero sum games, basic structure & components of decision, decision criteria, decision trees, basic characteristics of queueing system, terminologies & notation, Poisson process of queueing, M/M/1 system queueing model. queueing decision models. [8]

4. **Hybrid OR Models, Project Management PERT & CPM:** Assumption and comparison PERT & CPM, algorithms of PERT CPM techniques, fundamentals of network model, guidelines for network construction, critical path analysis, methods based on time estimates to find critical paths, concept of slack & oats in network analysis, Project Evaluation & Review Techniques (PERT) [6]

5. **Dynamic Programming:** Terminologies, multi decision process, Bellman's principles of optimality, characteristics of dynamic programming problems, dynamic programming algorithms, solving LPP using dynamic programming, recent applications of dynamic programming in OR. [6]

Outcome(s): Students will be able to apply Operation Research techniques relevant to their area of research.

Text Books:
[1] Hamdy A Taha, Operations Research: An Introduction, Pearson education India, 8th Edition, 2011.
[2] Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research, 8th edition McGraw-Hill, 2001.

Reference Books:
[1] Richard Bronson , Govindasami Naadimuthu, Schaum's Outline of Operations Research, 2nd edition, McGraw-Hill Education, 1997.
[2] Wayne L. Winston, Operations Research: Applications and Algorithms, Cengage Learning, 2003.

CS 19.562 **Mobile Cloud Computing** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Computer Networks, Cloud Computing

Objective(s):

- To learn the cloud services and requirements of cloud
- To become familiar with different cloud models and solutions
- To learn mobile computing architectures

1. **Introduction:** Cloud, Business and IT Perspective, Virtualization, Cloud Services Requirements, Cloud And Dynamic Infrastructure, Cloud Computing Characteristics, Cloud Adoption. [8]
2. **Cloud at a Service:** Internet Software Evolution, Web Services Deliver from the Cloud, Communication-as-a-Service, Infrastructure-as-a-Service, Monitoring-as-a-Service, Platform-as-a-Service, Software-as-a-Service, Building Cloud Network. [8]
3. **Cloud Models and Solutions:** Cloud Models, Cloud Characteristics, Measured Service, Security in a Public Cloud, Public Verses Private Clouds, Cloud Infrastructure Self Service. Cloud Solutions: Cloud Ecosystem, Cloud Business Process Management, Cloud Service Management, Cloud Stack, Computing On Demand, Cloud Sourcing. [16]
4. **Cloud Offerings and Virtualization technology:** Virtual Desktop Infrastructure, Storage Cloud. Cloud Virtualization technology: Virtualization, Virtualization Benefits, Server Virtualization, Hypervisor Management Software, Virtualized Data Center. [12]
5. **Mobile Computing:** Motivation, Applications, Architectures, Platforms For Mobile Cloud Computing, Windows Phone, Android, IPhone, Popular Mobile Apps, 3G, 4G, Bluetooth, Wi-Fi. [8]

Outcomes(s): On the successful completion of the course, the student will be able to:

- To understand the cloud infrastructure
- To understand the different services provided by cloud.
- To understand mobile computing

Text Books:

[1] Kumar Saurabh, "Cloud Computing", Wiley India, 2011.
[2] Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley: February 2011.

Reference Books:

[1] Haley Beard, "Cloud Computing Best Practices for Managing and Measuring Processes for On Demand computing applications and data Centers in the Cloud with SLAs" , Emereo Pty Limited, July 2008.
[2] Asoke Talkukder, Roopa R Yavagal, "Mobile Computing – Technology, Applications and Service Creation", Tata McGraw Hill, 2007
[3 Raj Kamal, "Mobile Computing", Oxford University Press, 2007.
[4] Michael Miller, "Cloud Computing: Web-Based Applications That Change the Way You Work and Collaborate Online", 1st Edition, Publisher: Pearson, 2008.

CS 19.563 **Advances in Distributed Computing** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Computer network, Computer Architecture, Distributed System

Objective(s): The objectives of this Course are :

- To learn distributed systems and distributed computing
- To learn synchronous and asynchronous system
- To learn fault tolerant and non-fault tolerant systems.
- To learn synchronous shared memory systems.

1. **Introduction:** Distributed Systems, Cluster Computing, Supercomputing, Cloud Computing. [6]
2. **Synchronous networks and Fault-tolerant Systems:** Leader election in synchronous ring networks. Leader election in rings. Basic computational tasks in general synchronous networks: leader election. Fault-tolerant Systems: Consensus, Link failures: the two generals problem. Process failures (stopping, Byzantine). Algorithms for agreement with stopping and Byzantine failures. Exponential information gathering. [12]
3. **Asynchronous distributed computing and Non-fault-tolerant Systems:** Formal modeling of asynchronous systems using interacting state machines (I/O automata). Proving correctness of distributed algorithms. Non-fault-tolerant Systems: Algorithms for asynchronous networks. Leader election. [10]
4. **Time, clocks, and the ordering of events:** State-machine simulation. Vector timestamps. Stable property detection. Distributed termination. Global snapshots. Deadlock detection, Synchronizers: Synchronizer applications. Synchronous vs. Asynchronous distributed systems. [12]
5. **Asynchronous shared-memory systems and Locking:** The mutual exclusion problem. Mutual exclusion algorithms. Bounds on shared memory for mutual exclusion. Resource allocation. The Dining Philosophers problem. Locking: Locking algorithms, optimistic algorithms, lock-free algorithms, lazy algorithms, Load scheduling and balancing techniques. [12]

Outcome(s): On successful completion the students will be able to:

- Understand distributed algorithms for synchronous and asynchronous distributed computing
- Understand various synchronizer applications with synchronous and asynchronous systems..

Text Books:

[1] Lynch, Nancy, “Distributed Algorithms”, Burlington, MA: Morgan Kaufmann, 1996. ISBN: 9781558603486.

[2] George Coulouris, Jean Dollimore, Tim Kindberg, “Distributed Systems, Concept and Design”, 3rd Edition, Pearson Education, 2005.

Reference Books:

[1] Pradeep K. Sinha, “Distributed Operating Systems: Concepts and Design”, PHI, 2007.

[2] Randy Chow, Theodore Johnson, “Distributed Operating Systems and Algorithm Analysis”, Pearson, 2009.

[3] Mukesh Singhal, Niranjan G. Shivaratri, Niranjan Shivaratri, “Advanced Concepts in Operating Systems”, TMH, 1994.

[4] Sunita Mahajan, Seema Shah, “Distributed Computing”, Oxford University Press,2010

CS 19.564 **Machine Intelligence and Robotics** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Artificial Intelligence

Objective(s):

- To learn artificial intelligence and knowledge representation
- To become familiar with knowledge organization and control strategies
- To learn robotics and robot programming

1. **Introduction:** Importance of AI, Knowledge Based System, Knowledge organization & manipulation, Conceptual Introduction to LISP and other AI programming Languages. [10]

2. **Knowledge Representation:** Syntax, Semantics, Inference Rules, Non-deductive Inference methods, and representations using rules. Forward chaining and backward chaining. Fuzzy Logic & Natural languages computations. Probabilistic Reasoning. Object Oriented Representation. [10]

3. **Knowledge Organization & Manipulation:** Search & control strategies, matching techniques, knowledge organization & management, Genetic Algorithms based search techniques. [10]

4. **Robotics:** Types of Robots, spatial transformation and kinematics of open chain linkages. Mobile robots, Actuators, sensors, programming and control. Applications - motion planning, grasping and industrial automation. [12]

5. **Robot Programming:** Languages, characteristics of Languages, Position Specification, Motion Specification. Robot Program synthesis, Programming solution using VAL Robot programming Language, Artificial Intelligence, search strategies, Heuristic search, Rule based problem solving, Knowledge Representation, Robot programming using LEGO robots. [10]

Outcomes(s): On the successful completion of the course, the student will be able to:

- To understand robot programming using LEGO NXT EV3
- To understand VAL robot programming language
- • To understand knowledge representation and AI Programming Languages.

Text Books:

[1] R.D. Klafter, Chemieleskio, T.A. and Negin M., "Robotics Engineering an Integrated approach", Prentice Hall , 1989.

[2] M. Nagenevtsky, "Artificial Intelligence –A guide to intelligent systems", Addison – Wesley , 2005.

Reference Books:

[1] K.S.FU, R.C. Gonzalez, and C.S.G.Lee., "Robotics control , Sensing, Vision ,and Intelligence" , Prentice Hall , 1987.

[2] J.J. Craig, "Introduction to Robotics", Addison Wesley Publishers, 2005.

[3] G. Bekey, "Autonomous Robots", MIT Press, 2005.

CS 19.565 **Advanced Compiler Construction** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Compiler design, Theory of automata

Objective(s):

- To learn the major conceptual areas of language translation and compiler design.
- To learn the knowledge in code optimization and register allocation techniques
- To extend the knowledge of different parsers.
- To provide practical programming skills necessary for construction of a compiler.

1. **Advanced Issues in Elementary topics:** Compiler, phases and passes, finite state machines, regular expressions and their applications to lexical analysis, implementation of lexical analyzer using FLEX, CFG, bottom-up and top-down parsers, implementation of parsers using YACC. [10]

2. **Symbol Table Structure and Intermediate Representations:** Storage classes, visibility and lifetime. Symbol attributes and symbol table entries, local symbol table management, and global symbol table structure, storage binding and symbolic registers. Intermediate Representations: Issues in designing intermediate languages, High level, medium level, low level and multi-level intermediate languages. Representing all intermediate languages in informal compiler algorithm notation (ICAN). [14]

3. **Code Optimization:** Introduction, early optimization, redundancy elimination. Loop optimization: Induction variable optimizations, bounds checking elimination. Procedure optimization: Tail-call optimization and Tail-recursion optimization, procedure integration, In-line expansion, leaf routine optimization and shrink wrapping. [8]

4. **Register Allocation**: Register allocation and assignment, local methods, graph coloring, priority based graph coloring. Code Scheduling: Instruction Scheduling, Speculative loads and boosting, speculative scheduling, trace scheduling, percolation scheduling. [12]

5. **Inter procedural Analysis and Optimization** Call graph, inter procedural data flow analysis, constant propagation, alias analysis, optimizations and register allocation. [8]

Outcome(s): On successful completion of this course, the students will be able to

- Use lexical analyzer and parser generator tools.
- Generate intermediate code.
- Be familiar with register allocation. and compiler code optimization

Text Books:

[1] Steven S. Muchnik, “Advanced Compiler Design Implementation”, Morgan Kauffman publishers, 2005.

[2] Alfred Aho, Monica Lam, Ravi Sethi, Jeffrey Ullman, “Compilers: Principles, Techniques, and Tools”, Second edition, Addison-Wesley, 2006.

Reference Books:

[1] Louden, Compiler Construction: Principles and Practice, Cengage Learning, 1st edition, 1997

[2] Fisher, Faraboschi, Young, “Embedded Computing - A VLIW Approach to Architecture, Compilers, and Tools”, Morgan Kaufmann, 2005.

CS 19.566 **Natural Language Processing** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Artificial Intelligence

Objective(s):

- To learn language modeling, syntactic analysis and parsing
- To learn semantic analysis and parsing
- To learn robotics and robot programming

1. **Language Modelling and Syntactic Analysis :** Definition, Origin of NLP, Language and Knowledge, The challenges of NLP, Language and Grammar, NLP application, Successful early NLP systems, Information retrieval. Various grammar-based language models, statistical language models. [16]

   Word Level Analysis and Syntactic Analysis: Introduction, Regular Expressions, Finite State Automata, Morphological Parsing, Spelling Error Detection and correction, words and words classes, Part-of-speech tagging . Context Free grammar, Constituency, Parsing, Probability Parsing.

2. **Semantic Analysis and Discourse Processing:** Introduction, Meaning Representation, Lexical Semantics, Ambiguity, word sense Disambiguation. Cohesion, Reference Resolution, Discourse Coherence and Structure. [8]

3. **Natural Language generation and Machine Translation:** Introduction, Architecture of NLG systems, Generation task and representation, Problems in Machine Translations, Machine Translation approaches, Direct Machine Translation, Rule based machine translation, corpus-based MT, Semantic or knowledge based MT systems. [10]

4. **Application and Lexical Resources:** Speech Recognition and Synthesis, Information Retrieval Systems, Information Extraction, Automatic Text Summarization, Question-Answering; Resources**:** WordNet, FrameNet, Stemmers, Part-of Speech Tagger. [10]

5. **NLP with Python:** Introduction, Processing Raw Text, Writing Structured Program, Categorizing and Tagging words, learning to Classify Text, Analyzing Sentence Structure. [8]

Outcome(s): On the successful completion of the course, the student will be able to:

- To understand Implementation of Natural language processing using Python
- To understand VAL robot programming language
- To understand knowledge representation and AI Programming Languages.

Text Books:

[1] Steven Bird, Ewan Klein and Edward Loper, "Natural Language Processing with Python", O" Reilly Media , 2009.

Reference Books:

[1] U. S. Tiwary and Tanveer Siddiqui, "Natural Language Processing and Information Retrieval", Oxford University Press, 2008.
[2] Christopher D. Manning and Hinrich Schutze," Foundation of Statistical Natural Language Processing", ISBN 026213360

CS 19.567 **Bioinformatics** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Computer Programming, DBMS

Objective(s):

- To learn the basics of bioinformatics
- To learn the bioinformatics databases and web techniques
- To extend the knowledge bioinformatics and distributed computing

1. **Introduction to Bioinformatics:** Definition and History of Bioinformatics, Internet and Bioinformatics, Introduction to Data Mining, Applications of Data Mining to Bioinformatics Problems and Applications of Bioinformatics. [6]

2. **Bioinformatics Databases:** Introduction, Nucleotide sequence database - Protein sequence databases, Sequence motif databases, Protein structure databases, other relevant databases. Data storage and retrieval and Interoperability: Flat files, relational, object oriented databases and controlled vocabularies. File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search. The challenges of data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON. [19]

3. **Sequence Alignments and Visualization:** Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example),Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm).Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol), Anatomical visualization. [16]

4. **Bioinformatics and Web Techniques:** Clustal V, Clustal W 1.7, RasMol, Oligo, Molscript, Tree view, Alscript, Genetic Analysis Software, Phylip. Semantic Web Techniques: Bridging databases, browsing space of information, life sciences identifiers, RDF data representation. [10]

5. **Bioinformatics and Distributed Computing:** Java Distributed computing platform, DPRml, DSEARCH. [5]

Outcome(s): On successful completion of the course, the students will be able to

- Use different bioinformatics databases and web techniques
- Understand sequence alignment algorithms

Text Books:

[1] Dan E. Krane ,"Fundamental Concepts of Bioinformatics", third edition, Pearson Education, 2009.

[2] Claverie, J.M. and Notredame C. ," Bioinformatics for Dummies", Wiley Editor , January 2003.

Reference Books:

[1] Shalini Suri, "Bioinformatics", APH Publishing Corporation, 2006.

CS 19.568 **Advanced Software Engineering** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Software Engineering

Objective(s):

- To understand the software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To acquire knowledge on implementation issues in software design..
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study object oriented system analysis, design and testing.

1. **Introduction:** Software life cycle models, Waterfall, Prototype, Evolutionary and Spiral Models, Overview of Quality Standards like ISO 9001, SEI – CMM, Software Requirements analysis & specifications, Software Project Management. [10]
2. **Fundamental issues in software design:** Goodness of design, cohesions, coupling, Classification of Cohesiveness & Coupling, Function-oriented design: structured analysis and design. [8]
3. **Software Testing:** Testing process, Design of test cases, functional testing: Boundary value analysis, Equivalence class testing, Decision table testing, Cause effect graphing, Structural testing, Path Testing, Data flow and mutation testing, Unit Testing, Integration and System Testing, Debugging, Alpha & Beta Testing, Regression Testing, Testing Tools & Standards. [8]
4. **Object Oriented System Analysis. Design and Testing:** Object oriented and object basics, object oriented system development cycle, process framework of OOSAD, unified approach UML, UML Diagrams: class diagram, use-case diagram, behavior diagram, OOAP, OOD and OODBMS. [16]
   Object-Oriented Testing: Testing Object Oriented Systems overview. Broadening the View of Testing, Testing OOA and OOD Models, Object-Oriented Testing Strategies, Test Case Design for OO Software , Testing Methods Applicable at the Class Level.
5. **Advanced Topics in Software Engineering:** Overview of Formal Methods, Cleanroom Software Engineering, Component-Based Software Engineering, Client-Server Software Engineering, Web Engineering, Reengineering, Computer-Aided Software Engineering, and the Road Ahead. [10]

Outcome(s): On successful completion of this course, students will be able to

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.
- Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

[1] R. S. Pressman, “Software Engineering – A practitioner‟s approach”, 5th Ed., McGraw Hill Int. Ed., 2001.
[2] Ian Sommerville, “Software Engineering”, Addison. Wesley, 1999.

Reference Books:

[1] K. K. Aggarwal & Yogesh Singh, “Software Engineering”, New Age International, 2001.
[2] Stephen R. Schach, “Classical & Object Oriented Software Engineering”, IRWIN, 1996.
[3] P. Jalote, “An Integrated approach to Software Engineering”, Narosa, 1991.
[4] Booch, Rumbaugh and Jacobson “The Unified Modeling Language User Guide”, Addison-Wesley 2005.

CS 19.569 **Advanced Computer Graphics** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Computer Graphics

Objective(s):

- To introduce the students with the principles of animation
- The objective of the course is to equip students with fundamental knowledge and technical competence in the field of computer graphics.
- Provide an understanding of rendering and 3D modeling.
- To learn three dimensional object representation.

1. **3D Transformation and Viewing**: 3D transformation, composite transformation, viewing pipeline, parallel and perspective projection, visible surface detection: classification of visible surface detection algorithms, back face detection, depth buffer method, A-buffer method, scan-line method, depth sorting method. [7]

2. **Animation:** Introduction of computer Animation, Principles of Animation, Keyframing, Kino-dynamics Planning- motion blending, skinning-skeleton animation, rigid skinning ,linear skinning, dual skinning, physics modeling-Physics-based animation, rigid body systems, articulated rigid bodies, forward and inverse dynamics. [7]

3. **Rendering:** Basic concepts of graphics models-illumination& reflection models Shading-Scanning polygons, Gourad and Phong shading , texture mapping- bump & environmental maps , mipmaps , shading languages-vertex shedders and fragment shedders. [12]

4. **Modeling:** Representation, Using homogeneous Coordinate systems, Modeling process, terrain-representation, methods , fault formation & weather, plants modeling , animals modeling. [12]

5. **Surface Representation:** Three dimensional object representation –polygon representations, implicit representation , Beziers ,B-splines-basis function, knot insertion, conversion , rational B-splines (NURBS)-properties and examples , evaluators, subdivision surfaces-coarse mesh and subdivision rule, types of subdivisions , Voxels . [14]

Outcome(s): On successful completion of this course, students will be able to.

- Perform 3D transformation and viewing techniques.
- Understand various styles of animation.
- Acquire knowledge about illumination models, color models and surface rendering.

Text Books:

[1] Peter Shirley, Stephen Robert Marschner, “Fundamentals of Computer Graphics” , A K Peters Limited, 2009.

[2] David F. Rogers, Procedural Elements for Computer Graphics, Tata McGraw Hill Publications, 2nd edition, 2001.

Reference Books:

[1] Shreiner Dave, “Opengl Programming Guide: The Official Guide To Learning Opengl”, Version 2.1, 6/E , Pearson Education India, 2008.

[2] Francis S. Hill, Jr., Stephen M. Kelley , “Computer Graphics: Using OpenGL”, Pearson Prentice Hall, 2008

[3] James D.Foley, Andries van Dam, Steven K. Feiner, John F. Hughes , “Computer Graphics , Principles & Practice”, 3rd Edition, Pearson Prentice Hall, 2013

CS 19.570 **Mathematical Modeling** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Engineering Mathematics

Objective(s):

- To acquire knowledge about basics of various mathematical models
- To learn methods of model fitting
- To study modeling with differential equations

1. **Introduction :** Basics of modeling, mathematical models, Modeling change with difference equations, Approximate change with difference equations, solutions to dynamical systems, systems of difference equations. Modeling using proportionality, modeling using geometric similarity. [12]

2. **Model fitting and Experimental modeling** : Fitting models to data graphically, analytic method of model fitting, applying the least square criterion, choosing a best model, one term models , high order polynomial models, smoothing of low order polynomial models, cubic spline models. [10]

3. **Simulation modeling:** Introduction, simulating deterministic behavior: area under a curve, generating random numbers, simulates probabilistic behavior, queuing models. Introduction to some simulators. [10]

4. **Discrete modeling:** Probability modeling with discrete systems, linear regression, an overview of discrete optimization modeling, linear programming: geometric and algebraic solutions, simplex method. [10]

5. **Modeling with differential equations:** Introduction, population growth, graphical solutions of autonomous differential equations, numerical approximation methods, graphical solutions of autonomous systems of First order differential equations. [10]

Outcome(s): On successful completion of this course, students will be able to

- Understand simulation modeling and discrete optimization modeling
- Understand queueing models and low order polynomial models

Text Books:

[1] Giordano, Weir, and Fox, “A First Course in Mathematical Modeling”, 4th edition, Brooks/Cole Thomson Learning, 2009.

[2] Randall James Swift, “A Course in Mathematical Modeling”, Cambridge University Press, 1999.

Reference Books:

[1] Edward A. Bender, “An Introduction to Mathematical Modeling”, Courier Dover Publications, 2000.

[2] Neville D. Fowkes, John J. Mahony, “An introduction to mathematical modeling”, Wiley, 1994.

[3] Jerry Banks, John S. Carson II Barry L. Nelson David M. Nicol,” discrete event system simulation ”, Prentice Hall, fourth edition , 2004

CS 19.571 **Advances in Algorithm Design** **Total Lectures: 52**

Credit: 4-0-0-4

Prerequisite: Data Structures, Design and Analysis of Algorithm

Objective(s):

- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms complexity

1. **Pattern matching algorithms:** Finite automata and regular expression, recognition of regular expression patterns, recognition of substrings, Two – way deterministic pushdown automata, position trees and substring identifiers. [11]

2. **Computability theory:** Turing machines, variants of Turing machines, Hilbert‟s problem, decidable languages, the halting problem, Un-decidable problems from language theory, mapping reducibility, the recursion theorem, decidability of logical theories, Turing reducibility, definition of information. [11]

3. **Fast Fourier Transform and Polynomials:** Representation of polynomials, the DFT and FFT algorithms, efficient FFT implementation, the FFT using bit operations, products of polynomials, the Schonhage – Strassen integer multiplication algorithm. [11]

4. **Randomized Algorithm and Parallel Algorithm:** Monte-Carlo algorithm, Las-Vegas algorithm, Game tree evaluation, De-randomization. Models for parallel computation basic techniques; Parallel matrix algorithms: matrix-vector multiplication, matrix multiplication, triangular system solution, sorting networks-parallel merging networks, zero –one principle. [8]

5. **Complexity theory:** Time complexity, the classes P,NP,NP complete and NP hard, Hierarchy theorems, Relativization, Circuit Complexity, approximation algorithms, probabilistic algorithms, circuit complexity, alteration, interactive proof systems, parallel computation, cryptography. [11]

Outcome(s): On the successful completion of the course, the student will be able to:

- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.

Text Books:

[1] Aho Alfred V., Hopcraft John E., Ullman Jefferey D. “The design and analysis of computer algorithms” Pearson education, tenth impression 2012.

[2] Cormen Thomas H. “Introduction to algorithms” PHI, Third edition – 2012.

Reference Books:

[1] MICHAEL SIPSER Sipser Michael, “Introduction to the theory of computation” Thomson press, Third edition 2012.

[2] Brassard G.,Fundamental of Algorithmcs, Prentice-Hall of India, 2003. 4.Horowitz E.,Computer Algorithms, Galgotia Publications, 2002.

RM 19.101 **Research Methodology** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): Communication Skills

Objective(s):

- To understand a general definition of research design.
- To identify the overall process of designing a research study from its inception to its report.
- To be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- To understand the primary characteristics of quantitative research and qualitative research.
- To identify a research problem stated in a study

1. **Introduction**: Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches, Research Process, Validity and Reliability in Research. [6]
2. **Problem Formulation**: Identification, Selection and Formulation of a Research Problem, Criteria of a good Research Problem, Review of Literature, Research Gaps. [10]
3. **Research Design**: Research Framework, Meaning &Significance of Research Designs, Features of a good Research Design, Types of Research Design. [10]
4. **Data Analysis and Simulation Tool**: Types of Data, Sources of Data, Methods of Collecting Data, Data Presentation Techniques. Methods of Data Analysis, SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [12]
5. **Report Writing**: Types of Reports, Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [2]

Outcome(s): On successful completion of this course, the students will be able to

- Assess critically the following methods: literature study, case study, structured surveys, interviews, focus groups, participatory approaches, narrative analysis, cost-benefit analysis, scenario methodology and technology foresight.

Text Books:

1. R.Pannershelvam, "ResearchMethodology" PrenticeHall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"ResearchMethodology: MethodsandTechniques",New Age International (p) Limited,Publishers New Delhi, 4ndedition,2018.

Reference Books:

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013

UC 19.101 **Social and Professional Ethics** **Total Lectures: 26**

2-0-0-2

Objective: To create an awareness on professional ethics and human values, To instill moral and social values and loyalty and to appreciate the rights of others.

Pre-requisite:

1. **Basic Human Values:** Morals, Values and Ethics – Truth, Rights Conduct (Righteousness), Love, non-violence and peace, Humility and character. Core areas of ethics: Social ethics, Personal ethics Integrity and Trustworthiness, Honesty, Loyalty, Courage, Prudence, Confidence, Confidentiality. **[5]**

2. **Theories of Ethics:** Kohlberg and Gilligan's analysis of moral development, - Deontology, Utilitarianism, Virtue Theory Rights Theory, Casuist Theory of Consequentialism – Robert Nozick's Theory of Entitlement and Property Rights. **[4]**

3. **Professional Ethics:** Introduction, meaning of work ethics, professional ethics for Journalists, Physicians, Lawyers, Engineers and Accountants. Intellectual property Rights, scope of ethics, code of conduct, business values and inner consciousness, Ethics at the workplace cybercrime, plagiarism, misconduct, fraudulent use of institutional resources, etc. **[7]**

4. **Corporate Social Responsibility:** Evolution of Corporate Social Responsibility (CSR) in India, CSR models, CSR to different stakeholders, Corporate Social Responsibility Initiatives of Major Companies of India, Promoting value based governance in organization. Whistle blower policy. **[6]**

5. **Ethics and Environment:** Introduction to environmental Issues- Industry and Environmental Pollution, Ethics of Controlling environmental pollution – Impact of environmental pollution on human health – Rights, Duties and care in environmental protection - Sustainable development. **[4]**

Outcome: The students will understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories.

Text Books:

1. B.N Ghosh "Business Ethics and Corporate Governance", McGraw Hill Education, Chennai, 2016
2. John R Boatright, "Ethics And The Conduct Of Business", Pearson Education, New Delhi, 2013.

Reference Books:

1. Raju Ramachandran, "Professional Ethics: Changing Profession and Changing Ethics", LexisNexis, Butterworths, 2nd Edition 2014.
2. Andrew Crane and Dirk Matten, "Business Ethics", Oxford University Press, 2nd Edition, 2015.
3. S.K Mandal "Ethics in Business and Corporate Governance" McGraw Hill Education, New Delhi, 2013.
4. R. Subramanian "Professional Ethics", Oxford University Press, 2015.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

M.Tech VLSI

EC 19.541	Semiconductor Device Models for Circuit Simulation	3-1-0-4
	Total Lectures:	**40**

Objectives: To provide foundation in various semiconductor device models.

Pre-requisite: **Semiconductor Devices and Circuits**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to Diode Models:** Principle of circuit simulation and its objectives. Introductions to SPICE- DC, small signal, large signal, high frequency, noise models of diodes and measurement of diode model parameters.	**[10]**
2.	**Bipolar Junction Transistor Models:** DC, small signal, high frequency and noise models of bipolar junction transistors, extraction of bipolar junction transistor model parameters.	**[8]**
3.	**MOSFET Models:** DC, small signal, high frequency and noise model of MOSFETs. MOSFET channel mobility model, level-1 and level-2 large signal MOSFET Models.	**[10]**
4.	**MOSFET Scaling and other Effects:** Devices scaling, short and narrow channel MOSFETs. Extraction of MOSFET model parameters.	**[6]**
5.	**Devices Models:** JFET, Heterojunction FET, Heterojunction bipolar transistor and MESFETs, JFET and MESFET model parameters.	**[6]**

Course Outcomes: At the end of the course student will be able

1. Explain the equations, approximations and techniques available for deriving a model with specified properties, for a general device characteristic with known qualitative theory.
2. Apply suitable approximations and techniques to derive the model referred to above starting from drift-diffusion transport equations.
3. Simulate characteristics of a simple device using MATLAB, SPICE.
4. Explain how the equations get lengthy and parameters increase in number while developing a compact model

Text Books:

1. Dasgupta, Nandita, and Amitava Dasgupta. *Semiconductor devices: modelling and technology*. PHI Learning Pvt. Ltd., 2004.
2. Streetman, Ben G., and Sanjay Kumar Banerjee. *Solid State Electronic Devices: Global Edition*. Pearson education, 2016.

Reference Books:

1. Adir Bar-Lev. *Semiconductors and electronic devices*. Prentice-Hall International.

EC 19.542	Analog VLSI Design	3-1-0-4
	Total Lectures:	**40**

Objectives:

- To develop the ability design and analyze MOS based Analog VLSI circuits to draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
- To develop the skills to design analog VLSI circuits for a given specification.

Pre-requisite: **Electronics Devices and Circuits, Network Theory**

Unit No.	Course Contents	Lecture Hours
1.	**Basic consideration in analog VLSI design**: Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.	**[8]**
2.	**Differential Amplifiers**: Single Ended and Differential Operation, Basic Differential Pair, Common-Mode Response, Differential Pair with MOS loads, Gilbert Cell. Passive and Active Current Mirrors – Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.	**[8]**
3.	**Frequency Response of Amplifiers**: General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs. CMOS comparators.	**[8]**
4.	**Feedback Amplifiers**: General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common – Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation. Mixed signal circuits.	**[8]**
5.	**MOS circuit components:** Switched capacitor filters realization by MOS technology.	**[8]**

Course Outcomes: At the end of the course student will be able

1. Draw the equivalent circuits of MOS based Analog VLSI and analyze their performance.
2. Design analog VLSI circuits for a given specification.
3. Analyse the frequency response of the different configurations of an amplifier.
4. Understand the feedback topologies involved in the amplifier design.
5. Appreciate the design features of the differential amplifiers.

Text Books:

1. Razavi, Behzad. *Design of Analog CMOS Integrated Circuits*. McGraw-Hill Higher Education, 2001.
2. Johns, David A., and Ken Martin. *Analog integrated circuit design*. John Wiley & Sons, 2008.

Reference Books:

1. Gray, Paul R., et al. *Analysis and design of analog integrated circuits*. Wiley, 2001.

EC 19.543	VLSI Fabrication Technology	3-1-0-4
	Total Lectures:	**40**

Objectives: To provide rigorous foundation in MOS and CMOS fabrication process.

Pre-requisite: **Semiconductor Physics**

Unit No.	Course Contents	Lecture Hours
1.	**Crystal Growth and Oxidation:** Electron grade silicon. Crystal growth. Wafer preparation. Vapour phase and molecular beam epitaxy. SOI. Epitaxial evaluation. Oxidation techniques, systems and properties. Oxidation defects.	**[8]**
2.	**Lithography:** Optical, electron, X-ray and ion lithography methods. Plasma properties, size, control, etch mechanism, etch techniques and equipment's.	**[8]**
3.	**Deposition:** Deposition process and methods. Diffusion in solids. Diffusion equation and diffusion mechanisms.	**[8]**
4.	**Process Simulation:** Ion implantation and metallization. Process simulation of ion implementation, diffusion, oxidation, epitaxy, lithography, etching and deposition. NMOS, CMOS, MOS memory and bipolar IC technologies. IC fabrication.	**[8]**
5.	**Packaging**: Analytical and assembly techniques. Packaging of VLSI devices.	**[8]**

Course Outcomes: At the end of the course student will be able

1. Appreciate the various techniques involved in the VLSI fabrication process.
2. Understand the different lithography methods and etching process.
3. Appreciate the deposition and diffusion mechanisms.
4. Analyze the fabrication of NMOS, CMOS memory and bipolar devices
5. Understand the nuances of assembly and packaging of VLSI devices.

Text Books:

1. S. M. Sze. *VLSI Technology*. Second Edition, McGraw-Hill 2017.
2. Gandhi, Sorab K. *VLSI fabrication principles: silicon and gallium arsenide*. Vol. 117. John Wiley, 2003.

Reference Books:

1. Wolf, Wayne. *Modern VLSI design: systems on silicon*. Prentice-Hall, Inc., 2002.
2. A.I.C.T.E, Design and Fabrication Technology, A.I.C.T.E, Bangalore, 2001.

EC 19.544 **VLSI Systems and Subsystems** **3-1-0-4**

Total Lectures: 40

Objectives:

- To prepare the student to understand the HDL language feature to realize the complex digital systems.
- To design and simulate sequential and concurrent techniques in HDL
- To explain modeling of digital systems using HDL and design methodology
- Understand the concepts of Memories and Programmable logic
- Understand the concepts of Physical Design Process such as partitioning, Floorplanning, Placement and Routing.

Pre-requisite: **Digital VLSI Design**

Unit No.	Course Contents	Lecture Hours
1.	**System specification using HDL:** Basic Concepts, Structural Gate-Level Modeling, Switch-Level Modeling, Behavioral and RTL Modeling.	**[8]**
2.	**General VLSI Components:** Multiplexers, Binary Decoders, Equality Detectors and Comparators, Priority Encoder, Shift and Rotation Operations, Latches and Flip-flops, Registers.	**[8]**
3.	**Arithmetic circuits in CMOS VLSI:** Bit Adder Circuits, Ripple carry adders, Carry-Look Ahead Adders, High speed adders, Multipliers.	**[8]**
4.	**Memories and Programmable logic:** SRAM, SRAM arrays DRAM, ROM arrays, Logic arrays.	**[8]**
5.	**System level physical design:** Interconnect Delay Modeling, Interconnect Scaling, Floorplaning and Routing, Input and Output Circuits, VLSI clocking and system design. Reliability and testing of VLSI circuits	**[8]**

Course Outcomes:

At the end of the course student will be able

1. Model, simulate, verify, and synthesize with hardware description languages.
2. Understand and use major syntactic elements of HDL - entities, architectures, processes, functions, common concurrent statements, and common sequential statements
3. Design digital logic circuits in different types of modeling
4. Demonstrate timing and resource usage associated with modeling approach.
5. Use computer-aided design tools for design of complex digital logic circuits.

Text Books:

1. Uyemura, John P. *Introduction to VLSI circuits and systems*. John Wiley, 2002.
2. Wolf, Wayne. *Modern VLSI design: system-on-chip design*. Pearson Education, 2002.

Reference Books:

1. Hill, Frederick J., Gerald R. Peterson, and Fredrick J. Hill. *Computer aided logical design with emphasis on VLSI*. Vol. 4. New York: Wiley, 1993.

EC 19.545 **Elements of Digital VLSI Design** **3-1-0-4**

Total Lectures: 40

Objectives:

- To provide rigorous foundation in MOS and CMOS digital circuits
- To train the students in transistor budgets, clock speeds and the growing challenges of power consumption and productivity

Pre-requisite: **Electronics Devices and Circuits**

Unit No.	Course Contents	Lecture Hours
1.	**CMOS Technology:** CMOS Technology & Device Scaling, Stick Diagram, Layout and Full Custom Mask Design, CMOS process enhancement, Technology related CAD issues.	**[8]**
2.	**Introduction to CMOS circuits:** MOS inverters : Static and Dynamic Characteristics, Inverter Delay and Power Dissipation, Interconnect delay	**[8]**
3.	**MOS Logic Circuits:** Combinational MOS Logic Circuits, Sequential MOS Logic Circuits, Circuit characterization and performance estimation: Delay estimation, Logical effort and transistor sizing, Power dissipation, Interconnect design margin, Reliability.	**[10]**
4.	**VLSI Circuits:** Dynamic Logic Circuits, Low power VLSI Circuits	**[8]**
5.	**Advance VLSI Circuits:** Introduction to BiCMOS Circuits, Introduction to FPGA and ASICS.	**[6]**

Course Outcomes: At the end of the course student will be able

1. Implement the logic circuits using MOS and CMOS technology.
2. Analyze various circuit configurations and their applications
3. Analyze the merits of circuits according to the technology and applications change.
4. Design low power CMOS VLSI circuits.
5. understand the rapid advances in CMOS Technology

Text Books:

1. Kang, Sung-Mo, Yusuf Leblebici, and Chulwoo Kim. *CMOS digital integrated circuits: analysis & design*. McGraw-Hill Higher Education, 2014.
2. Weste, Neil HE, and Kainran Eshraghian. *Principles of CMOS VLSI design: A systems perspective*. Pearson Education Asia, 2001.

Reference Books:

1. Baker, Jacob R., Harry W. Li, and David E. Boyce. *CMOS Circuit Design, Layout and Simulation*, Prentice-Hall of India, 2000.

EC 19.546	Embedded System Design	3-1-0-4
	Total Lectures:	**40**

Objectives:

- To learn basics of embedded hardware and software
- To understand the basics of the Embedded Processor Architecture and Microcontrollers
- To Understand the issues related to Embedded software Architecture & Development

Pre-requisite: **Microcontroller and Interfacing**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to Embedded System & Design Concepts:** Introduction & examples of embedded system, Concept of embedded system design , design challenges, processor technology & IC technology, Embedded processor & general purpose processor, trades-offs, development phase of embedded system & use of software tools for development of embedded system.	**[4]**
2.	**Embedded Processor Architecture/Microcontrollers:** Role of processor selection in embedded system, overviews of 8-bits/16-bits/32-bits microcontrollers, 8051 microcontroller: Architecture, basic assembly language programming concepts, instruction sets, addressing modes, logical operations, arithmetic operations, branching instructions, Boolean instructions, subroutines, timing subroutine, serial data communication & interrupt process, assembly language programming examples	**[12]**
3.	**Interfacing, programming & real-time applications:** Memory & I/O interfacing, Timer & counter operation & Programming, Serial communication, & interrupt handling, LCD & keyboard interfacing, DS 12887 RTC interfacing, interfacing ADC/DAC, real world interfacing & applications.	**[12]**
4.	**Embedded software Architecture & Development:** Challenges & issues in an embedded software development, real-time programming language & embedded OS, Embedded software architecture: Round-Robin, Round-Robin with interrupt, RTOS architecture, tasks & tasks states, priority based scheduling, Semaphore & shared data, timer function, memory management, encapsulating semaphore & queue, hard real-time scheduling consideration, saving memory space & power. Embedded software development process & tools.	**[6]**
5.	**Networks for Embedded system:** 12C two wire busses, the can bus, SHARC link ports, Ethernet, Myrinet, IEEE 1451.1 & IEEE 1451.2 plugs & play standards, embedded TCP/IP	**[6]**

Course Outcomes: At the end of the course student will be able Understand the embedded systems and embedded software architecture

Text Books:

1. Simon, David E. *An embedded software primer*. Vol. 1. Addison-Wesley Professional, 1999.
2. Ali, Mazidi Muhammad. *The 8051 Microcontroller and Embedded Systems: Using Assembly and C*. Pearson Education India, 2007.
3. Vahid, Frank, and Tony Givargis. *Embedded system design: a unified hardware/software introduction*. Vol. 52. New York: Wiley, 2002.

Reference Books:

1. Shibu K V. *Introduction to Embedded Systems*. Tata McGraw Hill Education Private Limited, 2009

EC 19.551	**Design of Digital Systems (Elective I)**	**3-1-0-4**
	Total Lectures:	**40**

Objectives:

- To get an idea about designing complex, high speed digital systems and how to

Pre-requisite: **Digital Electronics**

Unit No.	Course Contents	Lecture Hours
1.	**Mapping algorithms into Architectures:** Data path synthesis, control structures, critical path and worst case timing analysis. FSM and Hazards.	**[8]**
2.	**Combinational network delay:** Power and energy optimization in combinational logic circuit. Sequential machine design styles. Rules for clocking. Performance analysis.	**[8]**
3.	**Sequencing static circuits:** Circuit design of latches and flip-flops. Static sequencing element methodology. Sequencing dynamic circuits. Synchronizers.	**[8]**
4.	**Data path and array subsystems:** Addition / Subtraction, Comparators, counters, coding, multiplication and division. SRAM, DRAM, ROM, serial access memory, context addressable memory.	**[8]**
5.	**Reconfigurable Computing:** Fine grain and Coarse grain architectures, Configuration architectures-Single context, Multi context, partially reconfigurable, Pipeline reconfigurable, Block Configurable, Parallel processing.	**[8]**

Course Outcomes:

At the end of the course student will be able

1. Identify mapping algorithms into architectures.
2. Summarize various delays in combinational circuit and its optimization methods.
3. Summarize circuit design of latches and flip-flops.
4. Construct combinational and sequential circuits of medium complexity that is based on VLSIs, and programmable logic devices.
5. Summarize the advanced topics such as reconfigurable computing, partially reconfigurable, Pipeline reconfigurable architectures and block configurable.

Text Books:

1. Weste, Neil HE, and David Harris. *CMOS VLSI design: a circuits and systems perspective*. Pearson Education India, 2015.
2. Wolf, Wayne. *FPGA-based system design*. Pearson education, 2004.

Reference Books:

1. John F. Wakerly. *Digital Design: Principles and Practices*. Prentice Hall.

EC 19.552	VLSI Physical Design and Design Automation (Elective II)	3-1-0-4

Total Lectures: 40

Objectives:

- To learn basics of embedded hardware and software
- To understand the basics of the Embedded Processor Architecture and Microcontrollers
- To Understand the issues related to Embedded software Architecture & Development

Pre-requisite: **Elements of VLSI Design**

Unit No.	Course Contents	Lecture Hours
1.	**VLSI design automation tools-** algorithms and system design. Structural and logic design. Transistor level design. Layout design. Verification methods. Design management tools.	**[6]**
2.	**Placement and Routing:** Layout compaction, placement and routing. Design rules, symbolic layout. Applications of compaction. Formulation methods. Algorithms for constrained graph compaction. Circuit representation. Wire length estimation. Placement algorithms. Partitioning algorithms.	**[10]**
3.	**Floor planning and routing-** floor planning concepts. Shape functions and floor planning sizing. Local routing. Area routing. Channel routing, global routing and its algorithms.	**[8]**
4.	**Simulation and logic synthesis-** gate level and switch level modeling and simulation. Introduction to combinational logic synthesis. ROBDD principles, implementation, construction and manipulation. Two level logic synthesis.	**[8]**
5.	**High-level synthesis-** hardware model for high level synthesis. Internal representation of input algorithms. Allocation, assignment and scheduling. Scheduling algorithms. Aspects of assignment. High level transformations.	**[8]**

Course Outcomes: At the end of the course student will be able

1. Students are able to know how to place the blocks and how to partition the blocks while for designing the layout for IC.
2. Students are able to solve the performance issues in circuit layout.
3. Students are able to analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning, placement and routing

Text Books:

1. S.H. Gerez. *Algorithms for VLSI Design Automation*. John Wiley, 1998.
2. N.A.Sherwani. *Algorithms for VLSI Physical Design Automation*. Kluwer, 1999.

Reference Books:

1. R. Geiger, P. Allen, and N. R Strader. *VLSI Design Techniques for Analog and Digital Circuits*. McGraw-Hill, New York, 1990.

EC 19.553	ASIC Design (Elective I)	3-1-0-4
	Total Lectures:	**40**

Objectives:

- To prepare the student to be an entry-level industrial standard ASIC or FPGA designer.
- To give the student an understanding of issues and tools related to ASIC/FPGA design and implementation.
- To give the student an understanding of basics of System on Chip and Platform based design.
- To give the student an understanding of High performance algorithms

Pre-requisite: **Digital Electronics**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to Technology**: Types of ASICs, VLSI Design flow, Design and Layout Rules, Programmable ASICs - Antifuse, SRAM, EPROM, EEPROM based ASICs. Programmable ASIC logic cells and I/O cells. Programmable interconnects. Advanced FPGAs and CPLDs and Soft-core processors.	**[8]**
2.	**ASIC physical design issues**: System Partitioning, Floorplanning and Placement. Algorithms: K-L, FM, Simulated annealing algorithms. Full Custom Design: Basics, Needs & Applications. Schematic and layout basics, Full Custom Design Flow.	**[8]**
3.	**Semicustom Approach:** Synthesis (RTL to GATE netlist) - Introduction to Constraints (SDC), Introduction to Static Timing Analysis (STA). Place and Route (Logical to Physical Implementation): Floorplan and Power-Plan, Placement, Clock Tree Synthesis (clock planning), Routing, Timing Optimization, GDS generation.	**[8]**
4.	**Extraction**: Logical equivalence and STA: Parasitic Extraction Flow, STA: Timing Flow, LEC: Introduction, flow and Tools used. Physical Verification: Introduction, DRC, LVS and basics of DFM.	**[8]**
5.	**System-On-Chip Design** - SoC Design Flow, Platform-based and IP based SoC Designs, Basic Concepts of Bus-Based Communication Architectures. High performance algorithms for ASICs/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC.	**[8]**

Course Outcomes: At the end of the course student will be able

1. Demonstrate VLSI tool-flow and appreciate FPGA and CPLD architectures
2. Understand the issues involved in ASIC design, including technology choice, design management and tool-flow.
3. Understand the algorithms used for ASIC construction.
4. understand Semicustom Design Flow and Tool used - from RTL to GDS and Logical to Physical Implementation
5. understand the basics of System on Chip and on chip communication architectures appreciate high performance algorithms for ASICs

Text Books:

1. Smith, Michael John Sebastian. *Application-specific integrated circuits*. Vol. 7. Reading, MA: Addison-Wesley, 2003.
2. Pasricha, Sudeep, and Nikil Dutt. *On-chip communication architectures: system on chip interconnect*. Morgan Kaufmann, 2010.

Reference Books:

Gerez, Sabih H. *Algorithms for VLSI design automation*. John Wiley & Sons, Inc., 1999.

EC 19.554 **MEMS and Microsystems (Elective II)** **3-1-0-4**

Total Lectures: 40

Objectives:
- To learn basics of MEMS and Microsystems

Pre-requisite: **Electronic Devices**

Unit No.	Course Contents	Lecture Hours
1.	**Overview of Mems and Microsystems:** Mems And Microsystems, Evolution of micro fabrication, Microsystems and miniaturization, Application of Microsystems, Markets for Microsystems	**[8]**
2.	**Working Principles of Microsystems:** Introduction, MEMS and Micro actuators, Microfluidics, Micro actuators with Mechanical inertia	**[8]**
3.	**Engineering Science for Microsystems Design:** Introduction, Molecular theory of matter and intermolecular forces, Doping of semiconductor, Plasma physics, Electrochemistry	**[8]**
4.	**Thermo-fluid Engineering and Microsystems Design:** Introduction, Clock Skew and Sequential Circuit Performance, Clock Generation and Synchronization	**[8]**
5.	**Designing Arithmetic Building Blocks:** Introduction, Basic equation in continuum fluid dynamics, Laminar fluid flow in circular conduits, Computational fluid dynamics, incompressible fluid flow in micro-conduits	**[8]**

Course Outcomes:

At the end of the course student will be able

1. Understand the products and materials used in MEMS and Micro sensors.
2. Use the reconfigurable design implementation in MEMS.
3. Apply different bio medical applications

Text Books:

1. Tai-Ran Hsu, *MEMS and Microsystems*, 2nd Edition, Wiley, 2008.
2. Mohamad Gad El Hak, *MEMS Design and Fabrication*, 2nd Edition, CRC Press, 2006.

Reference Books:

1. Vijay. K. Varadan, K.J. Vinoy, and K.A. Jose, *RF MEMS and their Applications*, Wiley-India, 2011.

EC 19.555	Advanced Digital Communication (Elective I)	3-1-0-4
	Total Lectures:	**40**

Objectives:

- To give the student an understanding of issues related to Channel models and Modulation Schemes.
- To give the student an understanding of issues related to Digital Communications through Fading Channels.

Pre-requisite: **Digital Communication**

Unit No.	Course Contents	Lecture Hours
1.	**Channel models and Modulation Schemes:** Digital communication system model, communication channels and their characteristics, mathematical models for communication channels, AWGN channel, Probability and Stochastic Processes. Selected modulation schemes, digital PAM, PSK, QAM and FSK modulations, geometric (signal space) representation of modulated signals, Spectral Characteristics of Digitally Modulated Signals.	**[12]**
2.	**Receivers for AWGN channel**: Demodulation by correlation and matched filter receiver, detection by maximum likelihood detectors, performance analysis of optimum receiver for selected modulation schemes over AWGN channel.	**[6]**
3.	**Channel Capacity and Coding:** Channel capacity, Channel capacity with Orthogonal Signals, Random Selection of Codes – probabilistic approach and algebraic approach, Linear Block Codes, Cyclic Codes, Convolutional Codes, Soft-Decision Decoding and Hard-Decision Decoding	**[8]**
4.	**Channels and Mutual Information:** Channel capacity theorem (without proof), uncoded performance and Shannon limit, Information channels, probability relations in a channel, *a priori* and *a posteriori* entropies, generalization of Shannon's first theorem, mutual information, conditional mutual information, noiseless and deterministic channels, cascaded channels.	**[8]**
5.	**Digital Communications through Fading Channels:** Characterization of multipath fading channels, channel correlation and power spectra, statistical models of fading channels, frequency-nonselective, slowly fading, fast fading models, diversity techniques, digital signaling over fading channel, coded waveforms for fading channels, multiple antenna systems.	**[8]**

Course Outcomes: At the end of the course student will be able understand different digital modulation techniques, fading effects and information theory

Text Books:

1. John G. Proakis, *Digital Communications*, McGraw-Hill International Edition (4th Edition)
2. Bernard Sklar, Pabitra Kumar Ray, *Digital Communications – Fundamentals and Applications*, Pearson (2nd Edition)

Reference Books:

1. B. P. Lathi, Zhi Ding, *Modern Digital and Analog Communication Systems*, Oxford (International 4th Edition)

EC 19.556	**Advanced Wireless Communication (Elective II)**	**3-1-0-4**
	Total Lectures:	**40**

Objectives:

- To give the student an understanding of issues related to Wireless Channel Characteristics and Fading Channel Capacity and Diversity Techniques.
- To give the student an understanding of issues related to Modulation, Detection and Multiple access for wireless communication.

Pre-requisite: **Digital Communication**

Unit No.	**Course Contents**	**Lecture Hours**
1.	**Introduction:** Recent wireless systems and applications, cellular system concept and design fundamentals, dynamic resource allocation, frequency re-use concepts in time, frequency and code-division systems, improving coverage and capacity in cellular system-cell-splitting, microcell &picocell zone concept.	**[8]**
2.	**Wireless Channel Characteristics:** Concept of wireless channels- time varying channel impulse function. Basic propagation mechanisms- path loss and shadowing, outdoor and indoor propagation model- Okumura, Hata models, partition loss, log-distance loss, large-scale and small-scale propagation, multipath fading, outage probability, correlation, power-spectral density, average fade duration, channel coherency-coherence time and coherence bandwidth, Doppler shift.	**[8]**
3.	**Fading Channel Capacity And Diversity Techniques:** Capacity of AWGN and fading channels, MIMO-channel capacity, error probability over fading channels, diversity techniques to remove fading effects- space, time, frequency, polarization and transmit diversity techniques.	**[8]**
4.	**Channel coding for wireless communication:** coding as a means of time diversity, multiple- antennas coding, Alamouti codes, space- time block codes, design principle, coded modulation in MIMO frequency-selective channels, OFDM-MIMO system.	**[8]**
5.	**Modulation, Detection and Multiple access for wireless communication:** signal-space analysis, PSK, FSK, MSK, QAM modulation and signal constellation , multi-dimensional signals, orthogonal expansion of signals, spread spectrum modulation techniques-DS-SS & FH-SS in AWGN channels, multiple access techniques- FDMA, TDMA, spread – spectra multiple access, CDMA, space- division multiple access.	**[8]**

Course Outcomes:

At the end of the course student will be able

Understand different digital Wireless Channel Characteristics, Fading Channel Capacity And Diversity Techniques, Channel coding for wireless communication, Detection and Multiple access for wireless communication.

Text Books:

1. Andrea Goldsmith, *Wireless Communications*, Cambridge University Press, 2007.
2. Theodore S Rappaport, *Wireless Communication*, Pearson Education, Asia, New Delhi, 2002.

EC 19.557	RF and Microwave Engineering (Elective I)	3-1-0-4
	Total Lectures :	**40**

Objective 1. To Understand the basics of RF passive components and circuits.
2. To Analyze and evaluate the RF circuits using various RF circuit tools.

Pre-requisite Basic understanding of Electromagnetic field theory and Low frequency Electronics

Unit No.	Course Contents	
1.	**Two Port Network Theory:** Review of Low frequency parameters: Impedance, Admittance, ABCD parameters, High Frequency parameters, Formulation of S parameters, Properties of S parameters, Reciprocal and lossless Network, Transmission matrix, RF behavior of Resistors, Capacitors and Inductors.	**[8]**
2.	**Passive Microwave Devices:** Terminations, Attenuators, Phase shifters, Directional couplers, Hybrid Junctions, Power dividers, Circulator, Isolator, Impedance matching devices: Tuning screw, Stub and quarter wave transformers.	**[8]**
3.	**Microwave Generation:** Review of conventional vacuum Triodes, Tetrodes and Pentodes, High frequency effects in vacuum Tubes, Gunn diode oscillator, Varactor diode. Theory and application of Two cavity Klystron Amplifier, Reflex Klystron oscillator, Traveling wave tube amplifier, Magnetron oscillator using Cylindrical, Linear, Coaxial Voltage tunable Magnetrons, Backward wave Crossed field amplifier and oscillator.	**[10]**
4.	**Filters:** Analysis of periodic structures, filter design by insertion loss method, maximally flat and Chebyshev designs.	**[6]**
5.	**Microwave Measurements:** Measuring Instruments : Principle of operation and application of VSWR meter, Power meter, Spectrum analyzer, Network analyzer, Measurement of Impedance, Frequency, Power, VSWR, Q-factor, Dielectric constant, Scattering coefficients, Attenuation, S-parameters.	**[8]**

Outcome Student will be able to understand the fundamentals of RF and Microwave Engineering. They are also able to design and analyze the RF passive circuit using various RF circuit tools.

Text Books:

1. Collin, R.E., "*Foundations for Microwave Engineering*", 2nd Ed., John Wiley & Sons, 2000.
2. Pozar, D.M., "*Microwave Engineering*", 3rd Ed., John Wiley & Sons, 2004.

Reference Books:

1. Edwards, T.C. and Steer M.B., "*Foundations for Interconnects and Microstrip Design*", 3rd Ed., John Wiley & Sons, 2001.
2. Ludwig, R. and Bretchko, P., "*RF Circuit Design*", 2nd Ed., Pearson Education, 2000.
3. Hunter, I., "*Theory and Design of Microwave Filters*", 3rd Ed., IEE Press., 2001.

EC 19.558	**Advanced Antenna & Wave Propagation**	**(Elective II)**	**3-1-0-4**
		Total Lectures :	**40**

Objective 1. To Understand the basics of advanced antenna systems.
2. To Analyze different wave propagations.

Pre-requisite Basic understanding of Electromagnetic field theory

Unit No.	**Course Contents**	
1.	**Introduction of Antenna & its Parameters:** Reciprocity theorem, Review of microwave antennas-Parabolic Reflector, Cassegrain feeds, Horn Antennas, Open-ended wave guides, lens antennas, Dielectric rod Antennas, Antennas for mobile communication.	**[9]**
2.	**Frequency-independent antennas:** Scattering and diffraction. Internal-equation methods, current distribution: Self and mutual impedances, arrays: design and synthesis.	**[7]**
3.	**Different Antennas and their Characterization:** Full wave analysis of Microstrip Antenna (MSA),Active Integrated MSA, Compact MSA with enhanced gain, Broadband Antenna(MSA), Dual frequency & Dual polarized MSA. Antenna Measurements, Standardization and characterization of antennas, Anechoic Chamber, Open-air test range.	**[10]**
4.	**Review of Modes of Propagation:** Surface wave, Ground wave, Sky wave, Space wave, Troposphere propagation.	**[6]**
5.	**Propagation**: Propagation over plane-Earth, Spherical Earth, Refraction, Anomalous Propagation, Diffraction, Modified refractive index- Its effects on wave propagation, Duct and other nonstandard propagation. Environmental noise, Radiation Hazards.	**[8]**

Outcome Student will be able to understand the fundamentals of advanced antennas. They are also able to analyze different wave propagations.

Text Books:

1. R.E Collin, *Antennas & Radio Wave Propagation*, Mc-Graw Hill
2. R. Garg, P. Bhartia , InduBhal& A. Ittipibom, Microstrip, *Antenna Design Handbook*, Artech house
3. Jordan &Balmain, *Electromagnetic Waves and Radiating Systems*, PHI

Reference Books:

1. M. Dolukhanov, *Propagation of Radio Waves*, Mir Publication
2. Girish Kumar & K.P.Roy, *Broad band Microstrip Antenna*, Artech House
3. Kin. Lu. Wong, *Compact and Broadband Microstrip Antenna*, John Wiley & Sons

EC 19.560 **Low Power VLSI Technology (Elective III)** **3-1-0-4**

Total Lectures: 40

Objectives:

- To expose the students to the low voltage device modeling, low voltage, low power VLSI CMOS circuit design.

Pre-requisite: **Elements of VLSI Design**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to low power VLSI technology**: Voltage scaling and power-delay tradeoff, Sources of Power Dissipation, Static Power Dissipation, Active Power Dissipation Designing for Low Power, Circuit Techniques For Leakage Power Reduction	**[8]**
2.	**Threshold Voltage Scaling:** Multi-threshold CMOS, Standard Adder Cells, CMOS Adders Architectures, Low Voltage Low Power Design Techniques, Current Mode Adders	**[8]**
3.	**Dynamic Logic Circuits:** Variable threshold CMOS. Estimation and optimization of switching activity. Various problems associated with dynamic logic circuits. Differential, BiCMOS and low voltage dynamic logic circuits	**[8]**
4.	**Switched Capacitance:** Reduction of switched capacitance. Adiabatic logic circuits. Basic background on testing, Unsuitable design techniques for safety-critical applications, Low power and safely operating circuits, Case study – A Low power subsystem design	**[8]**
5.	**Low-Power Memories:** Sources of power dissipation in SRAMs, Low power SRAM circuit techniques, Sources of power dissipation in DRAMs, Low power DRAM circuit techniques, DC-DC converters. Low-power architecture.	**[8]**

Course Outcomes:

At the end of the course student will be able

1. Identify clearly the sources of power consumption in a given VLSI Circuit
2. Analyze and estimate dynamic and leakage power components in a DSM VLSI circuit
3. Choose different types of SRAMs/ DRAMs for Low power applications
4. Design low power arithmetic circuits and systems
5. Decide at which level of abstraction it is advantageous to implement low power techniques in a VLSI system design

Text Books:

1. Yeo K., Rofail S. S., and Goh W. *CMOS/BiCMOS ULSI Low Voltage, Low Power*. Pearsons Education Asia, 2003.
2. Weste N. H. *Principles of CMOS VLSI Design* Pearsons Education Asia, 2001.

Reference Books:

1. Geiger R. L. *VLSI Design Techniques for Analog and Digital Circuits*. McGraw-Hill, New York, 1990.

EC 19.562 **Mixed-Signal Systems (Elective III)** **3-1-0-4**

Total Lectures: 40

Objectives:

- To make the students to understand the design and performance measures concept of mixed signal circuit.

Pre-requisite: **Analog VLSI Design**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction to Mixed-Signal Systems:** Concepts of Mixed-Signal Design and Performance Measures. Fundamentals of Data Converters. Nyquist Rate Converters and Over sampling Converters.	**[4]**
2.	**Design methodology** for mixed signal IC design using gm/Id concept.	**[8]**
3.	**Static and dynamic logic**, OTA-C circuits. Silicon compilers.	**[8]**
4.	**CMOS Digital Circuits Design:** Design of MOSFET Switches and Switched-Capacitor Circuits, Layout Considerations.	**[10]**
5.	**Filter design strategies.** Design of frequency and Q tunable continuous time filters, Image processing.	**[10]**

Course Outcomes:

At the end of the course student will be able

1. Appreciate the fundamentals of data converters and also optimized their performances.
2. Understand the design methodology for mixed signal IC design using gm/Id concept.
3. Analyze the design of current mirrors and operational amplifiers
4. Design the CMOS digital circuits and implement its layout.
5. Design the frequency and Q tunable time domain filters.

Text Books:

1. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS, Circuit Design, Layout, and Simulation, Wiley-IEEE Press, 1998
2. David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley and Sons, 1997.

Reference Books:

1. Christoph G. *Languages for System Specification - Selected Contributions on UML, SystemC*. System Verilog, Mixed-Signal Systems, and Property Specifications from FDL'03, Springer Publisher, 1996.
2. Nishath K. V. *Simulation Techniques and Solutions for Mixed-signal Coupling in Integrated Circuits*. Springer Publisher, 1994.

EC 19.564 **Advanced Digital Signal Processing (Elective III)** **3-1-0-4**

Total Lectures: 40

Objectives:

- To give the student an understanding of issues related to Filter Structure and Design and Finite Word-length Effects.
- To give the student an understanding of Multi-rate DSP and Wavelets

Pre-requisite: **Digital Signal Processing**

Unit No.	Course Contents	Lecture Hours
1.	**Introduction:** Analog versus digital signal processing, Sampling and sampling theorem, Quantization, AD- and DA-conversion, AD- and DA hardware realizations, Digital signal processors.	**[4]**
2.	**Filter Structure and Design:** Short review of DFT and FFT, DCT, IIR and FIR, block diagram representation of filters, IIR and FIR structures, design aspects of digital filters, IIR filter design methods - Impulse Invariance method, Bilinear transformation, Butterworth and Chebyshev approximation, FIR filter design – Rectangular window, Kaiser window, comparison between IIR and FIR filters.	**[8]**
3.	**Finite Word-length Effects:** quantization of fixed-point and floating-point numbers, analysis of coefficient quantization effects, noise analysis in A/D conversion, analysis of round-off errors, dynamic range scaling, SNR in low-order IIR filters, low-sensitivity digital filters, limit cycles, limit-cycle free structures.	**[10]**
4.	**Multi-rate DSP:** Up-sampler and down-sampler, filters in sampling rate alternation systems; multi-stage design of decimator and interpolator, polyphase decomposition; arbitrary sampling rate converter, Lagrange interpolation, digital filter banks, uniform DFT filter banks, Nyquist filters, quadrature-mirror filter banks, perfect reconstruction two-channel FIR filter banks, multi-level filter banks.	**[10]**
5.	**Wavelets:** Wavelet Analysis, The Continuous Wavelet Transform, scaling, shifting scale and frequency, The Discrete Wavelet Transform, One Stage filtering, Approximation and Details, Filter bank analysis, Multilevel Decomposition, Number of levels, Wavelet reconstruction, Reconstruction filter- Reconstructing Approximations and details, Multilevel Reconstruction, Wavelet packet synthesis, Typical Applications.	**[8]**

Course Outcomes:

At the end of the course student will be able

Understand different filter Structure and Design and Finite Word-length Effects, Multi-rate DSP and Wavelets.

Text Books:

1. S. K. Mitra, *Digital Signal Processing*, McGraw Hill
2. Martin Vetterli & Jelena Kovacevic, *Wavelets and Subband Coding*, PHI
3. Oppenheim, Wilsky & Nawab, *Signals and Systems*, PHI

Reference Books:

1. Simon Haykin & Bary Van Veen, *Signals and Systems*, Wiley Eastern
2. Lathi, Bhagwandas Pannalal. *Signal processing and linear systems*. New York: Oxford University Press, 1998.

EC 19.566 **Wireless Sensor Networks (Elective III)** **3-1-0-4**

Total Lectures: 40

Objectives:

- To give the student an understanding of issues related to Wireless Sensor Networks.
- To give the student an understanding of Sensor Tasking and Control and Operating Systems for WSNs.

Pre-requisite: **Digital Communication**

Unit No.	Course Contents	Lecture Hours
1.	**Overview of Wireless Sensor Networks (WSNs):** Introduction, Constraints and Challenges, Advantages of Sensor Networks, Sensor Network Applications, Key definitions of Sensor Networks. Wireless Sensor Technological Background: Wireless Communication Technology, Hardware and Software Platforms.	**[8]**
2.	**Networking Sensors:** Medium Access Control – The S-MAC Protocol, The IEEE 802.15.4 Standard, Zigbee Standard; Geographic, Energy-Aware Routing – Unicast Geographic Routing, Routing on a Curve, Energy-Minimizing Broadcast, Energy-Aware Routing to a Region; Attribute-Based Routing – Directed Diffusion, Rumor Routing.	**[10]**
3.	**Infrastructure Establishment:** Topology Control, Clustering, Time Synchronization, Localization and Localization Services.	**[8]**
4.	**Sensor Tasking and Control:** Task-Driven Sensing, Roles of Sensor Nodes and Utilities, Information-Based Sensor Tasking, Joint Routing and Information Aggregation.	**[6]**
5.	**Operating Systems for WSNs:** Introduction, Operating System Design Issues, Examples of Operating Systems – TinyOS, Mate, MagnetOS, EYES OS, Node-Level Simulators – ns-2, TOSSIM.	**[8]**

Course Outcomes:

At the end of the course student will be able

Understand the Networking Sensors, Infrastructure Establishment, Sensor Tasking and Control.

Text Books:

1. Sohraby, Kazem, Daniel Minoli, and Taieb Znati. *Wireless sensor networks: technology, protocols, and applications*. John Wiley & Sons, 2007.
2. Zhao, Feng, Leonidas J. Guibas, and Leonidas Guibas. *Wireless sensor networks: an information processing approach*. Morgan Kaufmann, 2004.

Reference Books:

1. Zaman, Noor, ed. *Wireless Sensor Networks and Energy Efficiency: Protocols, Routing and Management: Protocols, Routing and Management*. IGI Global, 2012.
2. Raghavendra, Cauligi S., Krishna M. Sivalingam, and Taieb Znati, eds. Wireless sensor networks. Springer, 2006.

MA 19.509	Advanced Mathematics	3-1-0-4
	Total Lectures:	**40**

Objectives: To acquire fundamental knowledge computational numerical techniques and fundamentals of statistics and probability and apply in inter-disciplinary engineering disciplines.

Prerequisite: **Engineering Mathematics**

Unit No.	Course Contents	Lecture Hours
1.	**Computer based numerical methods:** Methods for numerical solution of algebraic and transcendental equations: Direct methods e.g. Bisection method, Regula-Falsi method; Iterative method e.g. Newton-Raphson method. Methods for the solution of simultaneous linear equations: Direct methods e.g. Gauss elimination method; Iterative method e.g. Gauss-Seidel method, Jacobi method.	**[8]**
2.	**Finite difference** table for equal and unequal intervals in the independent variable values. Newton's forward and backward interpolation formula; Newton's interpolation formula for divided differences. Numerical differentiation.	**[8]**
3.	**Numerical Integration methods:** Simpson's rules, Trapezoidal rule and Romberg's method. Numerical solution of ordinary differential equations: Euler method, Modified Euler method and Runge-Kutta methods. Numerical solution of elliptic and parabolic differential equations using finite difference approach.	**[8]**
4.	**Statistics and Probability:**Concept of random variable, total and conditional probability, Bayes' theorem, probability distributions and probability density functions, moments and moment generating functions. Some theoretical probability distributions such as binomial, Poisson, normal, uniform, exponential, rectangular, χ^2, t, F.	**[8]**
5.	**Sampling theory:** sampling distributions and sampling techniques. Estimation theory, Point and Interval estimation of mean and variance of data. Testing of hypotheses. Simple and Composite hypothesis. Correlation and Regression. Multiple and Partial correlation and regression. Concepts of stochastic processes with special reference to Monte Carlo methods.	**[8]**

Course Outcomes: After completion of the course, students would be able to apply the knowledge of computational numerical techniques with statistics and probability theory in inter-disciplinary engineering and solve curriculum problems.

Text Books:

1. Shastri S.S., *Introductory Method of Numerical Analysis, Prentice-Hall of India*, 3rd Ed., 2002.
2. Trivedi K.S., *Probability and Statistics with Reliability Queuing and Computer Science Application*, Prentice-Hall of India, 2002.

Reference Books:

1. Papoulis, Probability, *Random Variables and Stochastic Processes*, TMH, 2018.
2. Gupta & Kapoor, *Fundamental of Mathematical Statistics, SCS Publisher*, 2002.
3. Dass and Verma, *Higher Engineering Mathematics*, S.Chand, 2019.

Mody University of Science & Technology, Lakshmangarh (Sikar)

College of Engineering & Technology

Department of CSE

Course structure for

MCA

CA 20.500 **Computer Information System*** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): None.
Objective(s): To give essential knowledge about computer information system and its components.

1. **Introduction:** Evolution of Computers, Generation of Computers, Classification of Computers, Block Diagram of Digital Computers, Memory Unit, ALU,CPU, I/O Devices, Basic Bus Architecture. Software Classification, Machine Language, Assembly Languages And High Level Languages, Assembler, Compilers And Interpreters, Process of Compilation, Programming Language Generations, Introduction to Operating Systems and Role of the Operating System. **[8]**
2. **Digital Logic:** Introduction to Boolean Algebra and Logic Gates, K-map Representation and Boolean Function Simplification, Number Systems: Conversion from One Number System to Another, Binary Operations, Complement Representation of Numbers , Alphanumeric Codes, Floating Point Representation of Numbers, Floating Point Arithmetic Operations. **[6]**
3. **Digital Circuit Building Blocks:** Adders, Subtractors, Comparators, Encoders, Decoders, Multiplexers, De-Multiplexers, Latches, Flip-Flops, Master Slave Flip Flops, Shift Registers and Counters. **[10]**
4. **Internet Technologies**: Introduction to Computer Networks, Internet, WWW and E Mail, Web Browsers, Introduction to LAN,MAN, WAN, An Introduction to the Design of Web Pages, HTML tags and CSS, Web Servers, Server Scripting, XML. **[8]**
5. **Software Development:** A Systematic Approach to Program Design, Coding, Testing, and Debugging. Application of these Skills to the Construction of Robust Programs. Use of Programming Environments and Tools to Aid in the Software Development Process. **[8]**

Outcome(s): On successful completion of this course, students will be able totake specialized courses with strong fundamentals of Computer Information Systems.

Text Books:

1. P.K. Sinha, Computer Fundamentals, BPB Publications, latest Ed.
2. M. Morris Mano, Digital Logic & Computer Design, Pearson,latest Ed.
3. Roger S. Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill Higher Education, latest Ed.
4. Thomas Powell, HTML and CSS: The Complete Reference, Tata McGraw-Hill,5thEdition, 2010.

Reference Books:

1. Andrew S.Tanenbaum, Computer Networks, Pearson Education, 5thEdition, 2013.
2. V. Rajaraman, Fundamentals of Computers, PHI, 6th Edition, 2014.

CA 20.501 **Programming Concepts** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s):
- To learn the basics of programming skills through C-Programming language.
- To understand the fundamentals concepts like syntax, and statements with essentials of efficient compiling, running and debugging processes.

1.	**Introduction:**Brief History, Library& Linking, Compilation & Execution, Data Types, Operator and Expression Identifier, Keyword and Token, Constant, Data Declaration and Definition, Operators and Expression, Precedence& Associability of Operators.	[7]
2.	**Control and Loop Statement:** Introduction, Selection Statements, If, TheConditional Expression, switch, Iteration Statements: for loop, while loop, do-While loop, Jump, Go to label, break and continue, exit () function.	[7]
3.	**Array, Function and String:** Definition, declaration and Types of Array, Operation and application of array, Brief introduction on string header files and applications of strings. Function, argument passing, scope of variable, call by reference and call by value, recursion, passing array to function.	[5]
4.	**Structure, Union and Pointer:** Definition, Declaration and Initialization, Accessing Structure members, Arrays of Structure, Passing Structure to function, Structure to Pointer, Union. Definition, declaration, Pointer to Pointer, NULL Pointer, De-referencing Pointer, array to pointer (1-D array ,2-D array) pointer array, function to pointer.	[12]
5.	**File handling and Storage Classes:** Introduction, Defining and Opening a File in read and writes mode, Closing a file and ending of file, Enumerated data types, Error Handling During I/O Operation Random Access to Files, Command Line Arguments. Storage Classes, Preprocessor Directive.	[9]

Outcome(s): At the end of the course student will be able to:
- Describe the process of problem solving through C.
- Write a justifiable C program for a given algorithm.
- Trace the certain C program manually.

Text Books:
1. Scheldt Herbert, “C The Complete Reference” Tata McGraw hill Latest Ed.
2. Kernighan & Ritchie, “C Programming Language” Prentice Hall Second Edition, latest Ed

Reference Books:
1. Kanetkar Y.P., “Let us C Solutions” 10th edition, BPB publication, latest Ed.
2. Balaguruswamy E., “Programming in ANSI C “5th Edition Tata McGraw-Hill Education, latest Ed.

CA 20.502 **Operating System** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- Understand the fundamental operating system abstractions like processes, threads, files, semaphores, IPC and deadlocks.
- Understand operating system from user's perspective as well as from system's perspective.
- Understand the principles of concurrency and synchronization.
- Understand basic resource management techniques.

1.	**Introduction:** Overview, Evolution,Types, operating system functions andcharacteristics.	[3]
2.	**Process Management and Memory Management:** The process concept, operating system services for process management, scheduling algorithms and multiple processor scheduling. Storage allocation methods, paging, segmentation, virtual memory concept, demand paging, page replacement algorithms and trashing.	[10]
3.	**Input /Output and File Systems:** Hardware organization, device scheduling policies, Functions of file systems, file access and allocation methods, directory systems, structured organizations, directory and file protection mechanisms and implementation issues. Device dependent and device independent software.	[7]
4.	**Deadlocks and Process Synchronization:** Characterization, prevention and avoidance, deadlock detection and recovery and practical consideration. Critical section problem, semaphores, classical process co-ordination problems and their solutions, inter process communication and message-passing mechanisms. Client-server modeling, RPC, threads.	[10]
5.	**Protection & Security:** Goals of Protection, Principles of Protection. Domain of protection Access Matrix, Implementation of Access Matrix. Access control, Revocation of Access Rights. Capability- Based systems, Language - Based Protection, Security problem, program threats, system and network threats cryptography as a security tool, user authentication, implementing security defenses, fire walling to protect systems.	[9]

Outcome(s): By learning the course, the students will be able to,
describe, contrast and compare differing structures for operating systems
understand and analyse theory and implementation of: processes, resource control (concurrency etc.), physical and virtual memory, scheduling, I/O and files

Text Books:

1. Silberschatz A., and Galvin P.B., Operating System Concepts, John Wiley &Sons, latest Edition.
2. Tanenbaum A.S., Modern Operating Systems, Pearson Education Asia, latest Edition.

Reference Books:

1. Stallings W., Operating Systems, Pearson Education Asia, latest Edition.
2. Tanenbaum A.S. and Woodhull A. S., Operating Systems- Design and Implementation, Pearson Education Asia, latest Edition.

CA 20.503 **Management Information Systems**

Total Lectures:40
3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To introduce the concept of system analysis for managing the projects
- To analyze and document systems, design new systems and implement their plans.
- Understanding paradigm shift to E-enterprise
- Applications of IS and IT to management functions of the industry

1.	**MIS and Enterprise:** Management Information System (MIS) concepts, definition, role, impact, And management as a control system, MIS: A support to the management, goals, objectives and target, MIS for a digital firm, E-Business Enterprise: A digital firm-organization of business in digital firm, E-business, E-commerce, real time enterprise.	[8]
2.	**Strategic management of business performance:** Concept of corporate planning, essentiality of strategic planning, development of business strategies, types of strategies, short range planning, tools of planning,MIS: Strategic business planning.	[6]
3.	**Information and Knowledge:** Information Concepts, Classification of information, System Engineering: Analysis and Design- System concepts, system control, types of system, handling system complexity, system development model, Relationship between Information and Knowledge.	[8]
4.	**Development and implementation of MIS:** Determining the information requirement, Development and implementation of the MIS,Management of information, Quality of MIS, Business process reengineering.	[8]
5.	**Application of Management Information Systems:** Applications in manufacturing sector-personnel management, financial management, production management, raw material management, marketing management, applications in service sector, Decision support system.	[10]

Outcome(s):

By learning the course, the students will be able to

- Learn MIS and enterprise and strategic management of business performance.
- Learn management information system and its application
- Develop and implementation of MIS

Text Books:

[1] W. S.Jawadekar, Management Information Systems, New York, Latest Ed.

Reference Books:

[1] J. A.O' Brien, Management Information Systems, McGraw-Hill, Latest Ed.
[2] Davis G. B., and Olson M. H., Management Information Systems, Tata McGraw-Hill, Latest Ed.

CA 20.504 **Object Oriented Programming through Java** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): (C-Programming)

Objective(s):

- Cover issues related to the definition, creation and usage of classes, objects and methods.
- Discuss the principles of inheritance and polymorphism.
- Provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- Cover the basics of API and to explore the java abstract programming interface.

1.	**Overview:**IntroductiontoJava,importanceofJava, interactiveDevelopmentEnvironments: Eclipse/Net Beans, basics of OOP. DataTypes,Variable, andArrays:Primitivedatatypes,typecasting,arrays,operatorsand control structures, identifiers, constants and literals	[10]
2.	**Classes and Objects:** Class fundamentals, declaringobjects, assigning object reference variables, introducing methods, constructors, this keyword, garbage collection, the finalize()method, overloading methods, using objects as parameters and return type, introducing accesscontrol,understanding static, introducing final,introducing nestedandinnerclasses, exploringthe stringclass, usingcommand-linearguments.	[10]
3.	**Inheritance:** Inheritance basics, using super, multilevel hierarchy, constructor in hierarchy, method overriding, dynamic method dispatch, using abstract classes, using final in inheritance, the object class.	[4]
4.	**Package, Interfaces and Exception Handling:** Packages, access protection, importing packages, interfaces, exception-handling fundamentals, exception types, using try and catch, multiple catch clauses, nested try statements, throw, throws, finally, JAVA's built-in exceptions, user defined exception.	[8]
5.	**Multi threaded Programming:** The Java thread model, the main thread, creating multiple threads, threads priorities, managingthreads, thread class built-in functions.I/O and String Handling: I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer.	[8]

Outcome(s): Upon completion ofthis course, studentsareableto:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identifyclasses, objects,membersofaclassandthe relationships amongthem needed for aspecificproblem.
- Develop programs using the in-built JavaAPIandtheJavastandardclass library.
- CreateJavaapplicationprogramsusingsoundOOPpractices(e.g.,interfacesandAPIs) andproperprogramstructuring(e.g.,byusingaccesscontrolidentifies,automatic documentation throughcomments, error exception handling).
- Useof development environment like Eclipse forcollaborativeprogramming

Text Books:
[1] H. Schildt, Java The Complete Reference, Herbert Schildt, 10th Edition, 2017.
[2] John Jukowski, Mastering Java J2SE 1.4,SYBEX,Latest Ed.

Reference Books:
[1] A.B. Downey, Think Java: How to Think Like a Computer Scientist, Latest Ed.
[2] P.Deitel and H.Deitel, Java How To Program (Early Objects), 10thEdition, 2015.

CA 20.505 **Database Management Systems** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS, RDBMS& ODBMS in the organization

1.	**Introduction**: Databases and database users, database system concepts and architecture, data modeling using the Entity-Relationship (ER) model, Enhanced Entity Relationship model.	[6]
2.	**Relational Data Model**: Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model. Structured Query Language (SQL): SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views	[12]
3.	**Database Design**: Functional dependencies and normalization of relational databases, First Normal Form (1NF), 2NF, 3NF, Boyce-Codd normal form (BCNF), multivalued dependency, 4NF.	[6]
4.	**Transaction Processing**: Introduction, properties, recoverability, serializability. Concurrency control techniques: Two phase locking protocol, database recovery techniques: Recovery concepts, recovery techniques based on deferred and immediate update	[8]
5.	**Object and Object-Relational Databases**: Concepts for object databases, object database standards and design, object relational systems, object relational features, object database extensions to SQL, ODMG object model and the object definition language (ODL)	[8]

Outcome(s): After completion of the course, students will be able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.

Understand Object Oriented databases

Text Books:

[1]R.Elmasri & S.B.Navathe, Fundamentals of Database Management Systems, 7thEdition, Pearson Education, 2016.
[2] R. Ramakrishnan, DatabaseManagementSystems, Latest Edition, Tata McGraw Hill, latest Ed.

Reference Books:

[1] Korth and Schilberschatz, Database System Concepts, 6th Edition, Tata McGraw Hill, 2011.
[2] C.J. Date, Database Systems, Tata McGraw Hill, Latest Edition.

CA 20.506 **Software Engineering** **Total Lectures:40**

Credit:3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To understand the basic software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To know about software requirements specification, requirement elicitation, structured system analysis and introduction of object-oriented analysis and design, design techniques.
- To acquire knowledge on implementation issues such as modularity and coding standards.
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study web based-system and application, software re-use, software re-engineering, agile software engineering, software engineering and testing tools.
- To develop teamwork and have project based experience.

1.	**Introduction:** Software crisis, Software engineering Approach and Challenges, Software development process models with comparison: Waterfall, Rapid Prototyping, Spiral, Iterative, V-shape and Evolutionary Model, SEI-CMM.	[6]
2.	**Software Processes and Requirement Analysis:** Software engineering: a layered technology requirement elicitation, requirement analysis, software requirement and specifications, data flow diagrams, data dictionaries, entity-relationship diagrams. Software Measurement, planning schedule, Risk management, Quality Assurance.	[10]
3.	**Software Design and Estimation Techniques:** Introduction to object-oriented design, Function and Object Oriented Design concepts, Verification and Validations, Software size and cost estimation Techniques: Size oriented Metrix, FPA and COCOMO.	[8]
4.	**Testing:** Software testing fundamentals, test case design, white box testing:-basis path testing, control structure testing, black box testing: boundary value analysis, equivalence class testing, decision table testing, cause effect graphing, debugging, testing tools & standards, testing for client/server architecture,	[9]
5.	**Special Topics:**Brief of software re-use, reverse engineering, software re-engineering, agile software engineering, CASE Tools.	[7]

Outcome(s):

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Author a software requirements document and understanding of the proper contents of a software requirements document.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.

  Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

[1] R. S. Pressman, Software Engineering – A practitioner's approach, Tata-McGraw-Hill Int. Ed., 8th edition, 2014.

[2] K. K. Aggarwal, Yogesh Singh, Software Engineering, New Age International, latest edition.

Reference Books:

[1] Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publisher, Latest edition.

[2] Rajib Mall, Fundamentals of Software Engineering, Prentice-Hall, Latest edition

CA 20.507 **Mathematical Foundation** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Elementary Mathematics

Objective(s): To acquire fundamental knowledge of higher Mathematics and apply in Science and engineering disciplines.

1.	**Matrix Theory:** Introduction to the matrix theory, types of matrices, inverse of matrices, rank of matrices, solving system of linear equations.	[10]
2.	**Eigen Values:** Eigen values and Eigen vectors, Sparse matrix, diagonalization and triangulization of matrices.	[6]
3.	**Three-dimensional geometry and Vector calculus:** Basic concepts of three-dimensional geometry (viz. direction cosines and direction ratios), equation of aplane and of a straight line. Basic concepts of vectors, gradient, divergence and curl of a vector.	[8]
4.	**Calculus:** Introduction of differential and integral calculus, derivatives of various types of functions, basic idea of differential equations, solutions of ordinary differential equations with constant coefficients.	[10]
5.	**Complex Algebra:** Introduction to the complex algebra, complex numbers, geometrical representation of complex numbers, Argand diagram, De-Moirvre'stheorem.	[6]

Outcome(s): After completion of the course, students would be able to apply fundamentals of higher mathematical knowledge in science and engineering and also solve curriculum problems.

Text Books:

1. Ramana B. V. , " Higher Engineering Mathematics", Tata McGraw – Hill PublishingCompany Ltd., P 1390, Latest edition.
2. Babu Ram, "Engineering Mathematics", Pearson, New Delhi, 2010.
3. Narayan Shanti, "Analytical Solid Geometry", S Chand & Company, New Delhi, Latestedition.

Reference Books:

1. Grewal B. S. and Grewal J. S. , "Higher Engineering Mathematics" , Khanna Publishers,New Delhi, P. 1390, 40th edition,20014
2. KreyszigErrwin, "Engineering Mathematics", John Wiley& Sons, New York, , p. 1639, Latestedition.

CA 20.508 **Data Structure Concepts** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): C Programming

Objective(s):

- To provide knowledge of ways of structuring and operating on data, the nature of some fundamental problems, methods for addressing those problems,
- To promote an analytical and empirical appreciation of the behavior of algorithms using data structures.

1.	**Introduction:** Data Structure definition, Requirement of different Data Structures, Abstract Data Type, Analysis of Algorithm	[3]
2.	**Linear Data Structure:** One and Two-dimensional Arrays, Array Representation, Selection Sort, Bubble Sort, Quick Sort, Heap Sort and Merge Sort, Sequential Search, Binary Search. Linked List and its representations, Operations on Linked List, Types of Linked List, Stack and its representation, Operations on Stack, Queue and its representation, Operations on Queue, Applications of these data structures.	[15]
3.	**Tree :** Binary Tree and its travesals (Breadth-First, Depth-First), Expression Trees (Infix, Prefix, Postfix Traversals), Binary Search Trees, Heaps,AVL Tree	[12]
4.	**Graph:** Matrix Representation, List representation and applications, Minimum Spanning Tree finding algorithms, Shortest Path finding algorithms.	[5]
5.	**Hashing Techniques:** Hash Function, Address Calculation Techniques, Common Hashing Functions, Collision Resolution, Linear Probing, Double Hashing, Bucket Hashing, Deletion and Rehashing.	[5]

Outcome(s): On the successful completion of the course, the student will be able to:

- be knowledgeable of certain abstract data types (ADT)
- be able to make a critical assessment of different implementations of an ADT
- be familiar with a number of fundamental computational problems, and be aware of real world instances of those problems

Text Books:

1. Horowitz and Sahani, “Fundamental of data structures”,Galgotia Publication, Latest Ed.
2. Lipschutz, “Data Structures Schaum’s Outline Series”, Tata Mcgraw Hills, Latest Ed.

Reference Books:

1. TenenbaumAaron M., YedidyahLangsam and Moshe J. Augenstein “DataStructures through C, Tata Mcgraw Hills, Latest Ed.
2. Kruse R. etal, “Data Structures and Program Design in C”, Pearson Education,Latest Ed.

CA 20.510 **R Programming** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): Programming Concepts (CA 20.501)

Objective(s):

- To understand and learn programming concepts of R
- To Apply R programming to solve various statistical, graphics and modeling problems

1.	**Fundamentals of R**: Evolution of R, Features of R, R environmental Setup, R Script file. Data types- Vectors, Lists, Matrices, Arrays, Factors, Data Frames, Variables, finding and deleting variables, Operators in R.	[6]
2.	**Control Statements in R**: if-else statement, switch statement, Repeat loop, while loop, for loop, break statement, next statement	[8]
3.	**Functions, Strings and Vectors :** Function Definition , Function Components Built-in Function, User-defined Function, Calling a Function, Lazy Evaluation of Function, Strings and Strings Manipulation, Vector creation, accessing vector elements, vector manipulation,	[10]
4.	**Lists, Matrices and Arrays: List** Creation, Naming list elements, Accessing list elements, Manipulating list elements, Merging list, Converting list to Vector, Accessing elements of matrix, matrix computations, Naming row and column of array, accessing array elements, manipulating array elements, calculation across array elements.	[10]
5.	**Data frames, factors and packages:** Extract data from data frame, expand data frames, factors in data frames, changing the order of levels, generating factor levels, packages.	[6]

Outcome(s): After completing the course the student is expected to

- be able to use and program in the R programming language
- be able to use R programming to solve statistical problems
- be able to apply R Programming concept to solve real world problems

Text Books:

1. Hadley Wickham, Garrett Grolemund, R for Data Science, O'Reilly, January 2017.
2. John Maindonald and John Braun, Data Analysis and Graphics Using R, Cambridge University Press, Cambridge, Latest Ed.

Reference Books:

1. Peter Dalgaard, Introductory Statistics with R, Springer Verlag, Latest Ed.
2. Phil Spector. Data Manipulation with R. Springer, New York, 2008.

CA 19.603 **Design and Analysis of Algorithms** **Total Lectures: 40**
Credit:3-1-0-4

Prerequisite(s): CA19.516(Data Structures)

Objective(s):
- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms power.

1. **Introduction:** Fundamentals of algorithms and problem solving, asymptotic notations, time complexity and analysis of algorithms, solutions of recurrence relations, master theorem and summations techniques. [8]
2. **Analysis of Sorting and Searching Algorithms:** Linear, binary and interpolation search, insertion, selection, merge, quick and heap sort, stability and other issues, hashing. [8]
3. **Algorithm Design Approaches:** Greedy method (knapsack problem, job sequencing problem), dynamic programming (assembly line scheduling, matrix chain multiplication), backtracking (8 queens problem, sum of subsets), branch and bound (0/1 knapsack problem), divide and conquer algorithms (Strassen matrix multiplication), problems based on these design paradigms. [8]
4. **Tree and Graph algorithms:** Spanning trees, Prim and Kruskal's algorithm, Huffman coding, BFS and DFS, disjoint set operations, connected components, shortest path algorithms in a graph such as Dijkstra, Bellman Ford, Warshall's etc. [8]
5. **Complexity Classes:** P,NP,NP hard and NP complete problems, reducibility, decision and optimization problems, examples of NP complete problems such as 3 CNF, clique, vertex cover and traveling salesman problem, basic introduction of approximation algorithms. [8]

Outcome(s): On the successful completion of the course, the student will be able to:
- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.
- Modify existing algorithms to improve efficiency.

Text Books:

1. T. H.Cormen, C. E.Leiserson, R. L. Rivest and C. Stein, Introduction to Algorithms, PHI Learning Private Limited, 3rd edition, 2016.
2. E. Horowitz, S.Sahni, S.Rajasekaran, Computer Algorithms, Silicon Press, 2nd edition, 2008.

Reference Books:

1. A. Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 3rd edition, 2012.
2. A. V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, 1st edition, 2006.
3. D. E. Knuth, The Art of Computer Programming, Volumes 1& 3, Pearson Education, 2009.
4. S. S. Skiena, The Algorithm Design Manual, Springer, 2nd edition, 2008.

CA 19.605 **Computer Communications Networks** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CA 19.204 (Computer Networks)

Objective(s):

- To become familiar with layered communication architectures (OSI and TCP/IP).
- To understand the client/server model and key application layer protocols.
- To construct large-scale computer networks
- To understand fundamentals of computer networks and major protocols.
- To analyze and evaluate major Internet protocols.
- To program simple network applications using socket API
- To learn and adopt newly introduced computer network technologies by themselves.

1. **Introduction to Network Model:** History and development of computer networks, categories of networks, layering and protocols. [8]
   Physical Layer: Different types of transmission media, transmission impairments, encoding schemes (NRZ, NRZI, Manchester, 4B/5B, Manchester etc.)
2. **Data Link Layer:** Framing concept, Aloha, CSMA/CA, CSMA/CD protocols, performance evaluation and characteristics, error detection (parity, CRC), sliding window, stop and wait protocols,stop performance and efficiency,packet and circuit switching. [8]
3. **Local Area Network and Network Layer:** IEEE 802.3, 802.4, 802.5, 802.11, performance evaluation.IPv4, IP address classes, classless addressing, IPv6, ARP, RARP, DHCP, ICMP, routing algorithms: distance vector, metrics, RIP, OSPF, BGP, congestion control algorithms, leaky bucket, token bucket. [10]
4. **Transport Layer:** Duties of the transport layer, connection, TCP, TCP services, TCP header, UDP, evaluating protocol such as TCP/UDP using simulator like NS2. [6]
5. **Application Layer:** DNS, FTP, HTTP, SMTP, POP, basics of network security (cryptography, digital signature and firewall). [8]

Outcome(s): On successful completion of this course, students will be able to

- Analyze computer network component and devices.
- Synthesize how communication works in a network and internet.
- Formulate the concept of topologies and their applications.
- Analyze protocol at different layers and how they play important role in network implementation.
- Identify and analyze the latest technology with existing one.
- Enumerate the layers of OSI and TCP/IP models.
- Configure network and wireless technology including client/server programming.

Text Books:

[1]Forouzan B. A., Data Communications and Networking, Tata McGraw-Hill, 5th edition, 2013
[2] Stallings W., Data and Computer Communications, Prentice-Hall of India, 10th edition, 2013.

Reference Books:

[1] Tanenbaum A. S., Computer Networks, Prentice-Hall of India, 5th edition, 2010.
[2]Hayes J. F., Modeling and Analysis of Computer Communication Networks, Plenum Press, 1st edition, 1987.

CA 19.606 **Cryptography & Network Security** **Total Lectures: 40**

Credit: 3-1-0-4

Prerequisite(s): CA 19.204(Computer Networks)

Objective(s):

- To understand the classical encryption and decryption algorithms, their techniques as well cryptanalysis.
- To acquire basic knowledge of finite fields and number theory.
- To understand the various block ciphers, stream cipher models, principles of public key cryptosystems, hash functions and digital signatures.
- To understand the different authentication techniques.

1. **General Overview and Classical Cryptography:** General overview of threats, risks and consequences, sources of threats, attacks, classification and preventive measures, introduction to some simple ciphers such as shift cipher, substitution cipher, affine cipher, Vigener cipher, hill cipher, permutation cipher and stream ciphers. [8]

2. **Symmetric/Secret Key Cryptography:** Block ciphers and their principles- boxes, P-boxes, DES, 3 DES, AES. [6]

3. **Key Exchange/Distribution Schemes:** Diffie - Hellman key exchange, man- in- the-middle attack, Fiat-Naor key distribution, Needham – Schroeder scheme and attack possible on it, Kerberos. [7]

4. **Asymmetric Key/Public Key Cryptosystems:** RSA description, different attacks on RSA and remedies, other public keycryptosystems such as ElGamal and Rabin cryptosystems and possible attacks on them. [7]

5. **Digital Signature Schemes:**Security requirements for digital signatures, ElGamal digital signature scheme and its security analysis, the digital signature algorithm (DSA), Schnorr digital signature scheme, provably secure signature schemes and undeniable signatures. Network Security: Electronic mail security, IP security, Network management security.SSL, SET Indruders and Viruses, Firewalls, Intrusion Detection. [12]

Outcome(s): On successful completion of this course, students will be able to :

- Analyze the security threats.
- Design robust cryptographic algorithms.

Text Books:

[1] A. Kahate, Cryptography and Network Security, Tata McGraw Hill,2nd Edition, 2008

[2] William Stallings, Cryptography and Network Security: Principles and Practice, Pearson Education, 7th edition 2017

Reference Books:

[1] Jonathan Katz , Yehuda Lindell, Introduction to Modern Cryptography, (Cryptography and Network Security Series), Chapman and Hall/CRC; 2nd edition, 2014.

[2]Wenbo Mao, Modern Cryptography Theory & Practice, 1st edition, 2004.

CA19.607 **Database Management Systems** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisite(s): NIL

Objective(s): The objective of this Course is to:

- Understand the fundamental concepts of database management.
- Design and Normalize databases.
- Understand transaction processing control.
- Understand basic of object concepts and object relations.
- Understand the role of the DBMS, RDBMS& ODBMS in the organization

1. **Introduction**: Databases and database users, database system concepts and architecture, data modeling using the Entity-Relationship (ER) model, Enhanced Entity Relationship model. [6]
2. **Relational Data Model**: Concepts, relational model constraints, relational database schemas, update operations, dealing with constraint violations, relational algebra operations, relational calculus, mapping ER model to relational model.
   Structured Query Language (SQL): SQL data definition and data types, specifying constraints, schema change statements, basic queries, complex queries, update statements, views [12]
3. **Database Design**: Functional dependencies and normalization of relational databases, First Normal Form (1NF), 2NF, 3NF, Boyce-Codd normal form (BCNF), multivalued dependency, 4NF. [6]
4. **TransactionProcessing**:Introduction,properties,recoverability,serializability. Concurrency control techniques: Two phase locking protocol, database recovery techniques: Recovery concepts, recovery techniques based on deferred and immediate update [8]
5. **Object and Object-Relational Databases**: Concepts for object databases, object database standards and design, object relational systems, object relational features, object database extensions to SQL, ODMG object model and the object definition language (ODL) [8]

Outcome(s): After completion ofthecourse, students willbe able to:

- Analyze database models & entity relationship models. Understand architecture for database development.
- Design E-R diagram
- Use Structured Query Language (SQL) with complex queries.
- Design and normalize the relations for any organization.
- Understand transaction processing control.
- Understand Object Oriented databases

Text Books:

[1] R.Elmasri&S.B.Navathe,FundamentalsofDatabaseManagementSystems,7th Edition, Pearson Education, 2016.

[2] R. Ramakrishnan, DatabaseManagementSystems, 3rd Edition, Tata McGraw Hill, 2008.

Reference Books:

[1] Korth and Schilberschatz, Database System Concepts, 6th Edition, Tata McGraw Hill, 2011.

[2] C.J. Date, Database Systems, Tata McGraw Hill, 2nd Edition, 2003.

CA 19.608 **Management Information Systems** **3-0-0-3**
Total Lectures:40

Prerequisite(s): CA 19.106 (System Analysis and Design)

Objective(s):

- To introduce the concept of system analysis for managing the projects
- To analyze and document systems, design new systems and implement their plans.
- Understanding paradigm shift to E-enterprise
- Applications of IS and IT to management functions of the industry

1.	**MIS and Enterprise:**Management Information System(MIS) concepts, definition, role, impact, management as a control system, MIS: A support to the management, goals, objectives and target, MIS for a digital firm, E-Business Enterprise: A digital firm-organization of business in digital firm, E-business, E-commerce, real time enterprise.	[8]
2.	**Strategic management of business performance:** Concept of corporate planning, essentiality of strategic planning, development of business strategies, types of strategies, short range planning, tools of planning,MIS: Strategic business planning.	[6]
3.	**Information andKnowledge:** Information Concepts, Classification of information,System Engineering: Analysis and Design- System concepts, system control, types of system, handling system complexity, system development model, Relationship between Information and Knowledge.	[8]
4.	**Development and implementation of MIS:** Determining the information requirement, Development and implementation of the MIS,Management of information, Quality of MIS, Business process reengineering.	[8]
5.	**Application of Management Information Systems:** Applications in manufacturing sector-personnel management, financial management, production management, raw material management, marketing management, applications in service sector, Decision support system.	[10]

Outcome(s): By learning the course, the students will be able to

- Learn MIS and enterprise and strategic management of business performance.
- Learn management information system and its application
- Develop and implementation of MIS

Text Books:

[1] W. S.Jawadekar, Management Information Systems, , New York, 4th ed, 2009..

Reference Books:

[1] J. A.O' Brien, Management Information Systems, McGraw-Hill, 2004.
[2] Davis G. B., and Olson M. H., Management Information Systems, Tata McGraw-Hill,1985.

CA 19.609 **Java Programming** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CA 19.509 (C-Programming)

Objective(s):

- Cover issues related to the definition, creation and usage of classes, objects and methods.
- Discuss the principles of inheritance and polymorphism.
- Provide the foundation of good programming skills by discussing key issues of the design of object- oriented software, including programming design and documentation.
- Cover the basics of API and to explore the java abstract programming interface.

1. **Overview:**IntroductiontoJava,importanceofJava, interactiveDevelopmentEnvironments: Eclipse/Net Beans, basics of OOP. DataTypes,Variable, andArrays:Primitivedatatypes,typecasting,arrays,operatorsand control structures, identifiers, constants and literals [10]
2. **Classes and Objects:** Class fundamentals, declaringobjects, assigning object reference variables, introducing methods, constructors,this keyword,garbagecollection,the finalize()method, overloading methods, using objects as parameters and return type, introducing accesscontrol,understanding static, introducing final,introducing nestedandinnerclasses, exploringthe stringclass, usingcommand-linearguments. [10]
3. **Inheritance:**Inheritancebasics,usingsuper,multilevelhierarchy,constructorinhierarchy, methodoverriding,dynamicmethoddispatch,usingabstractclasses,usingfinalin inheritance, the objectclass. [4]
4. **Package, Interfaces and Exception Handling:** Packages, access protection, importing packages,interfaces,exception-handlingfundamentals,exceptiontypes,usingtry andcatch, multiplecatchclauses,nestedtrystatements,throw,throws,finally,JAVA'sbuilt-in exceptions, userdefinedexception. [8]
5. **MultithreadedProgramming:**TheJavathreadmodel,themainthread,creatingmultiple threads, threads priorities, managingthreads, thread class built-in functions. I/O and String Handling: I/O basics, reading console input, writing console output, the print writer class, reading and writing files, string constructors, operations on string, string tokenizing, string buffer. [8]

Outcome(s): Upon completion ofthis course, studentsareableto:

- Understand the concepts of OOP as well as the purpose and usage principles of inheritance, polymorphism, encapsulation and method overloading.
- Identifyclasses, objects,membersofaclassandthe relationships amongthem needed for aspecificproblem.
- Develop programs using the in-built JavaAPIandtheJavastandardclass library.
- CreateJavaapplicationprogramsusingsoundOOPpractices(e.g.,interfacesandAPIs) andproperprogramstructuring(e.g.,byusingaccesscontrolidentifies,automatic documentation throughcomments, error exception handling).
- Useof development environment like Eclipse forcollaborativeprogramming

Text Books:

[1] H.Schildt, Java The Complete Reference, Herbert Schildt, 10th Edition, 2017.
[2] John Jukowski, Mastering Java J2SE 1.4,SYBEX, 2002.

Reference Books:

[1] A.B. Downey, ThinkJava:HowtoThinkLikeaComputer Scientist, 2011.
[2] P.Deitel andH.Deitel,JavaHowTo Program (EarlyObjects),10th Edition, 2015.

CA 19. 610 **Mobile Computing** **3-0-0-3**

Total Lectures:40

Prerequisite(s):
- To learn GSM , HLR-VLR CDMA, GPRS
- To learn database management issues

Objective(s):
- To learn how mobile computing are different from others traditional computing by learning thoseaspects of mobile programming that make it unique from other platforms
- Program mobile applications for the Android operating system that use basic and advanced phone features.

1.	**Introduction:** Issues in mobile computing, overview of wireless telephony: cellular concept, GSM: air-interface, channel structure, location management: HLR-VLR, hierarchical, handoffs, channel allocation in cellular systems, CDMA, GPRS	[8]
2.	**Wireless Networking:** Wireless LAN Overview: MAC issues, IEEE 802.11, Blue Tooth,Wireless multiple access protocols, TCP over wireless, Wireless applications, data broadcasting, Mobile IP, WAP: Architecture, protocol stack, application environment, applications.	[8]
3.	**Data Management Issues**: Data replication for mobile computers, adaptive clustering for mobile wireless networks, File system, Disconnected operations.	[8]
4.	**Mobile Agents computing**: Security and fault tolerance, transaction processing in mobile computing environment.	[8]
5.	**Ad Hoc Networks**: Localization, MAC issues, Routing protocols, global state routing (GSR), Destination sequenced distance vector routing (DSDV), Dynamic source routing (DSR), Ad Hoc on demand distance vector routing (AODV), Temporary ordered routing algorithm (TORA),QoS in Ad Hoc Networks, applications.	[8]

Outcome(s):
- Understanding of Ad Hoc Networks and wireless networking and its applications
- Understanding of CDMA, GPRS

Text Books:
[1] J. Schiller, “Mobile Communications”, Addison Wesley, 2003.
[2] S. T. Rappaport, Wireless communications: principles and practice. Vol. 2. New Jersey: prentice hall PTR, 1996.

Reference Books:
[1] Perkins Charles, “Mobile IP”, Addison Wesley,1994
[2] Perkins Charles, “Ad hoc Networks”, Addison Wesley,2001.

CA 19.629 **Computer Organization and Architecture** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): CA19.511 (Digital Electronics)

Objective(s):

- To have a thorough understandingofthebasicstructure and operation ofamodern digitalcomputer.
- To discuss in detail the operation of the arithmetic unit including the algorithms &implementation of fixed-point and floating-point representation
- TostudythedifferentwaysofcommunicatingwithI/OdevicesandstandardI/Ointerfaces.
- Tostudythehierarchicalmemorysystemincludingcachememoriesandvirtualmemory.

1. **Principles of Computer Organization:** Introduction to computer architecture, central processing unit, machine language instructions, addressing modes, instruction types, instruction set selection, instruction cycle and execution cycle, floatingpointrepresentation. [6]

2. **Processor and ALU Design:** Computer arithmetic and ALU design,control unit, data path and control path design, microprogramming versus hardware control, RISC vs CISC [8]

3. **Memory Organization:** Memory subsystem, storage technologies, memory arrayorganization, memory hierarchy interleaving, cache and virtual memories and architectural aids to implement these. [6]

4. **Input-Output Organization:**Input-output devices and characteristics, bus interface, data transfer techniques, I/O interrupts. [4]

5. **Advance computer Architecture**: Overview of parallel processing and pipelining, Superscalar processors,study and comparison of uni-processors and parallel processors, speedup.Pipelining: Principles and implementation of pipelining, classification of pipelining processors, pipeline architecture, general pipelining reservation table, design aspect of arithmetic and instructional pipeline, pipelining hazards and resolving techniques. [16]

Outcome(s): On successful completion of this course, students will be able to

- Understand basic structure of a digital computer.
- Perform arithmetic operations of binary number system.
- Know the organization of the control unit, arithmetic and logical unit, memory unit and the
- Describe the operation of performance enhancements such as pipelines, dynamic scheduling, branch prediction, cache, and vector processors.
- Describe modern architectures such as RISC, super scalar

Text Books:

[1] Hayes J. P., "Computer Architecture and Organization", McGraw- Hill, New York, 3rd ed.,2012.
[2] Hwang K., "Advanced Computer Architecture: Parallelism, Scalability and Programmability", McGraw-Hill, New York., 3rd ed ,2012.

Reference Books:

[1] Mano M. M., "Computer System Architecture", Prentice-Hall of India, 3rd ed. 1993

ELECTIVES

CA19.630 **ADVANCED DBMS** **3-0-0-3**

Total Lectures :40

Prerequisite(s): CA 19.607 (Database Management Systems)

Objectives:

- To cover and impart knowledge of various aspects of a Data Base Management systems like, databases, different database models, how transaction is managed, query is processed and different types data [8]

1. **Object based databases:** Introduction, OODM, OODB, OODBMS, ODMG, ORDBMS, ORDBMS design [8]
2. **Parallel and distributed databases:** Introduction, advantages and disadvantages, architecture, Parallel data processing and query parallelism. [8]
3. **Distributed databases:** Introduction, Properties, types, advantages, disadvantages, architecture, design, query processing, concurrency control, recovery control [8]
4. **XML Databases:** XML Databases: XML Data Model – DTD - XML Schema - XML Querying – Web Databases – JDBC – Information Retrieval – Data Warehousing – Data mining. [8]
5. **Emerging Database Technologies:** Internet databases, digital libraries, multimedia databases, mobile [8]

Outcome:

- Design and normalize the relations for any organization.
- Understand transaction processing control.
- Understand Object Oriented databases

Text Books:

[1] **Korth,** "Database Systems Concepts, Design and Applications", 1st Ed., Pearson Ed., 2016

Reference Books:

[1] C. J. Date, "An Introduction to Database Systems", 7th Ed., Narosa Publishing, 2004

[2] Elmsari and Navathe, "Fundamentals of Database Systmes", 4th Ed., A. Wesley, 2004

CA 19.631 **Real Time Systems** **3-0-0-3**

Total Lectures :40

Prerequisite(s): **CA 19.201(Computer Architecture)**

Objectives:

- Real-time scheduling andschedulability analysis
- Formal specification and verification of timing constraints and properties
- Design methods for real-time systems
- Development and implementation of new techniques to advance the state-of-the-art real-time systems research

1. **Introduction:** Issues in Real Time Computing, Structure of a Real Time System. Task Classes, Performance Measures for Real Time Systems, Estimating Program Run times. Task Assignment and Scheduling -Classical Uniprocessor scheduling algorithms, Task Assignment,Mode Changes, and Fault Tolerant Scheduling. [8]
2. **Programming Language and Tools**: Desired Language characteristics, Data Typing, Control structures,Facilitating Hierarchical Decomposition, Packages, Run-time (Exception) Error handling, Overloading andGenerics, Multitasking, Low Level programming, Task scheduling,Timing Specifications, Programming Environments, Run-time Support. [8]
3. **Real time Databases**: Basic Definition, Real time Vs General Purpose Databases, MainMemoryDatabases,Transaction priorities, Transaction Aborts, Concurrency Control Issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time systems. [8]
4. **Real-Time Communication:** Communications Media, Network Topologies Protocols, Fault Tolerant Routing. Fault Tolerance Techniques - Fault Types, Fault Detection. Fault Error containment Redundancy, Data Diversity, Reversal Checks, Integrated Failure handling. [8]
5. **Reliability Evaluation Techniques:** Obtaining Parameter Values, Reliability Models for Hardware Redundancy, Software Error models. Clock Synchronization - Clock, A Nonfault-Tolerant Synchronization Algorithm, Impact of Faults, Fault Tolerant Synchronization in Hardware, Fault Tolerant Synchronization in Software. [8]

Outcomes:

- Fundamental principles for programming of real time systems with time and resource limitations.
- Foundation for programming languages developed for real time programming.
- Use of real time system programming languages and real time operating systems for real time applications.
- Analyse real time systems with regard to keeping time and resource restrictions.

Text Books:

[1] C.M. Krishna, Kang G. Shin, “Real-Time Systems”, McGraw-Hill International Editions,1997

[2] J. S. Liu, Real Time Systems, Pearson Education, 2004

Reference Books:

[1] S. Bennett, “Real Time Computer Control-An Introduction”,Second edition Perntice Hall PTR,1994.

[2] 1. Peter D. Lawrence, “Real time Micro Computer System Design – An Introduction”, McGraw Hill,1988.

CA 19.632 **Software Project Management** **3-0-0-3**

Total Lectures: 40

Prerequisite(s): CA 19.634 (Software Engineering)

Objectives:

- Understand the fundamental principles of Software Project management
- To gain good knowledge of responsibilities of project manager and how to handle these.
- Be familiar with the different methods and techniques used for project management.

1. **Introduction To Software Project Management:** Project Definition, Contract Management Activities Covered By Software Project Management, Overview Of Project Planning, Stepwise Project Planning. [6]

2. **Project Evaluation :** Strategic Assessment, Technical Assessment, Cost Benefit Analysis, Cash Flow Forecasting, Cost Benefit Evaluation Techniques, Risk Evaluation. [6]

3. **Activity Planning:** Objectives, Project Schedule, Sequencing and Scheduling Activities, Network Planning Models, Forward Pass, Backward Pass, Activity Float, Shortening Project Duration, Activity on Arrow Networks, Risk Management, Nature Of Risk, Types Of Risk, Managing Risk, Hazard Identification, Hazard Analysis, Risk Planning and Control. [9]

4. **Monitoring And Control:** Creating Framework, Collecting the data Visualizing Progress, Cost Monitoring, Earned Value, PriortizingMonitoring, Getting Project Back To Target, Change Control, Managing Contracts – Introduction, Types Of Contract, Stages In Contract Placement, Typical Terms Of A Contract, Contract Management – Acceptance. [9]

5. **Managing People And Organizing Teams:**Introduction , Understanding Behavior, Organizational Behaviour: A Background, Selecting The Right Person For The Job, Instruction In The Best Methods, Motivation, The Oldman, Hackman Job Characteristics Model, Working In Groups, Becoming A Team, Decision Making. [10]

Outcomes:

- Student will have good knowledge of the issues and challenges faced while doing the Software project Management and will also be able to understand why majority of the software projects fails and how that failure probability can be reduced effectively.
- Will be able to do the Project Scheduling, tracking, Risk analysis, Quality management and Project Cost estimation using different techniques.

Text Books:

[1] Bob Hughes, Mikecotterell, “Software Project Management”, Third Edition, Tata McGraw Hill,2011.

[2] R.Gopalaswamy, "Managing Global Projects", Tata McGraw Hill,2001.

Reference Books:

[1] Jalote, “Software Project Management in Practice”, Pearson Education,2002.

[2] Royce, “Software Project Management”, Pearson Education,2005

CA 19.634 **Software Engineering** **Total Lectures:40**

Credit:3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To understand the basic software engineering approaches, software development process models, project planning, software size estimation, software effort and cost estimation and risk management.
- To know about software requirements specification, requirement elicitation, structured system analysis and introduction of object-oriented analysis and design, design techniques.
- To acquire knowledge on implementation issues such as modularity and coding standards.
- To learn coding style guidelines and standard and software testing, different type of testing strategies and their application in real time system.
- To study web based-system and application, software re-use, software re-engineering, agile software engineering, software engineering and testing tools.
- To develop teamwork and have project based experience.

1. **Introduction:** Software crisis, Software engineeringApproach and Challenges, Software development process models with comparison: Waterfall, Rapid Prototyping, Spiral, Iterative, V-shape and Evolutionary Model, SEI-CMM. [6]

2. **Software Processes and Requirement Analysis:** Software engineering: a layered technology requirement elicitation, requirement analysis, software requirement and specifications, data flow diagrams, data dictionaries, entity-relationship diagrams. Software Measurement, planning schedule, Risk management,Quality Assurance. [10]

3. **Software Design and Estimation Techniques:** Introduction to object-oriented design, Function and Object Oriented Design concepts, Verification and Validations, Software size and cost estimation Techniques: Size oriented Metrix, FPA and COCOMO. [8]

4. **Testing:** Software testing fundamentals, test case design, white box testing:-basis path testing, control structure testing, black box testing: boundary value analysis, equivalence class testing, decision table testing, cause effect graphing, debugging, testing tools & standards, testing for client/server architecture, [9]

5. **Special Topics:**Brief of software re-use, reverse engineering, software re-engineering, agile software engineering, CASE Tools. [7]

Outcome(s):

- Demonstrate knowledge of the distinction between critical and non-critical systems and ability to manage a project including planning, scheduling and risk assessment/management.
- Author a software requirements document and understanding of the proper contents of a software requirements document.
- Demonstrate proficiency of different life cycle models.
- Identify specific components of a software design that can be targeted for reuse.

Demonstrate proficiency in software development cost estimation, software testing plan and advanced topics of software engineering.

Text Books:

[1] R. S. Pressman, Software Engineering – A practitioner's approach,Tata-McGraw- Hill Int. Ed., 8th edition, 2014.

[2] K. K. Aggarwal, Yogesh Singh, Software Engineering, New Age International, 1st edition, 2008.

Reference Books:

[1] Pankaj Jalote, An Integrated Approach to Software Engineering, Narosa Publisher, 3rdedition, 2005.

[2] Rajib Mall, Fundamentals of Software Engineering, Prentice-Hall, 2ndedition, 2004

ELECTIVES

CA19.642 **Digital Image Processing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CA19.103 (C-Programming)

Objective(s):

- To study the image fundamentals and mathematical transforms necessary for image processing.
- To study the image enhancement techniques
- To study image restoration procedures.
- To study the image compression procedures.
- To study the image segmentation and representation techniques
- To study the image representation in form of features and descriptors

1. **Digital Image Fundamentals:** Elements of digital image processing systems, elements of visual perception, brightness, contrast, hue, saturation, mach band effect, color image fundamentals - RGB, HSI models, image sampling, quantization, dither, two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD. [8]
2. **Image Enhancement and Restoration:** Histogram equalization and specification techniques, noise distributions, spatial averaging, directional smoothing, median, geometric mean, harmonic mean, contra harmonic mean filters, image restoration - degradation model, unconstrained restoration, inverse filtering, removal of blur caused by uniform linear motion. [8]
3. **Morphological Image Processing:** Basics, structuring element, erosion, dilation, opening, closing, hit-or-miss transform, boundary detection, hole filling, connected components, convex hull, thinning, thickening, skeletons, pruning, and reconstruction by dilation and erosion. [8]
4. **Image Segmentation:** Edge detection, edge linking via Hough transform, thresholding, region based segmentation, region growing, region splitting and merging, and segmentation by morphological watersheds, basic concepts, dam construction, and watershed segmentation algorithm. [8]
5. **Image Representation:** Boundary representation, chain code, polygonal approximation, signature, boundary segments, boundary description, shape number, Fourier descriptor, regional descriptors, and topological features. [8]

Outcome(s): On successful completion of this course, students will be able to

- Analyze the basic algorithms used for image processing &image compression with morphological image processing.
- Apply image enhancement and restoration techniques.
- Use image compression and segmentation Techniques.
- Represent features of images.

Text Books:

[1] Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.
[2] Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011.

Reference Books:

[1] Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, “Digital Image Processing Using MATLAB”, Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.
[2] William K Pratt, “Introduction to Digital Image Processing”, CRC Press, 13-Sep-2013.

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CA 19. 644 **Artificial Intelligence** **Total Lectures: 40**
3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To understand the basic problem solving in Artificial Intelligence.
- To learn different blind as well as heuristic search strategies.
- To understand the various ways of knowledge representation in Artificial Intelligence.

1	**OverviewofA.I.:**IntroductiontoAI,ImportanceofAI,AIanditsrelatedfield,AI techniques.	[4]
2	**Problem space and search:** Defining the problem as a state space search, Production system and its characteristics, Issues in the design of the search problem.	[6]
3	**Heuristic search techniques:** Generate and test, hill climbing, best first search technique, problem reduction, constraint satisfaction	[7]
4	**Game Playing and Predicate Logic:** Minimax, alpha-beta pruning. Predicate logic definition, representation of simple facts in logic, well-formed formula, resolution.	[11]
5	**Knowledge representation and Learning:** Definition and importance of knowledge, Knowledge representation, Various approaches used in knowledge representation, Issues in knowledge representation.Introduction to learning, Types of learning, Introduction to neural networks.	[12]

Outcome(s): On successful completion of this course, students will be able to

- Solve the basic problems and apply searching techniques used in Artificial Intelligence.
- To select knowledge representations to solve AI problems.
- Apply various game playing algorithms.

Text Books:

[1]. R. Elaine and K. Knight, Artificial Intelligence, 3rd ed., Tata McGraw Hill, 2012

Reference Books:

[1]. S. Russell and P. Norvig,ArtificialIntelligence: A Modern Approach, 3rd ed., PrenticeHall, 2009

[2]. D. W. Patterson, Introduction to AI and Expert Systems, PHI, 1999

CA19.646 **Parallel Processing** **3-0-0-3**

Total Lectures: 40

Prerequisite(s): CA 19.201(Computer Architecture)

Objective(s):

- To understand parallel processing and Array processing and their applications
- To understand multiprocessors and multicomputer
- To understand parallel programming languages

1.	**Parallel Processing:** Introduction, data and control parallelism,(concurrency, scalability,speedup, Amolahl's Law), PRAM model of parallel computation, parallel algorithm design	[8]
2.	**Multiprocessors andMulticomputers:** Processor organization, shared memory and message passing systems, message passing interface programming with respect to PARAM 10000.	[9]
3.	**Array Processing:** SIMD array processing, communications, SIMD interconnectionnetworks, algorithms for array processing.	[8]
4.	**Applications:** Parallel algorithms for matrix multiplication, fast Fourier transform, linearsystems, sorting, numerical integration, and optimization.	[7]
5.	**Parallel Programming Languages:** C, C++ and high performance FORTRAN.	[8]

Outcome(s):

- Understanding of parallel processing and array processing
- Understanding of multiprocessors and multicomputers
- Understanding programs of parallel programming languages.

Text Books:

[1] Hwang K., "Advanced Computer Architecture", Tata McGraw-Hill,2003.

[2] Quinn M. J., "Parallel Computing", Tata McGraw-Hill, 2nd ed,2002.

Reference Books:

[1] Hwang K. and Briggs F. A., "Computer Architecture and Parallel Processing", McGraw-Hill, New York.,1984.

[2] Sinha P. K., "Distributed Operating System", Prentice-Hall of India,1997.

CA 19.709 **Distributed Systems** **Total Lectures: 40**
Credit: 3-1-0-4

Prerequisite(s): CA 19.102(Operating Systems), CA 19.204 (Computer Networks)

Objective(s): To make students aware of:

- What a distributed system is, its example, use and utilities.
- Hardware and software requirements/constraints for implementation of distributed systems.
- Abstractions like, RMI, distributed objects, RPC, distributed shared memory etc.
- Notion of time in a distributed system.
- Databases in a distributed system.

1. **Characterization of Distributed Systems:** Definition, distributed systems-Internet, intranet, mobile, ubiquitous computing, resource sharing and World Wide Web challenges- heterogeneity, openness, security scalability failure handling concurrency and transparency. [8]

2. **System Models:** Architecture models- software layers, system architecture, variations on client-server model, interfaces, design requirement for distributed architectures, fundamental and interaction models, and failure and security models. [8]

3. **Distributed Object and Remote Invocation:** Introduction to remote method invocation (RMI) and interface in distributed systems, communication between distributed objects- objects model, distributed objects, distributed objects model and design issues for RMI, implementation of RMI and distributed garbage collection, remote procedures call. [8]

4. **Time and Global State:** Clocks, events and process states, synchronizing physical clocks- synchronization in a synchronous system, Cristian method for synchronizing clocks, Berkley algorithm, network time protocol, global state and consistent cuts. [8]

5. **Distributed Shared Memory:** Introduction, message passing versus DSM, implementation approaches to DSM, design and implementation issues-structure and synchronization model. [8]

Outcome(s): On successful completion of the course the student will be able to:

- Understand the concept of distributed systems.
- Explain the principles underlying the functioning of distributed systems as well as how these principles are applied in distributed systems.
- Comprehend the problems and challenges of distributed systems.
- Understand and estimate the impact of different design choices, system features on distributed systems.

Text Books:

[1] Colouris, “Distributed Systems Concepts and Design”, Addison Wesley, 5th edition, 2011.
[2] George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair,"Distributed Systems" , Pearson Education Limited, 2013

Reference Books:

[1] Pradeep K. Sinha,"Distributed Operating Systems",PHI Learning Pvt. Limited, 2011.

[2] MukeshSinghal, NiranjanShivrathri, “Advanced Concepts in Operating Systems”, TMH, 2011.

CA 19.711 **Data Mining and Warehousing** **3-0-0-3**

Prerequisite(s): **NILTotal Lectures:40**

Objective(s):

- **To learn data mining and warehousing and knowledge base**
- **To learn data marts OLAP**

1.	**Overview:** Concept of data mining and warehousing, data warehouse roles and structures, cost of warehousing data, roots of data mining, approaches to data exploration and data mining, foundations of data mining, web warehousing, web-warehousing for business applications and consumers, introduction to knowledge management, data warehouses and knowledge bases.	[8]
2.	**Data Warehouse:** Theory of data warehousing, barriers to successful data warehousing, bad data warehousing approaches, stores, warehouse and marts, data warehouse architecture, data about data - metadata, metadata extraction, implementing the data warehouse, data warehouse technologies.	[8]
3.	**Data Mining and Data Visualization:** Data mining, OLAP, techniques used to mine the data, market basket analysis, current limitations and challenges to DM, data visualization.	[8]
4.	**Designing and Building the Data Warehouse:** Theenterprise model approach of data mining design, data warehouse project plan, analysis and design tools, data warehouse architecture, specification and development.	[8]
5.	**Web-Based Query and Reporting:** Delivering information over the web, query and reporting tools and business value, architectural approaches to delivering query capabilitiesover the web. Web Based Statistical Analysis and Data Mining: Analytical tools, business value from analytical tools,	[8]

Outcome(s):

- To understand data mining and data warehousing
- To understand and use tools for data mining

Text Books:

[1] Marakas G. M., "Modern Data Warehousing, Mining and Visualisation", Pearson Education Asia, 2003.
[2] Mattison R., "Web Warehousing and Knowledge Management", Tata McGraw-Hill,2002.

Reference Books:

[1] Mallach E., "Decision Support and Data Warehousing", Tata McGraw-Hill,2002.
[2] Hand D., Mannila H., and Smyth P., "Principles of Data Mining", Prentice-Hall of India, 2001.

CA 19.715 **Computer Graphics** **3-1-0-4**

Total Lectures: 40

Prerequisite(s): CA 19.103 (C-Programming)

Objective(s):

- To introduce the students with the graphics mode, with the help of basic algorithms and methodologies.
- The objective of the course is to equip students with fundamental knowledge and basic technical competence in the field of computer graphics.
- Provide an understanding of how a computer draws the fundamental graphics primitives.
- To learn Computer Graphics methodologies/Algorithms and techniques.

1	**Basic Concepts:** Application Areas of Computer Graphics, Graphical User Interface, RGB Color model, CMY color models, Advantages of Computer Graphics.	**[8]**
2	**Graphics Hardware:** Random Scan Displays, Raster Scan Display (with Introduction to Flickering, Interlacing, American Standard Video), Color CRT Monitors, Flat Panel Display (Plasma Panel, Liquid Crystal Display, Electroluminescent Display).	**[7]**
3	**Raster Graphics Algorithms:** Line Drawing Algorithms-DDA, Bresenham's Algorithm, Circle and Ellipse Drawing Algorithms, Filling (Scan-Converting Polygon Filling, Inside Outside Tests Boundary Fill and Area Fill Algorithm). Cohen- Sutherland Algorithm of clipping.	**[12]**
4	**Transformations:** 2-D Transformations (Rotation, Reflection,Shearing, Scaling), Homogeneous Coordinate Representation, and Translation.	**[8]**
5	**Animation Introduction:** Conventional and Computer-Assisted Animation, Animation languages, methods of controlling Animation, basic rules of Animation.	**[5]**

Outcome(s): On successful completion of this course, students will be able to

- Understand basic concepts of computer graphics.
- Acquire knowledge about drawing basic shapes such as lines, circle ellipse, polygon.
- Perform processing of basic shapes by various processing algorithms /techniques.
- Implement two dimensional transformations.

Text Books:

[1]. D. D. Hearn and M. P. Baker, Computer Graphics, 3rd ed., Prentice Hall India, 2011.
[2]. A. Kalbag, Computer graphics & animation, 1st ed., Usborne, 1999.

Reference Books:

[1]. J. D. Foley, A. V. Dam, S. K. Feiner, J. F. Hughes, Computer Graphics Principles and Practice, 2nd ed., Addison Wesley, 1995.
[2]. D. F. Rogers, Procedural Elements for Computer Graphics, 2nd ed., Tata McGraw Hill Publications, 2001.

ELECTIVES

CA 19.741 **Design and Analysis of Algorithms** **Total Lectures: 40Credit:3-0-0-3**

Prerequisite(s): CA-19.209(Discrete Mathematics), CA-19.104 (Data Structures)

Objective(s):

- To learn the algorithm analysis techniques.
- To become familiar with the different algorithm design techniques.
- To understand the limitations of the algorithms power.

1.	**Introduction:** Fundamentals of algorithms and problem solving, asymptotic notations, time complexity and analysis of algorithms, solutions of recurrence relations, master theorem and summations techniques.	[8]
2.	**Analysis of Sorting and Searching Algorithms:** Linear, binary and interpolation search, insertion, selection, merge, quick and heap sort, stability and other issues, hashing.	[8]
3.	**Algorithm Design Approaches:** Greedy method (knapsack problem, job sequencing problem), dynamic programming (assembly line scheduling, matrix chain multiplication), backtracking (8 queens problem, sum of subsets), branch and bound (0/1 knapsack problem), divide and conquer algorithms (Strassen matrix multiplication), problems based on these design paradigms.	[8]
4.	**Tree and Graph algorithms:** Spanning trees, Prim and Kruskal's algorithm, Huffman coding, BFS and DFS, disjoint set operations, connected components, shortest path algorithms in a graph such as Dijkstra, Bellman Ford, Warshall's etc.	[8]
5.	**Complexity Classes:** P,NP,NP hard and NP complete problems, reducibility, decision and optimization problems, examples of NP complete problems such as 3 CNF, clique, vertex cover and traveling salesman problem, basic introduction of approximation algorithms.	[8]

Outcome(s): On the successful completion of the course, the student will be able to:

- Design algorithms for various computing problems.
- Analyze the time and space complexity of algorithms.
- Critically analyze the different algorithm design techniques for a given problem.
- Modify existing algorithms to improve efficiency.

Text Books:

[1] Thomas H.Cormen, Charles E.Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, PHI Learning Private Limited, 3rd edition, 2016.

[2] Ellis Horowitz, SartajSahni, SanguthevarRajasekaran, Computer Algorithms, Silicon Press, 2nd edition, 2008.

Reference Books:

[1] Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 3rd edition, 2012.

[2] Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, Data Structures and Algorithms, Pearson Education, 1st edition, 2006.

[3] Donald E. Knuth, The Art of Computer Programming, Volumes 1& 3, Pearson Education, 2009.

CA 19.745 **Compiler Design** **Total Lectures:40**
Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- To introduce the major conceptual areas of language translation and compiler design.
- To enrich the knowledge in various phases of compiler, code optimization techniques
- To extend the knowledge of different parsers.
- To provide practical programming skills necessary for construction of a compiler.

1. **Introduction:** Introduction of compiler, compiler structure: analysis-synthesis model of compilation, various phases of a compiler, Symbol table: Role and data structure used for symbols tables .Lexical Analysis: Input buffering, specification & recognition of tokens, error detection &recovery . [8]
2. **Syntax Analysis & Syntax Directed Translation:** Syntax analysis: CFGs, top down parsing, Brute force approach, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence parsing, LR parsers (SLR, LALR, LR), parser generation error detection & recovery. [9]
3. **Syntax Directed Definition**: Construction of syntax trees, bottom up evaluation, S-attribute definition, L-attribute definition, top down translation, bottom up evaluation of inherited attributes, recursive evaluation, analysis of syntax directed definition. [8]
4. **Intermediate Code Generation:** Intermediate code, postfix notation, parse trees & syntax trees, three address code, quadruple & triples, translation of assignment statements, Boolean expressions, statements that alter the flow of control, postfix translation, translation with a top down parser, more about translation: array references in arithmetic expressions, procedures call, declarations, case statements. [8]
5. **Code Optimization & Code Generation:** Loop optimization, the DAG representation of basic blocks, flow graphs, global data-flow analysis, peephole optimization, generating code from DAG, register allocation and assignment. [7]

Outcome(s): On successful completion of this course, the students will be able to

- Use lexical analyzer and parser generator tools.
- Generate intermediate code.
- Be familiar with register allocation.
- Expose compiler code optimization.

Text Books:

1. A. V. Aho, R. Sethi, and J. D. Ullman. Compilers: Principles, Techniques and Tools, Pearson Education, 2nd edition, 2014.
2. Louden, Compiler Construction: Principles and Practice, Cengage Learning, 1st edition, 1997.

Reference Books:

1. Allen I. Holub, Compiler Design in C, Prentice-Hall Inc., 1st edition, 1994.
2. AW Appel, M Ginsburg, Modern Compiler Implementation in C, Cambridge University Press, 1st edition, 2004.
3. J. R. Levine, T. Mason, D. Brown, Lex and Yacc, O'Reilly, 2nd edition, 2000.

CA 19.747 **Neural Network** **3-0-0-3**

Total Lectures:40

Prerequisite(s): CA 19.603(Design and Analysis of Algorithms)

Objective(s):

- To understand neural network and its algorithms
- To understand competitive learning neural network
- To understand activation and synaptic dynamics

1.	**Introduction :** Features , structure and working of Biological Neural Network Trends in Computing Comparison of BNN and ANN, History of neural network research, characteristics of neural networks terminology, models of neuron McCulloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture.	[8]
2.	**Back Propagation Networks :** Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, backpropagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning	[8]
3.	**Activation and Synaptic Dynamics :** Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks.	[5]
4.	**Basic functional units of ANN for pattern recognition tasks:** Basic feedforward, Basic feed back and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks.	[8]
5.	**Competitive learning neural networks :** Components of CL network pattern clustering and feature mapping network, ART networks, Features of ART models, character recognition using ART network. Applications of ANN :Pattern classification – Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron.	[11]

Outcome(s):

- Understanding of neural network and its algorithms
- Understanding of ART model and use that network.

Text Books:

[1] b. Yegnanarayana., “Artificial Neural Networks”, PHI,1999
[2] S. R. Sekaran , P. Vijayalakshmi, “Neural networks, Fuzzy logic and Genetic Algorithms”, PHI.

Reference Books:

[1] 1 S. Kumar, “Neural Networks”, PHI, 2013.

ET 19.465 **Agile Software Development** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): Software Engineering, System Analysis and Design

Objective(s):

- To learn the fundamental principles and practices associated with each of the agile development methods.
- To learn how agile methods scale to large and distributed projects.
- To learn the essentials of collaboration as they apply to agile methods.
- To perform in-depth explorations into aspects of agile development that are particularly relevant to each student through detailed discussion sessions.

1	**Fundamentals of Agile:** The genesis of Agile, introduction and background, Agile manifesto and principles, overview of Scrum, extreme programming, feature driven development, lean software development, Agile project management, design and development practices in Agile projects, test driven development, continuous integration, refactoring, pair programming, simple design, user stories, Agile testing, Agile tools.	[7]
2	**Agile Scrum Framework:** Introduction to Scrum, project phases, Agile estimation, planning game, product backlog, sprint backlog, iteration planning, user story definition, characteristics and content of user stories, acceptance tests and verifying stories, project velocity, burn down chart, sprint planning and retrospective, daily scrum, Scrum roles – product owner, Scrum master, Scrum team, Scrum case study, tools for Agile project management.	[9]
3	**Agile Testing:** The Agile lifecycle and its impact on testing, test driven development (TDD), unit framework and tools for TDD, testing user stories – acceptance tests and scenarios, planning and managing testing cycle, exploratory testing, risk-based testing, regression tests, test automation, tools to support the Agile tester, securing Agile software.	[10]
4	**Agile Software Design and Development:** Agile design practices, role of design principles including single responsibility principle, open closed principle, Liskov substitution principle, interface segregation principles, dependency inversion principle, Agile design, need and significance of refactoring, refactoring techniques, continuous integration, automated build tools, version control.	[10]
5	**Industry Trends:** Market scenario and adoption of Agile, Agile ALM, roles in an Agile project, Agile applicability, Agile in distributed teams, business benefits, challenges in Agile, risks and mitigation, Agile project on cloud, balancing Agility with discipline, Agile rapid development technologies.	[4]

Outcome(s): On successful completion of this course, students will be able to

- Understand concept of agile software engineering and its advantages in software development. Recognize various agile methods.
- Design and manage a project using Scrum.
- Write user stories for project requirements.
- Write test cases for developing features.

Text Books:

1. Ken Schawber, Mike Beedle, Agile Software Development with Scrum, Pearson, 2008.
2. Robert C. Martin, Agile Software Development Principles, Patterns and Practices, Prentice Hall

ET 19.471 **Cloud Computing** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 19.306 (Computer Networks)

Objective(s): To learn how to use cloud services.
To implement virtualization and task scheduling

1	**Overview of Cloud Computing:** Brief history and evolution - history of cloud computing, evolution of cloud computing, traditional vs. cloud computing, cloud service models (IaaS, PaaS & SaaS), cloud deployment models (public, private, hybrid and community cloud), benefits and challenges of cloud computing, introduction to AWS public cloud vendor, cost optimization in AWS, basics of virtualization, virtualization technologies, server virtualization, VM migration techniques, role of virtualization in cloud computing, introduction to EC2 service of AWS.	[10]
2	**Working with Private Cloud:** Private cloud definition, characteristics of private cloud, private cloud deployment models, private cloud vendors - CloudStack, OpenStack, Eucalyptus Microsoft, private cloud – benefits and challenges, private cloud implementation in Amazon EC2 service.	[8]
3	**Working with Public Clouds:** What is public cloud, why public cloud, when to opt for public cloud, public cloud service models, public cloud players, infrastructure as a service offering, IaaS vendors, PaaS offerings, PaaS vendors, software as a service, demonstrating public cloud with AWS – storage and database services, private vs. public cloud – when to choose.	[10]
4	**Overview of Cloud Security:** Explain the security concerns in traditional IT, introduce challenges in cloud computing in terms of application security, server security, network security, security reference model, abuse and nefarious use of cloud computing, insecure interfaces and APIs, malicious insiders, shared technology issues, data loss or leakage, account or service hijacking, unknown risk profile, shared security model between vendor and customer in IaaS/PaaS/SaaS, implementing security in AWS.	[8]
5	**Future directions in Cloud Computing:** When and not to migrate to cloud, migration paths for cloud, selection criteria for cloud deployment, issues/risks in cloud computing, future technology trends in cloud computing.	[4]

Outcome(s):

On successful completion the students will be able to:

- Analyze the cloud computing setup with its vulnerabilities and applications using different architectures.
- Design different workflows according to requirements and apply map reduce programming model.
- Create combinatorial auctions for cloud resources and design scheduling algorithms for computing clouds.

Text Books:

1. Raj Kumar Buyya, James Broberg and Andrezi M Goscinski, “Cloud Computing: Principles and Paradigms”, John Wiley & Sons, 2010
2. Nick Antonopoulos and Lee Gillam, “Cloud computing: Principles, Systems and Applications”, Springer, 2010.

Reference Books:

1. Anthony T Velte, Toby J Velte and Robert Elsenpeter, “Cloud Computing: A Practical Approach”, McGraw Hill, 2010
2. BorkoFurht and Armando Escalante (Editors), “Handbook of Cloud Computing”, Springer, 2010
3. Judith Hurwitz, Robin Bllor, Marcia Kaufman and Fern Halper, “Cloud Computing for Dummies”, John Wiley & Sons, 2010.

RM 19.101 **Research Methodology** **Total Lectures: 40**

Credit: 3-0-0-3

Prerequisite(s): Communication Skills

Objective(s):

- To understand a general definition of research design.
- To identify the overall process of designing a research study from its inception to its report.
- To be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
- To understand the primary characteristics of quantitative research and qualitative research.
- To identify a research problem stated in a study

1. **Introduction**: Meaning of research, Objectives, Motivation for Research, Types of Research, Research Approaches,ResearchProcess,ValidityandReliabilityin Research. [6]
2. **ProblemFormulation**:Identification,Selection andFormulation ofa ResearchProblem, Criteria ofagoodResearchProblem,Reviewof Literature, Research Gaps. [10]
3. **Research Design**:ResearchFramework, Meaning &SignificanceofResearchDesigns,Featuresofa goodResearch Design, Types of Research Design. [10]
4. **Data Analysis and Simulation Tool**:TypesofData,Sources of Data, Methods of CollectingData,DataPresentation Techniques.Methodsof DataAnalysis, SPSS, MATLAB, Network Simulators, ETAP, Solid Works, MultiSim. [12]
5. **ReportWriting**:Types of Reports,Contents, Style Manuals, Results & Findings, Contributions, Implications, Scope for future work and conclusion, Referencing Styles, Anti Plagiarism Policy. [2]

Outcome(s): On successful completion of this course, the students will be able to

- Assess critically the following methods: literature study, case study, structured surveys, interviews, focus groups, participatory approaches, narrative analysis, cost-benefit analysis, scenario methodology and technology foresight.

Text Books:

1. R.Pannershelvam, "ResearchMethodology" PrenticeHall India, New Delhi, 2nd Edition, 2013.
2. C.R.Kothari,"ResearchMethodology: MethodsandTechniques",New Age International (p) Limited,Publishers New Delhi, 4ndedition,2018.

Reference Books:

1 William G.Zikmund, “Business Research Methods”, Cengage Learning New Delhi, 8th edition, 2016.
2. Mark Saunders, “Research Methods for Business Students” Pearson Education New Delhi, 7th edition, 2015.
3. Donald R Cooper, “Business Research Methods” Tata McGraw-Hill Publishing Company Limited New Delhi, 12th edition, 2013

Mody University of Science & Technology
Lakshmangarh (Sikar)

College of Engineering & Technology

Department of Nuclear Science & Technology (NST)

Detailed Syllabus for

M. Tech. (Nuclear Science & Technology)

NU- 501 Quantum Mechanics and Electrodynamics 3-1-0-4

Quantum Mechanics

1. Origin of quantum theory and related experiments, wave-particle duality, wave function and its Born interpretation, uncertainty principle, Schrodinger equation, wave functions, wave packets, probability amplitudes, solutions to Schrodinger equation in one dimensions; Barrier penetration, Potential wells, Simple harmonic oscillator, Schrodinger equation in three dimensions.

[7]

2. Formalism of quantum mechanics; Liner vector space, Function spaces, Hilbert space formalism, inner product and probability, completeness of Eigen functions, delta functions, Bra & Ket notation, matrix representation of an operator, change of basis, unitary transformations.

[6]

3. General treatment of angular momentum, spin, identical particles; SHM problem by operator method; Pauli exclusion principle; Scattering theory; some calculations, Perturbation theory, WKB approximation.

[7]

Electrodynamics

4. Coulomb law and electrostatics, Laplace and Poisson equations, Maxwell's equations, partial polarization, Lorentz force, Poynting theorem. Scalar and vector potentials, Gauge transformations and gauge invariance.

[5]

5. Special theory of relativity, four vectors, Field tensor, Relativistic formulation of electrodynamics, Maxwell equations in covariant form

[4]

6. Relativistic charged particle in an electromagnetic field, Motion in uniform electric and magnetic fields and combinations of E and B fields, Non uniform static magnetic field

[4]

7. Green's function for wave equation (relativistic), Radiation from localized moving charges, Multi pole expansion, dipole and quadrupole radiation, Radiation from accelerated charge

[4]

8. Power radiated by point charge, Larmor's formula, Angular distribution of power, Bremsstrahlung and synchrotron radiation, Dispersion theory, Radiative reaction, Radiative damping

[5]

Text Books:

1. Griffiths D. J., Introduction to Quantum Mechanics, 2nd edition, Pearson, 2009.
2. Griffiths D. J., Introduction to Electrodynamics, 3rd edition, Prentice Hall India, 1999.
3. Ghatak A. K. & Lokanathan S., Quantum Mechanics: Theory and Applications, 5th edition, Macmillan India, 2004.

Reference Books:

1. Schiff L. I., Quantum Mechanics, 3rd edition, Tata McGraw-Hill, 2010.
2. Zettili N., Quantum Mechanics: Concepts & Applications, 2nd edition, Wiley, 2009.
3. Jackson J. D. Classical Electrodynamics, 3rd edition, Wiley, 1998.
4. Lifshitz E. M. & Landau L. D., Quantum Electrodynamics (Course of Theoretical Physics), 2nd edition, Pergamon Press, 1981.

NU- 503 **Nuclear Physics** **3-1-0-4**

1. Basic concepts of general properties of nuclei: Charge, Masses and relative abundances, mass defect, size and shape, binding energy, angular momentum, magnetic dipole moments and electric quadrupole moments, Parity, Nuclear radius, Radioactivity, units of radiation, Aplha, Beta and Gamma decay.

[8]

2. Nuclear forces: The Deutron, Nucleon- Nucleon scattering, p-p and n-n interactions, properties of nuclear force, phase shift analysis, Measurement of nuclear parameters, Mossbaur effect

[8]

3. Nuclear models: Liquid drop model, Fermi gas model, Shell model, Collective model, Compound nucleus and Statistical model

[8]

4. Nuclear reactions: Types of reactions and conservation laws, Reaction dynamics, Scattering and reaction cross sections, the Q of Nuclear reaction, Nuclear fission, Nuclear fusion

[8]

5. Elementary particle physics, Hadrons and leptons, their masses, spin parity decay structure, quarks and gluons, Charge conjugation, The CPT theorem and applications of symmetry arguments to particle reactions, symmetries, weak interactions

[**8**]

Text Books:

1. Krane K. S., Introductory Nuclear Physics, John Wiley, 1987.
2. Roy R. R. & Nigam B. P., Nuclear Physics; Theory and Experiments, 1st edition, New Age International, 1967.
3. Burcham W. E. & Jobes M., Nuclear and particle Physics, 2nd edition, John Wiley, 1995.

Reference Books:

1. Wong & Samuel S. M., Introductory Nuclear Physics, 2nd edition, John Wiley, 1999.
2. Cohen B. L., Concepts of Nuclear Physics, Tata McGraw-Hill edition, 2008.

NU 505 **Reactor Physics** **3-1-0-4**

Nuclear Fission; Delayed Neutrons; Reactor Types, Neutron Slowing-down and Thermalization, Critical Reactor; Multigroup Transport and Diffusion Equations for a Critical Reactor [12]

Reactor Calculations and Homogenization, Multigroup Constants, Group Constants in Resonance Region [8]

Perturbation & Variational Methods; Nodal and Finite-Element Transport Theory Methods; Integral Transport Theory [8]

Non-critical Reactors; Point Reactor Kinetics Equations; Solution of Kinetics Equations; Determination of Kinetics Parameters; Feedback; Xenon Oscillations; Fuel Depletion; Spatial Effects. [12]

Text Books:

1. P. F. Zweifel, *Reactor Physics*, McGraw-Hill, New York (1973).
2. Rudi J.J. Stamm'ler and M. J. Abbate, *Methods of Steady-State Reactor Physics in Nuclear Design*, Academic Pr (1983)
3. K. Sriram and Y. R. Waghmare, Introduction to Nuclear Science and Technology, South Asia Book (1990)
4. S.Garg, F. Ahmed and L.S.Kothari, *Physics of Nuclear Reactors*, Tata McGraw Hill, New Delhi (1986).

NU 520 Nuclear Power Plant Operation and Control 3-1-0-4

1. Applications of Reactor Physics for operation, Function of Delayed Neutron Monitoring System and method of identifying failed fuel, Neutron Flux Monitoring, Steady State operation of reactor [6]

2. Subcritical multiplication and reactor startup- Reactor operation without feedback- Analytic solution of reactor kinetics, Dynamic period , Reactor operation with feedback effects- Achievement of feedback effects, Shutdown margin [6]

3. Energy release and deposition, Heat generation parameters, Neutron flux distributions and power profiles in reactor cores, Power peaking factors, Heat generation in the structure, Reactor shutdown [6]

4. Temperature coefficients of reactivity, reactivity feedback, Loss-of-cooling accidents, Reactivity insertion accidents, Containment pressurization process, Response of a PWR pressurizer to load changes, Nuclear Power Plant control [6]

5. Review of fundamentals: Laplace transforms, frequency response and stability analysis, process identification, Advanced control techniques: Feed forward control, ratio control, cascade control, Computer process control: z-transforms, digital signal conditioning, system identification, stability analysis, classical control algorithms (PID etc.), Introduction to Model predictive and adaptive control schemes [8]

6. Sensors for pressure, flow, leak, level, temperature and composition, valve dynamics, neutronic instrumentation, reactor protection instrumentation, process instrumentation [8]

BOOKs

1. Lamarsh, John. Introduction to Nuclear Engineering. 3rd ed. Englewood Cliffs, NJ: Prentice Hall, 2001
2. Reactor Control Engineering by J M Harrer, Van Nostrand, (1963)
3. Control of Nuclear Reactors and Power Plants, by M. A. Schulz , McGraw-Hill Co., New York (1961)

Suggested Readings:

1. D R Coughanowr, Process Systems Analysis and Control, McGrawHill, 1991**.**
2. G Stephanopoulos, *Chemical Process Control*, Prentice Hall, 1985.
3. S Glasstone and A Sesonske, *Nuclear Reactor Engineering*, Vonostrand, 1981

NU- 522 Radiation Physics Instruments and Shielding 3-1-0-4

1. Atomic and Nuclear Structure, Natural and Artificial Radiation, Units and Measurement, Laws of Decay, Properties of Different Types of Radiation, Production of Radionuclides, Interactions of Charged Particles and Photons, Biological Effects of Ionizing Radiation, Radiation Protection Standards and Their Implementation [**10**]

2. Radiation detectors: Gas-filled ionization detectors-Ionization chambers, proportional counters and GM counters, Pulse height spectra and energy resolution, Semi-conductor detectors – Working of a p-n junction detector, partially and totally depleted detectors, surface barrier detectors, Lithium drifted Silicon detectors (Si(Li)), high-purity Germanium(HPGe) gamma detectors, Particle identification and time of flight technique, Scintillation detectors- scintillation mechanism in inorganic crystal scintillators and organic scintillators, Pulse height spectrum using a monoenergetic gamma ray source, Production and detection of neutrons-typical neutron sources, He proportional counters, fission counters. [**10**]

3. Radiation Instrumentation, Portable Survey Instruments, Use of radiation Survey Instruments, Scintillation Counters Radiation Shielding, Shielding Materials for Different Types of Radiation, Requirement for Shielding, Acceptable Radiation Levels for Various Areas, Merits and Demerits of Shielding Material, Criterion for Selecting Shielding Material [**10**]

4. Protection against Radiation Exposure, External radiation protection, Internal radiation protection, Calculation of Radiation Dose, Field, Man-rem and Duration of Work, Biological and Genetic Effects. [**10**]

Books:

1. Knoll G. F., *Radiation Detection and Measurement*, 3rd Edition, John Wiley and Sons (2000)
2. Martin A. A. & Samuel A. H., Introduction to Radiation Protection, 5th edition, Oxford university Press, (2006)
3. Cember H., Introduction to Health Physics, 3rd edition, McGraw-Hill, (1996)

Suggested Readings:

1. Turner J. E., Atoms, Radiation, and Radiation Protection, 3rd edition, Wiley, 1995.
2. Kapoor S. S. and Ramamurthy V. S., *Nuclear Radiation Detectors*, Wiley Eastern Limited, New Delhi (1986).

NU 523 Simulations in Nuclear Engineering 1-0-6-4

Physical simulation- advantage and limitations, Transport phenomena – concept of physical domain and computational domain- assumptions and limitations in numerical solutions [3]

Introduction to Finite difference Techniques, Finite Element Techniques, Finite Volume Techniques [3]

Basics about Monte Carlo Simulation, Algorithms for Monte carlo simulations [4]

Computational methods to analyze nuclear reactor systems described by various differentials, integral and integro-differential equations, Typical problem studies related with radionuclide decay chain, spatial dependence of radiation diffusion, transient heat diffusion [30]

Text Books:

1. Law, A. M. and Kelton, W. D., Simulation, Modeling & Analysis", 3rd Edition, Tata Mc Graw Hill , New Delhi-2003
2. Kenneth H. Huebner, Donald L. Dewhirst, Douglas E. Smith, Ted G. Byrom, "The Finite Element Method for Engineers".
3. Banks, J, Carson J. S. H. and Nelson, B. L. " Discrete Event System simulations", 2nd edition , PHI, New Jersey, 1999
4. Elmer E Lewis and warren F Miller Jr., Computational methods of Neutron Transport, Wiley – Inter science, 1993

Reference Books:

1. Hector Guerrero Excel Data Analysis: Modeling and Simulation.
2. James; Biersack, J.P.; Ziegler, M.D. Ziegler, "SRIM - The Stopping and Range of Ions in Matter"
3. COMSOL Multiphysics manuals

NU 524 **Physics and Technology of Nuclear Fusion** **3-1-0-4**

1. Plasma- the fourth state of matter, Debye shielding, Collective behavior, Plasma frequency, Plasma Sheath, Plasma in nature and Laboratory, Industrial applications of plasma **[6]**
2. Basic plasma processes, Ionization and Recombination, Coulomb collision, Radiations from plasmas, Plasma Transport processes **[5]**
3. Motion of charged particles in electric and magnetic fields, Adiabatic invariance, Introduction to kinetic theory, Boltzmann equation, Vlasov plasma model, Fluid model from kinetic model, MHD equation, Plasma equilibrium and stability analysis **[6]**
4. Waves and instabilities in plasma **[5]**
5. Plasma generation using DC, RF and microwave power, Plasma diagnostics- Langmuir probe and Spectroscopy **[5]**
6. Energy crisis and role of fusion, Lawson criterion, Ignition criterion and burn physics, Plasma confinement approaches, Open and closed magnetic systems, alternate confinement concepts **[7]**
7. Fusion technology: Plasma heating, First wall sputtering and cooling, Diverter, Blanket physics, Fusion materials **[6]**

Books:

1. Introduction to Plasma Physics, F. F. Chen, 2nd edition, Plenum Press, (1984)
2. Physics of High Temperature Plasma, G. Schmidt , 2nd edition Burlington, MA: Academic Press (1979)
3. Fusion Research, Thomas J Dolan, Pergamon Press, 1982

Suggested Readings:

4. Industrial Plasma Engineering, Vol.1, Principles, J. R. Roth, Institute of Physics, 2001
5. Fusion Plasma Physics, Weston M Stacy, Wiley-VCH, 2001
6. Plasma physics and Fusion Energy, J. P. Freidberg, Cambridge University Press, 2007

NU 525 **Nuclear Power Engineering – I** **3-1-0-4**

Principles of the conversion of nuclear energy to useful power, Over view of various types of nuclear power plants that have been designed, built and operated, Economics of nuclear vs. other types of power plants. Economics of nuclear power plants, accounting for capital costs, fuel costs and O&M (operations and maintenance) costs, as well as environmental aspects - sustainability, proliferation, safety [6]

Neutron induced reactions-Reaction mechanism-microscopic cross sections-variation of cross section with neutron energy-resonances-1/v law, Nuclear fission-fission products-prompt & delayed neutrons-energy balance per fission-mechanism of fission-fissile and fertile materials[6]

Introduction of Nuclear reactor plant design, Reactor Assembly, Coolant Channels, Moderator and Auxiliary Systems, Primary heat Transport and Auxiliaries, Special Safety Systems and Reactor Shield cooling systems, Detailed features of pressurized water reactor components, including steam generators, Pressurisers and chemical-shim control systems. [12]
Problems related to features of gas-cooled reactor cycles and components, and compare/contrast those features with those of conventional LWRs. Difference in neutron spectrum and fuel type between a fast reactor and a LWR affect fast reactor physics and performance. [8]
Advanced future types of nuclear power plants that are in the design or developing stages. Reactor designs of power plants, their energy conversion principles, cycles and load-following characteristicsCompare and contrast the relative merits of different types of power plants. [8]

Text Books:

1. S. Glasstone & A. Sessoske, Vol I & II, CBS Publishers & Distributors, New Delhi (2009)

2. M. M. El-Wakil, *Nuclear Energy Conversion,* American Nuclear Society; Revised edition (1982)

3. John R. Lamarsh and Anthony J. Baratta, *Introduction to Nuclear Engineering*, 3rd Edition, Prentice Hall (2001).

NU-526 Nuclear Power Engineering-II

Chain reaction-classical four factor formula-eta vs. energy curve-conversion & breeding ratios-thermal and fast reactors.- Neutron lifetime-Conversion & breeding though eta vs. energy curve, Macroscopic cross-section, mean free path, neutron flux ,neutron current, beam attenuation-dependence of flux on space, energy, direction and time- simplified model, Neutron balance equation-rigorous Boltzmann and simplified diffusion equation through Fick's law. Multiplying and non-multiplying media

[10]

Boiling Water Reactors : **[10]**
Reactor Internals and Their Functions, Emergency Safeguard Systems, Reactor Safety, Containment System, Spent Fuel Management

Pressurized Water Reactor: **[10]**
Reactor Internals and Their Functions, Emergency Safeguard System, Reactor Safety, Containment System, Spent Fuel Management

Application of Reactor Physics for Operation **[5]**
Design Basis of Reactor Regulation and Protection System **[5]**

NU 528 **Reactor Thermal Hydraulics** **3-1-0-4**

1. Introduction – Different Reactor Types, Introduction – Types of Fuels and Steam Generators [**3**]
2. Conservation Equations, Heat Transfer – Basics, Basic Modes of Heat Transfer, Conduction Heat Transfer Equations [**4**]
3. Thermal Conductivity, Capacity and Diffusivity 1-D Steady-State Heat Conduction without Heat Generation – Plane Wall, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Hollow Cylinder, Sphere, Series-Composite Slab, 1-D Steady-State Heat Conduction without Heat Generation Conduction Through Series-Parallel Composite Slab, Composite Cylinder, Heat Flow Through Composite Structures Critical Thickness of Insulation Variable Thermal Conductivity, Conduction Heat Transfer with Internal Heat Generation Conduction Heat Transfer in Multidimensional Systems [**11**]
4. Transient Heat Transfer, Convective Heat Transfer, Heat Transfer Coefficient with Phase Change Thermosyphon cooling, Dimensional Analysis, Radiation Heat Transfer, Pressure Drop Analysis, Pressure Drop Analysis [**10**]
5. Fuel, Clad and Coolant Temperatures, Sub channel Analysis of Rod Bundle Fuels, Sub channel Analysis of Rod Bundle Fuels, Hotspot and Hot channel Factors, Coolant Channel Orificing, Introduction to Two-phase Flow and Basic Relations, Two-phase Flow and Boiling, Reactor Thermal Hydraulics Critical Heat Flux [**12**]

Books:

1. El-Wakil, M. M., Nuclear Heat Transport, McGraw Hill Book Co., New York (1985)
2. Glasstone S. & Sessonske A., Nuclear Reactor Engineering, Vol I and Vol II CBS Publishers & Distributors, New Delhi (2009)
3. Lahey R. T. and Moody F. J., The Thermal-Hydraulics of Boiling Water Nuclear Reactor, 2nd Edition, (1993)

Suggested Readings:

1. Todreas N. E. and Kazimi M., Nuclear Systems Volume I: Thermal Hydraulics Fundamentals, Taylor & Francis Pubs. 2nd Edition, (1989)

List of Nuclear Laboratory Experiments

1. To verify inverse square law using an α- source (^{241}Am) and p-i-n detector
2. Attenuation of α-particles in air and determination of thickness of mylar foil using α-source
3. Characteristic and dead time of a GM Counter, counting statistics using a GM counter
4. To determine the linear and mass attenuation coefficient of lead/ aluminium/ copper using ^{60}Co source (micro- curie) with GM setup
5. Determination of half life of ^{116}In using a GM counter
6. Determination of end point energy of β – particles by absorption method using a GM counter
7. Determination of gamma energy by using a scintillation detector
8. Determination of energy resolution of a Si- surface barrier detector with an ^{241}Am alpha source
9. Determination of the photo peak efficiency of a NaI (Tl) scintillation detector as a function of gamma ray energy.
10. Study of γ-γ directional correlation using a ^{60}Co source and a pair of scintillation Detectors
11. Study of angular distribution of Compton scattered gamma rays using scintillation spectrometer and deduction of total scattering cross section.
12. Determination of rest mass of electron by measuring the energy of Compton scattered gamma rays using a scintillation spectrometer.
13. Measurement of resolving time of a fast-slow coincidence set-up and determination of true-to- chance ratio.
14. Measurement of energy of β-particles using a β–ray spectrometer

NU 532 **Plasma Laboratory** **0-0-2**

List of Plasma Experiments

1. Glow discharge characteristic- Paschen curve
2. Density and electron temperature measurement using Langmuir probes in the glow discharge.
3. To study the conditions of striations in Plasma
4. Plasma confinement studies using magnetic field
5. Dielectric barrier discharge- plasma generation at atmospheric pressure
6. Ion acoustic wave propagation in plasma

Third Semester

NU- 603 Fast Breeder Reactors and Nuclear Engineering Materials 2-1-0-3

1. Fast breeder Reactor : Breeding requirements and fast reactors, Fast reactor system features, Oxide fuels in fast reactors, Carbide/Nitride fuels in fast reactors, Metal fuel development (emphasis on U-Pu-Zr) **[4]**

2. Fast reactor physics, Four-group flux and adjoint flux distributions, Reactivity and stability, System response to accident initiators **[3]**

3. Fast reactor thermal hydraulics: sodium heat transfer, Natural circulation in fast reactors, SGTR mitigation. **[3]**

4. Nuclear Materials and Processing: Nuclear fuels: Metallic, ceramic (Oxides, MOX and Carbide fuels)- fabrication, properties and applications, Reactor Core Materials: Zircalloys, Zr-Nb alloy--- fabrication, properties and applications in reactors, Heavy water: production process, purification and applications **[10]**

5. Fuel Chemistry, Solid Fission Products, Swelling and Fission Gas Bubbles, Fission Gas Release, Corrosion in Nuclear Reactors, Plant Life Extension **[5]**

6. Nuclear waste; types - liquid waste - solid waste - aerial effulent -disposal of fuel or wastes; waste categories – low - level waste - intermediate level waste - high level waste. Basics about Nuclear Waste treatment, PUREX, Waste forms for long-term storage **[5]**

Books:

1. Waltar A. E. and Reynolds A.B., Fast Breeder Reactors, Pergamon Press, New York (1981).
2. Bendict M., Pigford T. and Levi H., Nuclear Chemical Engineering,
3. Wilson P. D., Nuclear Fuel Cycle: From ore to wastes, Oxford Press, 1996

Suggested Readings:

1. Callister D., Fundamentals of Material Science & Engineering, Wiley
2. Raghvan V., Physical Metallurgy: Principles & Practices,
3. Gupta C. K., Materials in Nuclear Applications

NU-605 Nuclear Plant Safety & Regulatory Frame work 2-1-0-3

1. Nuclear power plant safety requirements, Basic concepts in safety and reliability, Loss of coolant accident, Conceptual design of safety systems, Risk and reliability analysis of systems, Operational safety procedures, Manrem budgeting and control, Surface contamination and control

[15]

2. Role of Atomic Energy Regulatory Board (AERB) and Department of Atomic Energy (DAE), Legislation, rules and regulations for safe electricity generation, Legislation for regulation and its effective implementation for nuclear power plants, Role of Central and State Electricity Regulatory Commissions, Applicable AERB Safety Codes, Guides and Technical Specifications, Surveillance requirements and systems, Comparison with the regulatory framework of conventional industry

[15]

Books:

1. Lewis E. E., Nuclear Power Reactor Safety, E. E. Lewis, Wiley-Inter science publication, 1977
2. M. Rosen, Regulatory Codes and Guides issued by the International Atomic Energy Agency (IAEA), (1985)

Suggested Readings:

1. Mishra K. B., Reliability Analysis and Prediction, Elsevier Publications, (1992)
2. Haldar A. and Mahadevan S., Probability, Reliability and Statistical Methods, John Wiley & Sons (2000)
3. Codes and Guides issued by the Atomic Energy Regulatory Board) (AERB), (1982), Niyamak Bhavan, Anushaktinagar, India