

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING



**B.TECH (COMPUTER SCIENCE AND ENGINEERING-
SPECIALIZATION)**

FOUR YEAR PROGRAM

**CURRICULUM STRUCTURE & SYLLABI
(2023-2027 BATCH ONWARDS)**



**SCHOOL OF ENGINEERING AND TECHNOLOGY
MODY UNIVERSITY OF SCIENCE AND TECHNOLOGY
LAKSHMANGARH**

Curriculum Components

Component	Credits
1. University Core (4 Courses)	8
2. University Elective (2 Courses)	6
3. Basic Science (9 Courses)	24
4. Engineering Science (9 Courses)	21
5. Program Core (31 Courses)	69
6. Program Elective / MOOCs(6 Courses)	18
7. Project / Summer Internship Project (7 Courses)	17
8. Proficiency (Non-Graded) (6 Courses)	6
Total	163

First Year - Autumn Semester

Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage			
		L	T	P			CW	MTE	PBL	ETE
UC 23.101	Human Values & Professional Ethics	2	0	0	2	3	10	40		50
MA 23.101	Mathematics-I	3	1	0	4	3	10	40		50
PY 23.101	Engineering Physics	3	0	0	3	3	10	40		50
EE 23.101	Basics of Electrical Engineering	3	1	0	4	3	10	40		50
CS 23.101	Programming for problem solving	3	0	0	3	3	10	40		50
PY 23.111	Physics laboratory	0	0	2	1	2	20	20	20	40
EE 23.111	Electrical Laboratory	0	0	2	1	2	20	20	20	40
CS 23.111	Programming laboratory	0	0	4	2	2	20	20	20	40
ME 23.112	Mechanical Workshop	0	0	2	1	2	20	20	20	40
CY 23.102	Environmental Sciences	2	0	0	2	3	10	40		50
SF 101	Personal Grooming and Fine Dining(Non Grade)	0	0	2	1	2	50			50
	Total				23					

First Year -Spring Semester

First Year -Spring Semester										
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage			
		L	T	P			CW	MTE	PBL	ETE
UC 23.102	Pragmatic English Communication	2	0	0	2	3	10	40		50
MA 23.102	Mathematics-II	3	1	0	4	3	10	40		50
CY 23.101	Engineering Chemistry	3	0	0	3	3	10	40		50
ME 23.101	Applied Mechanics	3	1	0	4	3	10	40		50
EC 23.101	Basics of Electronics Engineering	3	1	0	4	3	10	40		50
CS 23.102	Object Oriented Programming Through C++	3	0	0	3	3	10	40		50
ME 23.111	Computer Aided Engineering drawing	0	0	4	2	2	20	20	20	40
CY 23.111	Chemistry Laboratory	0	0	2	1	2	20	20	20	40
EC 23.111	Electronics Laboratory	0	0	2	1	2	20	20	20	40
CS 23.112	Object Oriented Programming Laboratory	0	0	2	1	2	20	20	20	40
SF 102	Social Grooming, Home & Decor and Business Communication (Non Grade)	0	0	2	1	2	50			50
	Total				25					

Second Year - Autumn Semester										
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage			
		L	T	P			CW	MTE	PBL	ETE
UC 23.201	Introduction to Management & Leadership	2	0	0	2	3	10	40		50
MA 23.201	Mathematics-III	3	1	0	4	3	10	40		50
CS 23.201	Discrete Mathematics	3	1	0	4	3	10	40		50
CS 23.203	Data Structures	3	0	0	3	3	10	40		50
CS23.205	General Purpose Programming	3	0	0	3	3	10	40		50
EC 23.202	Digital Electronics	3	0	0	3	3	10	40		50
CS 23.253	Data Structures Laboratory	0	0	2	1	2	20	20	20	40
CS 23.255	General Purpose Programming laboratory	0	0	2	1	2	20	20	20	40
EC 23.224	Digital Electronics Laboratory	0	0	2	1	2	20	20	20	40
SF 201	Personal Grooming Fine Dining and Home Safety (Non Grade)	0	0	2	1	2	50			50
					22					

Second Year -Spring Semester										
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage			
		L	T	P			CW	MTE	PBL	ETE
UC 23.202	Entrepreneurship Development	2	0	0	2	2	10	40		50
UE	University Elective-I	3	0	0	3	3	20			80
CS23.204	Database Management Systems	3	0	0	3	3	10	40		50
CS 23.202	Advanced Programming	3	0	0	3	3	10	40		50
CS23.206	Theory of Computation	3	0	0	3	3	10	40		50
CS23.208	Computer Organization and Architecture	3	0	0	3	3	10	40		50
CS 23.211	Software Engineering	3	0	0	3	3	10	40		50
CS23.252	Advanced Programming Laboratory	0	0	2	1	2	20	20	20	40
CS23.254	Database Management Systems Laboratory	0	0	2	1	2	20	20	20	40
SF 202	Social Grooming and Professional Skills(Non Grade)	0	0	2	1	2	50			50
					22					

Third Year - Autumn Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	ETE
RM 23.101	Research Methodology	2	0	0	2	3	10	40	50
CS23.301	Design and Analysis of Algorithms	3	1	0	4	3	10	40	50
CS23.303	Operating System	3	0	0	3	3	10	40	50
CS23.307	Cyber Security	3	0	0	3	3	10	40	50
	Program Elective 1*	0	0	0	3		Based on NPTEL exam		
	Specialization	3	0	0	3	3	10	40	50
CS23.351	Design and Analysis of Algorithms Laboratory	0	0	2	1	2	20	40	40
CS23.357	Cyber Security Laboratory	0	0	2	1	2	20	40	40
CS23.353	Operating System Laboratory	0	0	2	1	2	20	40	40
CS 23.373	Summer Internship-I**	0	0	0	2	-	100		
CS 23.371	Project-1	0	0	4	2	2	-	50	50
SF 301	Civility and Ethics Business and Professional Grooming, Corporate Dinning Etiquettes (Non Grade)	0	0	2	1	2	50	0	50
					25				

Third Year -Spring Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	ETE
CS23.302	Artificial Intelligence and Machine Learning	3	0	0	3	3	10	40	50
CS23.304	Compiler Design	3	0	0	3	3	10	40	50
CS23.306	Computer Networks	3	0	0	3	3	10	40	50
CS 23.308	Digital Image Processing and Computer Graphics	3	0	0	3	3	10	40	50
	Specialization	3	0	0	3	3	10	40	50
CS 23.392	Colloquium	0	0	2	1	-	100		
CS 23.354	Compiler Design Laboratory	0	0	2	1	2	20	40	40
CS 23.356	Computer Networks Laboratory	0	0	2	1	2	20	40	40
CS 23.358	Digital Image Processing and Computer Graphics Laboratory	0	0	2	1	2	20	40	40
CS 23.372	Project-2	0	0	4	2	2	-	50	50
SF 302	Soft Skills and Interview Skills (Non Grade)	0	0	2	1	2	50	0	50
					21				

*The course may be taken through MOOC. NPTEL/SWAYAM/Coursera will be the authorized platform for this MOOC course. Minimum 8 weeks course is required for a 3 credit. After successful completion of these MOOCs courses the students, shall, provide their successful completion NPTEL status/certificates to the University (COE) through HOD/NPTEL coordinator.

Fourth Year - Autumn Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	ETE
UE	University Elective-II	3	0	0	3	3	20		80
	Program elective-2	3	0	0	3	3	10	40	50
	Specialization	3	0	0	3	3	10	40	50
CS 23.473	Summer Internship-II**	0	0	0	2	-	100		
CS 23.471	Capstone Project-1	0	0	4	2		100		
					13				

Fourth Year -Spring Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	ETE
	Program elective-3	3	0	0	3	3	10	40	50
	Program elective-4	3	0	0	3	3	10	40	50
CS23.472	Capstone Project-2	0	0	12	6			50	50
	Total				12				

** Summer Internship-I must be performed in an Industry between summer vacation of end of Second Year and end of Third Year.

Credit Distribution across all Components								
Semester	UC	UE	BS	ES	PC	PE	Proj/SIP	Total
First	2		10	6	5			23
Second	2		8	11	4			25
Third	2		4	4	12			22
Fourth	2	3			17			22
Fifth			2		13	6	4	25
Sixth					18		3	21
Seventh		3				6	4	13
Eighth						6	6	12
Total	8	6	24	21	69	18	17	163

UC	University Core
UE	University Elective
BS	Basic Science
ES	Engineering Science
PC	Program Core
PE	Program Elective / MOOC
Proj/SIP	Project/Summer Internship

Program Elective 1	
	MOOC

Program Elective 2	
CS 23.412	Big Data and Unstructured Databases
CS 23.413	Distributed Databases
CS 23.462	Mobile App Development (Infosys)

Program Elective 3	
CS 23.493	Foundations and Applications of IoT
CS 23.495	Principles and Practices of Secure Computing
CS 23.463	Agile Software Development (Infosys)

Program Elective 4	
CS 23.494	Software Defined Networking
CS 23.464	Business Intelligence and its application (Infosys)
CS 23.465	Machine Learning using R (Infosys)

B.Tech. in Computer Science & Engineering -Specialization

B.Tech. in Computer Science & Engineering (Specialization in BlockChain Technology)

Course Code	Course name
CS 23.381	Block Chain and Crypto Currency
CS 23.391	Blockchain Components and Architecture
CS 23.482	Cyber Security with Blockchain

B.Tech. in Computer Science and Engineering (Specializing in Business System)

Course Code	Course name
CS 23.382	E-Customer Relationship Management
CS 23.390	Digital Marketing and Trend Analysis
CS 23.483	Enterprise Resource Planning

B.Tech in Computer Science & Engineering (Specialization in Data Science)

Course Code	Course name
CS 23.383	Introduction to Data Science
CS23.310	Predictive Modeling Analysis
CS 23.484	Big Data Analysis

B.Tech in Computer Science & Engineering (Specialization in Internet of Things)

Course Code	Course name
CS 23.384	Introduction to IOT
CS 23.394	Wireless Sensor Networks & IoT Standards
CS 23.485	IoT for Industries

B.Tech in Computer Science & Engineering (Specialization in Education Technology)

Course Code	Course name
CS 23.385	IT Service Management (ITSM)
CS 23.395	IT Infrastructure Management
CS 23.483	Enterprise Resource Planning

B.Tech in Computer Science & Engineering (Specialization in E-Commerce Technology)

Course Code	Course name
CS 23.382	E-Customer Relationship Management
CS 23.390	Digital Marketing and Trend Analysis
CS 23.483	Enterprise Resource Planning

B.Tech in Computer Science & Engineering (Specialization in Artificial Intelligence and Deep Learning)

Course Code	Course name
CS 23.387	Artificial Neural Networks
CS 23.397	Deep Learning
CS 23.488	Natural Language Processing

B.Tech.Computer Science & Engineering (Specialization in Edge Computing)

Course Code	Course name
CS 23.388	Microprocessors and Embedded Systems
CS 23.398	Cloud Architecture and Deployment of Models
CS 23.489	Edge Computing

B.Tech. Computer Science & Engineering (Specialization in Health Informatics)

Course Code	Course name
CS 23.387	Artificial Neural Networks
CS 23.399	Healthcare Data Analytics
CS 23.474	App of AI in HealthCare

B.Tech.Computer Science & Engineering (Specialization in Cloud Computing and Automation)

Course Code	Course name
CS 23.361	Cloud Architecture and Services
CS 23.374	Cloud Security Management
CS 23.475	IoT on Cloud

B.Tech. Computer Science & Engineering (Specialization in Bioinformatics)

Course Code	Course name
CS 23.362	Analytical Bioinformatics
CS 23.375	Molecular Modelling and Drug Design
CS 23.479	Molecular Evolution and Phylogeny

B.Tech. Computer Science & Engineering (Specialization in Information Security)

Course Code	Course name
CS 23.376	Network Security and Cryptography
CS23.374	Privacy and Security in IoT
CS 23.477	Blockchain for Cyber Security

B.Tech. Computer Science & Engineering (Cyber Security and Digital Forensics)

Course Code	Course name
CS 23.376	Network Security and Cryptography
CS23.374	Privacy and Security in IoT
CS 23.499	Digital Forensics and Malware Analysis

B.Tech. Computer Science & Engineering (Specialization in Robotics)

Course Code	Course name
CS 23.340	Elements of Robotics and Kinematics of Robot
CS 23.341	Human-Robot Interaction
CS 23.441	Robotic Process Automation

B.Tech. Computer Science & Engineering (Specialization in Gaming Technology)

Course Code	Course name
CS 23.342	Virtual and Augmented Reality
CS 23.343	Designing Human Computer Interfaces
CS 23.443	Game Design & Asset Creation

CS 23.387

Artificial neural networks

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Mathematics

Objective(s):

- To understand the biological neural network and to model equivalent neuron models.
- To understand the architecture, learning algorithms
- To know the issues of various feed forward and feedback neural networks.
- To explore the Neuro dynamic models for various problems.

1. **Introduction:** A Neural Network, Human Brain, Models of a Neuron, Neural Networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks Learning Process: Error Correction Learning, Memory Based Learning, Hebbian Learning, Competitive, Boltzmann Learning, Memory, Adaption, Statistical Nature of the Learning Process. [8]
2. **Single Layer Perceptron:** Adaptive Filtering Problem, Unconstrained Organization Techniques, Perceptron –Convergence Theorem, Relation Between Perceptron and Bayes Classifier for a Gaussian Environment Multilayer Perceptron: Back Propagation Algorithm XOR Problem, Heuristics, Output Representation and Decision Rule, Computer Experiment, Feature Detection. [8]
3. **Back Propagation:** Back Propagation and Differentiation, Hessian Matrix, Generalization, Cross Validation, Network Pruning Techniques, Virtues and Limitations of Back Propagation Learning, Accelerated Convergence, Supervised Learning [8]
4. **Self-Organization Maps (SOM):** Basic Feature Mapping Models, Self-Organization Map, SOM Algorithm, Properties of Feature Map, Computer Simulations, Learning Vector Quantization, Adaptive Patter Classification [8]
5. **Neuro Dynamics:** Dynamical Systems, Stability of Equilibrium States, Attractors, Neuro Dynamical Models, Manipulation of Attractors as a Recurrent Network Paradigm, Hopfield Models – Hopfield Models, restricted Boltzmann machine. [8]

Outcome(s): Upon completing this course, the student will be able to

- Understand the similarity of Biological networks and Neural networks
- Perform the training of neural networks using various learning rules.
- Understanding the concepts of forward and backward propagations.
- Understand and Construct the Hopfield models.

Text Books:

1. Neural Networks a Comprehensive Foundations, Simon S Haykin, PHI Ed.,.
2. Introduction to Artificial Neural Systems Jacek M. Zurada, JAICO Publishing House Ed. 2006.

Reference Books:

1. Neural Networks in Computer Inteligance, Li Min Fu TMH 2003
2. Neural Networks -James A Freeman David M S Kapura Pearson Ed., 2004.

Artificial Neural Networks – B. Vegnanarayana Prentice Hall of India P Ltd 2005

CS 23.397

Deep Learning

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Artificial Neural Networks

Objective(s):

- To introduce the foundations of Artificial Neural Networks
- To acquire the knowledge on Deep Learning Concepts
- To learn various types of Artificial Neural Networks
- To gain knowledge to apply optimization strategies

1. **Artificial Neural Networks Introduction:** Basic models of ANN, important terminologies, Supervised Learning Networks, Perceptron Networks, Adaptive Linear Neuron, Back-propagation Network. Associative Memory Networks. Training Algorithms for pattern association, BAM and Hopfield Networks. [8]
2. **Unsupervised Learning Network:** Introduction, Fixed Weight Competitive Nets, Maxnet, Hamming Network, Kohonen Self-Organizing Feature Maps, Learning Vector Quantization, Counter Propagation Networks, Adaptive Resonance Theory Networks. Special Networks-Introduction to various networks. [8]
3. **Introduction to Deep Learning:** Historical Trends in Deep learning, Deep Feed - forward networks, Gradient-Based learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms [8]
4. **Regularization for Deep Learning:** Parameter norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Dataset Augmentation, Noise Robustness, Semi-Supervised learning, Multi-task learning, Early Stopping, Parameter Typing and Parameter Sharing, Sparse Representations, Bagging and other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, tangent Prop and Manifold, Tangent Classifier [8]
5. **Optimization for Train Deep Models:** Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates, Approximate Second Order Methods, Optimization Strategies and Meta-Algorithms Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing [8]

Outcome(s): Upon completing this course, the student will be able to

- Ability to understand the concepts of Neural Networks
- Ability to select the Learning Networks in modeling real world systems
- Ability to use an efficient algorithm for Deep Models
- Ability to apply optimization strategies for large scale applications

Text Books:

1. Deep Learning: An MIT Press Book By Ian Goodfellow and Yoshua Bengio and Aaron Courville
2. Neural Networks and Learning Machines, Simon Haykin, 3rd Edition, Pearson

Prentice Hall.

**Reference
Books:**

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, “ Deep Learning”, MIT Press, 2017.
2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
3. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.
4. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012. 5Ethem Alpaydin,"Introduction to Machine Learning”, MIT Press, Prentice Hall of India, Third Edition 2014.

CS 23.488

Natural language processing

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Artificial Neural Networks

Objective(s):

- To introduce the foundations of Natural Language Processing
- To gain knowledge of various language models
- To acquire the knowledge on problems and solutions of NLP and their relation to linguistics and statistics.

1. **Natural Language Processing Introduction: Basics of NLP**, important terminologies, Structure of Words: Words and Their Components, Issues and Challenges, Morphological Models, Finding the Structure of Documents: Introduction, Methods, Complexity of the Approaches, Performances of the Approaches [8]
2. **Syntax Analysis:** Parsing Natural Language: Dependency grammar, A Data-Driven Approach to Syntax, Representation of Syntactic Structure, Parsing Algorithms, Models for Ambiguity Resolution in Parsing, Multilingual Issues [8]
3. **Semantic Parsing:** Introduction, Semantic Interpretation, System Paradigms, Word Sense Systems, Distributional Semantics, Word embedding, Lexical Semantics [8]
4. **Discourse Processing:** Cohesion, Reference Resolution, Discourse Cohesion and Structure Language Modeling: Introduction, N-Gram Models, Language Model Evaluation, Parameter Estimation, Language Model Adaptation, Types of Language Models, Language-Specific Modeling Problems, Multilingual and Crosslingual Language Modeling [8]
5. **Topic Models:** Introduction, Latent Dirichlet Allocation (LDA), Gibbs sampling for LDA and its applications, LDA Variants, Entity Linking, Sentiment Analysis [8]

Outcome(s): Upon completing this course, the student will be able to

- Understand and carry out proper experimental methodology for training and evaluating empirical NLP systems
- Able to design, implement, and analyze NLP algorithms
- Able to design different language modeling Techniques

Text Books:

1. Multilingual natural Language Processing Applications: From Theory to Practice – Daniel M. Bikel and Imed Zitouni, Pearson Publication
2. Natural Language Processing and Information Retrieval: Tanvier Siddiqui, U.S. Tiwary.

Reference Books:

1. Speech and Natural Language Processing – Daniel Jurafsky & James H Martin, Pearson Publications

CS 23.362

Analytical Bioinformatics

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): NIL

Objective(s):

- Adapt basic knowledge on various techniques and areas of applications in bioinformatics.
- Analyze common problem in bioinformatics, alignment techniques, ethical issues, public data sources, and evolutionary modeling.
- Discover the practical use of tools for specific bioinformatics areas

1. **Introduction to bioinformatics:** Scope and applications of bioinformatics, Alignment of pairs of sequences; Introduction- Definition of sequence alignment, Methods - Dot matrix sequence comparison [4]
2. **Pairwise sequence alignment:** Dynamic programming algorithm for sequence alignment – Global Alignment: Needleman Wunsch, Local Alignment: Smith-Waterman, Gap penalty, Assessing the significance of an alignment [4]
3. **Multiple sequence alignment:** Dynamic programming, progressive methods, Iterative methods, MSA using CLUSTAL W, PILEUP and CLUSTAL X, purpose and applications of multiple sequence alignment [8]
4. **Scoring matrices:** Similarity searches - PAM and BLOSUM matrix, Dayhoff mutation matrix, construction of PAM and BLOSUM matrix. Differences between PAM & BLOSUM [8]
5. **Database search methods:** Database searching for similar sequences. Sequence similarity search, FASTA sequence database similarity search, BLAST sequence database similarity search, other methods of comparing database of sequences and patterns. [8]
6. **Neural Networks:** The Theory - Introduction – Priors & likelihoods - Learning algorithms: backpropagation - Neural Networks: Applications - Sequence encoding & output interpretation- Sequence correlations & neural networks Hidden Markov Models Learning algorithms - Applications of HMMs: general aspects - Protein applications [8]

Outcome(s): At the end of the course the student should be able to

- Apply knowledge of bioinformatics in a practical project.
- Develop the ability for critical assessment of scientific research publications in bioinformatics.
- Build an understanding of the research process in general, such as research methods, scientific writing, and research ethics.
- Evaluate the main databases at the NCBI and EBI resources
- Compare the databases, tools, repositories and be able to use each one to extract specific information
- Demonstrate the selected tools at NCBI and EBI to run simple analyses on genomic sequences.

Text Books:

1. Bioinformatics: Sequence and Genome Analysis David W.Mount, David Mount
2. Bioinformatics: the Machine Learning Approach – Pierre Baldi and Søren Brunak
Publisher: MIT Press.

Reference

Books:

1. Hooman H Rashidi, Lukas K Buehler. Bioinformatics Basics - 2000.
2. Per Jambeck, Cynthia Gibas. Developing BioinformaticsComputer Skills. Computers – 2001.
3. Bioinformatics Methods and Protocols: Methods and Protocols. edited by Stephen Misener, Stephen A Krawetz - Science – 1999.

CS 23.376

Molecular Modeling and Drug Design

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Analytical Bioinformatics

Objective(s): To understand the theoretical background of molecular mechanics force fields and basic background of drug designing concept 2. To understand their application using tools and software's

1. **Quantum mechanics & concepts in molecular modeling:** Introduction – coordinate systems, potential energy surfaces. Introduction to quantum mechanics: Schrodinger wave equation, Born-Oppenheimer approximation. Introduction to computer hardware and software [4]
2. **Biomolecules:** Overview of Biomolecules - protein structures and classifications, Protein folding and Ramachandran plot [4]
3. **Force Fields:** The simple molecular mechanics force field and general features; bond stretching; angle bending; torsional terms; non-bonded interactions; electrostatic interactions; van der Waals interactions; steepest descent method, conjugate gradient method [8]
4. **Analysis and Properties:** Geometry optimization, Vibrational frequencies: potential energy surface, harmonicvs. fundamental frequencies, zero-point vibrational energies (ZPVE's) [8]
5. **Molecular Structures & Modeling:** Protein and nucleic acid structures, the molecular basis, stability, molecular complexes. Steps in homology modeling, tools, databases, side chain modeling, loop modeling. Predicting Protein Structures by Threading [8]
6. **Drug design:** Deriving and using 3D pharmacophores. Structure-based methods to identify lead compounds: finding lead compounds by searching 3D databases; de novo ligand design, Docking - molecular modeling in drug design – structure based drug design, AUTODOCK and HEX. Visualization tools for molecular systems [8]

Outcome(s): At the end of the course the student should be able to

- Understand molecular mechanics force fields and concept of drug designs computationally
- Learn the Quantum mechanics & concepts in molecular modeling
- Use simple molecular mechanics force field and general features
- Apply Molecular Structures & Modeling for biological databases

Text Books: 1. Andrew R. Leach, Molecular Modeling, Principles & Applications, 2nd Edition (Dorling Kindersley (india) (P)Ltd with pearson education Ltd, UK, 2010

Reference Books: 1. R.K. Prasad, Quantum Chemistry, 4th Edition (New Age international (P) Ltd, ND, 2010)
2. Alan Hinchliffe, Molecular Modelling for Beginners, 2 nd Edition, John-Wiley, 2010
3. S. C. Rastogi, Namita Mendiratta, Parag Rastogi, Bioinformatics: Methods And Applications: (Genomics, Proteomics and Drug Discovery), 3 rd Edition, PHI learning (P) Ltd, 2010

CS 23.479

Molecular Evolution and Phylogeny

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Molecular Modeling and Drug Design

Objective(s):

- To demonstrate the basic models for comparative genome research including the analysis of observed DNA base and amino acid mutation patterns.
- To apply the use of mathematical models in phylogenetic reconstruction and statistical methods for the comparison of different models.
- To reconstruct and infer the biological data in a meaningful way complimentary to biological research.

1. **Molecular Archeology:** Introduction to molecular evolution, driving forces in evolution, [4]
evolutionary changes in nucleotide sequences.
2. **Phylogenetic Trees:** Molecular phylogenetics, phylogenetic trees, trees and distances. [4]
3. **Phylogeny Algorithms :** Measuring genetic change, Genetic distance-Measuring [8]
evolutionary change on tree- kinds of data.
4. **Methods of reconstruction:** Distance matrix methods, Maximum parsimony methods, [8]
Maximum likelihood methods
5. **Evolutionary Analysis:** Models of Molecular evolution, Functional constraints and the [8]
rate of substitution patterns of codon usage and base composition.
6. **Molecular Evolution theory :** Evolutionary clocks, Neutral theory, Genetic variation [8]
within species, Natural selection. Applications of molecular phylogenetics : Organismal
phylogeny, what does evolutionary medicine to offer, host parasite co-specification.

Outcome(s): At the end of this course students will be able to:

- Analyze the present the mathematical models in the study of molecular evolution and to illustrate how to use them in actual data analysis.
- . Solve the biological processes that shape evolution at the molecular level and the improved ability to infer from sequence data the story of the evolution of life on earth.
- Explore and analyze nucleotide and protein data and infer evolutionary relationships
- Develop skills to challenge the upcoming NGS big-data content analysis using tree based approach.
- Identify unique data from biology and perform pattern search and bridge ontological information in research.

Text Books: 1. Lindell Bromham, An Introduction to Molecular Evolution and Phylogenetics, 2016, 2nd Edition, Oxford University press, UK

Reference Books: 1. Graur Dan, Molecular and Genome Evolution, 2016, Sinauer Associates Inc. USA
2. Alexei J. Drummond, Remco R. Bouckaert, Bayesian Evolutionary Analysis with BEAST, 2015, Cambridge University Press, England

CS 23.361

Cloud Architecture and Services

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Operating system, Computer Networks

Objective(s):

- To understand the concepts of cloud computing
- To understand the concepts of the Concepts of Virtualization and the Cloud delivery and Deployment Models
- To understand the concepts of cloud computing security architectural issues, Identity management and Autonomic security.

1. **Cloud Computing fundamentals:** Essential characteristics, Architectural Influences, Technological Influences, and Operational Influences
2. **Cloud Computing Architecture:** Cloud Delivery models, The SPI Framework, Cloud Software as a Service (SaaS) , Cloud Platform as a Service(PaaS), Cloud Infrastructure as a Service(IaaS), Cloud deployment models, Public Clouds, Community Clouds, Hybrid Clouds, Alternative Deployment models, Expected benefits.
3. **Cloud Computing Software Security fundamentals:** Cloud Information Security Objectives, Confidentiality, Integrity, Availability, Cloud Security Services, Relevant Cloud Security Design Principles, Secure Cloud Software Requirements, Secure Development practices, Approaches to Cloud Software Requirement Engineering, Cloud Security Policy Implementation
4. **Cloud Computing Risk Issues:** The CIA Traid, Privacy and Compliance Risks, Threats to Infrastructure, Data and Access Control, Cloud Access Control Issues, Cloud Service Provider Risks. Cloud Computing Security challenges: Security Policy Implementation, Policy Types, and Computer Security Incident Response Team (CSIRT).
5. **Cloud Computing Security Architecture:** Architectural Considerations, General Issues, Trusted Cloud Computing, Secure Execution environments and Communications, Micro architectures, Identity Management and Access Control, Autonomic Security.

Outcome(s): By the completion of the course, the students are able to:

- Articulate the main concepts, key technologies, strengths, limitations of cloud computing and the possible applications for state-of-the-art cloud computing.
- Identify the architecture and infrastructure of cloud computing, including cloud delivery and deployment models.
- Analyze appropriate cloud computing solutions and recommendations according to the applications used.

Text Books:

1. Ronald L. Krutz, Russell Dean Vines, “Cloud Security A comprehensive Guide to secure Cloud Computing” Wiley

Reference Books:

1. John W. itinghouse james F.Ransome, “Cloud Computing Implementation, Management and Security” , CRC Press.
2. Borko Furht. Armando Escalante, “Handbook of Cloud Computing”, Springer
3. Charles Badcock, “Cloud Revolution” , TMH

CS 23.374

Cloud Security Management

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s):

Cloud Architecture and Services

Objective(s):

- To understand the architecture of cloud
- To understand the cloud securities

1. **Fundamentals of Cloud Computing and Architectural Characteristics:** Cloud Benefits, Business scenarios, Cloud Computing Evolution, cloud vocabulary, Essential Characteristics of Cloud Computing, Cloud deployment models, Cloud Service Models, Multi- Tenancy, Approaches to create a barrier between the Tenants, cloud computing vendors, Cloud Computing threats, Cloud Reference Model, The Cloud Cube Model, Security for Cloud Computing, How Security Gets Integrated. [8]
2. **Compliance and Audit:** Cloud customer responsibilities, Compliance and Audit Security Recommendations. Portability and Interoperability: Changing providers reasons, Changing providers expectations, Recommendations all cloud solutions, IaaS Cloud Solutions, PaaS Cloud Solutions, SaaS Cloud Solutions. [8]
3. **Cloud Security:** Traditional Security, Business Continuity, Disaster Recovery, Risk of insider abuse, Security baseline, Customers actions, Contract, Documentation, Recovery Time Objectives (RTOs), Customers responsibility, Vendor Security Process (VSP). [6]
4. **Data Center Operations:** Data Center Operations, Security challenge, Implement Five Principal Characteristics of Cloud Computing, Data center Security Recommendations. Encryption and Key Management: Encryption for Confidentiality and Integrity, Encrypting data at rest, Key Management Lifecycle, Cloud Encryption Standards, Recommendations. [8]
5. **Identity and Access Management:** Identity and Access Management in the cloud, Identity and Access Management functions, Identity and Access Management (IAM) Model, Identity Federation, Identity Provisioning Recommendations, Authentication for SaaS and Paas customers, Authentication for IaaS customers, Introducing Identity Services, Enterprise Architecture with IDaaS , IDaaS Security Recommendations. Virtualization: Hardware Virtualization, Software Virtualization, Memory Virtualization, Storage Virtualization, Data Virtualization, Network Virtualization, Virtualization Security Recommendations. [10]

Outcome(s):

Should be able to provide cloud solutions
Should be able to provide security to cloud
Provide access management to the cloud

Text Books:

1. Tim Mather, Subra Kumaraswamy, Shahed Latif "Cloud Security and Privacy" (September 2009) Publisher(s): O'Reilly Media, Inc. ISBN: 9781449379513
2. Ronald L. Krutz , Russell Dean Vines, Cloud Security: A Comprehensive Guide to Secure Cloud computing, Wiley 2010

Reference Books:

1. Ben Halpert , Auditing Cloud Computing: A Security and Privacy Guide: , John Wiley Sons, 2011.
2. Ianlim, E.Coleen Coolidge, Paul Hourani, Securing Cloud and Mobility: A Practitioners Guide, Auerbach Publications, Feb 2013.
3. Pethuru Raj, Cloud Enterprise Architecture, CRC Press, 2013

CS 23.475

IoT on Cloud

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s):

Objective(s):

- Introduction to fundamentals of IoT
- Application of IoT in various domain
- Hardware and software that enable IoT
- Upload data on cloud for further analysis and visualization
- Access the IoT data from cloud using mobile computing devices.
- Learn to use of tools such as Apache servers, WebAPI,
- Design product for automation various domain such as for Home, Industry.

1. **Introduction to IoT:** Things in IoT, IoT protocols, IoT communication model, IoT communication APIs, IoT enabling Technologies. [4]
2. **Application of IoT:** Home, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health, Life style, M2M – Machine to Machine, Difference between IoT and M2M. Industry 4.0 concepts - cyber physical system, Security aspects in IoT [4]
3. **IOT Supported hardware :**Introduction to wireless sensor network, RFID, Sensors, Overview of IoT supported Hardware platforms (Any two hardware can be handled) Raspberry pi, Arduino and Intel Galileo boards, Beaglebone, ARM Cortex Processors. [8]
4. **Communication in IOT:** Interface protocol , Serial, SPI, I2C, 6LoWPAN, 802.11wifi, 802.15 Bluetooth, 802.15.4 ZigBee, RTLS, GPS, CoAP – Constrained application protocol, RPL – routing protocol for lossy networks - MQTT. [8]
5. **IOT Physical Servers and cloud :**Data retrieval from cloud – data storage to cloud – data dissemination from sensors of IoT – Cloud Access to Sensors with IBM Bluemix, Juju Framework, Google Cloud Engine – data visualization [8]
6. **IoT on Cloud DevOps** – Contained based software - Designing a REST ful Web API – PubNub API for IoT to cloud – mobile device as IoT – Mobile cloud access IoT Operating Systems Introduction to Contiki OS and RIOT OS – Proto threads – tasking – Simple IoT application with border router, implementation of CoAP in Contiki OS. [8]

Outcome(s):

By the completion of the course, the students are able to:

- Have a clear understanding of the subject related concepts and of contemporary issues
- Have design thinking capability
- Have problem solving ability- solving social issues and engineering problems

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A hands-on Approach, University Press, 2015 (1 st edition)

Reference Books:

1. Adrian McEwen & Hakim Cassimally, Designing the Internet of Things by Nov 2013, (1st edition)
2. Claire Rowland, Elizabeth Goodman, Martin Charlier, Ann Light, Algreed Lui Designing Connected Products: UX for the consumer internet of things, O'Reilly, (1 st edition).
3. Rethinking the Internet of things: A Scalable Approach to Connecting5. Learning Internet of Things by Peter Waher, Packt Publishing, 2015
4. Designing the Internet of Things, by Adrian Mcewen, Hakin Cassimally, Wiley India Private Limited
5. Cloud Computing, Thomas Erl, Pearson Education, 2014
6. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, William Stallings, Addison-Wesley Professional; 1 edition

CS 23.388

Microprocessor and Embedded systems

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s):

Mathematics

Objective(s):

- To understand the concepts of Microprocessor.
- To understand the basic assembly language Programming concepts and its applications
- To understand the concepts of Embedded systems

1. **The 8051 Architecture** : Introduction, 8051 Micro controller Hardware, Input/Output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/Output, Interrupts. [4]
2. **Basic Assembly Language Programming Concepts** : The Assembly Language Programming Process, Programming Tools and Techniques, Programming the 8051. Data Transfer and Logical Instructions. Arithmetic Operations, Decimal Arithmetic. Jump and Call Instructions, Further Details on Interrupts. **Applications** : Interfacing with Keyboards, Displays, D/A and A/D Conversions, Multiple Interrupts, Serial Data Communication. [12]
3. **Introduction to Real – Time Operating Systems** : Tasks and Task States, Tasks and Data, Semaphores, and Shared Data; Message Queues, Mailboxes and Pipes, Timer Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment, **Basic Design Using a Real-Time Operating System** : Principles, Semaphores and Queues, Hard Real-Time Scheduling Considerations, Saving Memory and Power [12]
4. **Embedded Computing**: Introduction, Complex Systems and Microprocessor, The Embedded System Design Process, Formalisms for System Design, Design Examples. [4]
5. **Introduction to advanced architectures** : ARM and SHARC, Processor and memory organization and Instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus; Internet-Enabled Systems, Design Example-Elevator Controller [8]

Outcome(s):

Upon completing this course, the student will be able to

- Ability to the concepts of Assembly language to solve various problems
- Ability to the concepts of advanced architectures
- Ability to concepts of embedded system to solve real time problems

Text Books:

1. Computers as Components-principles of Embedded computer system design, Wayne Wolf, Elsevier.
2. The 8051 Microcontroller, Third Edition, Kenneth J.Ayala, Thomson.

Reference Books:

1. Embedding system building blocks, Labrosse, via CMP publishers.
2. Embedded Systems, Raj Kamal, TMH.
3. Micro Controllers, Ajay V Deshmukhi, TMH.
4. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley.
5. Microcontrollers, Raj kamal, Pearson Education.
6. An Embedded Software Primer, David E. Simon, Pearson Education.

CS 23.398

Cloud Architecture and Deployment of Models

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Microprocessor and Embedded systems

Objective(s):

- To introduce the foundations of cloud computing
- To acquire the knowledge distributed system models.
 - To learn various types cloud service models, service- oriented architecture

1. **Computing Paradigms:** High-Performance Computing, Parallel Computing, Distributed Computing, Cluster Computing, Grid Computing, Cloud Computing, Bio computing, Mobile Computing, Quantum Computing, Optical Computing, Nano computing [8]
2. **Cloud Computing Fundamentals:** Motivation for Cloud Computing, The Need for Cloud Computing, Defining Cloud Computing, Definition of Cloud computing, Cloud Computing Is a Service, Cloud Computing Is a Platform, Principles of Cloud computing, Five Essential Characteristics, Four Cloud Deployment Models [8]
3. **Cloud Computing Architecture and Management:** Cloud architecture, Layer, Anatomy of the Cloud, Network Connectivity in Cloud Computing, Applications, on the Cloud, Managing the Cloud, Managing the Cloud Infrastructure Managing the Cloud application, Migrating Application to Cloud, Phases of Cloud Migration Approaches for Cloud Migration. [8]
4. **Cloud Service Models:** Infrastructure as a Service, Characteristics of IaaS. Suitability of IaaS, Pros and Cons of IaaS, Summary of IaaS Providers, Platform as a Service, Characteristics of PaaS, Suitability of PaaS, Pros and Cons of PaaS, Summary of PaaS Providers, Software as a Service, Characteristics of SaaS, Suitability of SaaS, Pros and Cons of SaaS, Summary of SaaS Providers, Other Cloud Service Models. [8]
5. **Cloud Service Providers:** EMC, EMC IT, Captiva Cloud Toolkit, Google, Cloud Platform, Cloud Storage, Google Cloud Connect, Google Cloud Print, Google App Engine, Amazon Web Services, Amazon Elastic Compute Cloud, Amazon Simple Storage Service, Amazon Simple Queue ,service, Microsoft, Windows Azure, Microsoft Assessment and Planning Toolkit, SharePoint, IBM, Cloud Models, IBM Smart Cloud, SAP Labs, SAP HANA Cloud Platform, Virtualization Services Provided by SAP, Sales force, Sales Cloud, Service Cloud: Knowledge as a Service, Rack space, VMware, Manjra soft, Aneka Platform. [8]

Outcome(s):

- Upon completing this course, the student will be able to
- to understand various service delivery models of a cloud computing architecture
 - to understand the ways in which the cloud can be programmed and deployed. Understanding cloud service providers.

Text Books:

Essentials of cloud Computing: K. Chandrasekhran, CRC press, 2014

Reference

Books:

1. Cloud Computing: Principles and Paradigms by Rajkumar Buyya, James Broberg and AndrzejM. Goscinski, Wiley, 2011.
2. Distributed and Cloud Computing, Kai Hwang, Geoffery C. Fox, Jack J. Dongarra, Elsevier, 2012.
3. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, Subra Kumaraswamy, Shahed Latif, O'Reilly, SPD, rp 2011.

CS 23.489

Edge Computing

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s):

Cloud computing and Deployment of Models

Objective(s):

- To acquire the knowledge of edge computing
- To acquire the knowledge of Internet of Things (IoT)
- To acquire the knowledge of applications of IoT systems.

1. **IoT and Edge Computing** :Definition and Use Cases: Introduction to Edge Computing [8]
Scenario's and Use cases - Edge computing purpose and definition, Edge computing use cases, Edge computing hardware architectures, Edge platforms, Edge vs Fog Computing, Communication Models - Edge, Fog and M2M.
2. **IoT Architecture and Core IoT Modules**:A connected ecosystem,IoT versus machine-to-machine versus, SCADA, The value of a network and Metcalfe's and Beckstrom's laws, IoT and edge architecture, Role of an architect, Understanding Implementations with examples-Example use case and deployment, Case study – Telemedicine palliative care, Requirements, Implementation, Use case retrospective. [8]
3. **RaspberryPi**: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware [8]
Layout and Pinouts, Operating Systems on RaspberryPi, Configuring RaspberryPi, Programming RaspberryPi, Connecting Raspberry Pi via SSH, Remote access tools, Interfacing DHT Sensor with Pi, Pi as Webserver, Pi Camera, Image & Video Processing using Pi.
4. **Implementation of Microcomputer** RaspberryPi and device Interfacing, Edge to Cloud [8]
ProtocolsProtocols, MQTT, MQTT publish-subscribe, MQTT architecture details, MQTT state transitions, MQTT packet structure, MQTT data types, MQTT communication formats, MQTT 3.1.1 working example
5. **Applications**: Edge computing with RaspberryPi, Industrial and Commercial IoT and [8]
Edge, Edge computing and solutions.

Outcome(s):

Upon completing this course, the student will be able to

- Understand use of the IoT architecture with its entities and protocols, from the IoT devices.
- Security and privacy issues related to the area of edge computing and IoT.
- Understand the RaspberryPi architecture and its components.
- Work with RaspberryPi components and evaluate its performance.

Text Books:

1. IoT and Edge Computing for Architects - Second Edition, by Perry Lea, Publisher: Packt Publishing, 2020, ISBN: 9781839214806.
2. Raspberry Pi Cookbook, 3rd Edition, by Simon Monk, Publisher: O'Reilly Media, Inc., 2019, ISBN: 978149204322.

Reference Books:

1. Fog and Edge Computing: Principles and Paradigms by Rajkumar Buyya, Satish Narayana Srirama, wiley publication, 2019, ISBN: 9781119524984.
2. David Jensen, "Beginning Azure IoT Edge Computing: Extending the Cloud to the Intelligent Edge, MICROSOFT AZURE

CS 23.399

Healthcare Data Analytics

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s):
Objective(s):

AI and ML

- Describe how data-based healthcare can help in improving outcomes for patient health.
- To design data models that combine patient records from multiple sources to form a patient centric view of data.
- To use data analytics to find health concerns and solutions to the problem faced by a patient.
- To find meaningful patterns and trends in healthcare data to help the overall population.

1. **Introduction to Healthcare Data Analytics:** Need for Healthcare Analytics - Foundations [4]
of Healthcare Analytics – Examples of Healthcare Analytics.
2. **Healthcare Foundations: Healthcare delivery** - Healthcare financing - Healthcare policy [4]
– Handling Patient data: the journey from patient to computer - Standardized clinical
codesets - Breaking down healthcare analytics: population, medical task, data format,
disease.
3. **Machine Learning Foundations for Healthcare:** Model frameworks for medical decision [8]
making: Tree-like reasoning, Probabilistic reasoning and Bayes theorem, Criterion tables
and the weighted sum approach, Pattern association and neural networks - Machine
learning pipeline: Loading the data, Cleaning and preprocessing the data, Exploring and
visualizing the data, Selecting features, Training the model parameters, Evaluating model
performance.
4. **Measuring Healthcare Quality:** Introduction to healthcare measures, Medicare value- [8]
based programs: The Hospital ValueBased Purchasing (HVBPP) program, The Hospital
Readmission Reduction (HRR) program, The Hospital-Acquired Conditions (HAC)
program, The End-Stage Renal Disease (ESRD) quality incentive program, The Skilled
Nursing Facility Value-Based Program (SNFVBP), The Home Health Value-Based
Program (HHVBP), The Merit-Based Incentive Payment System (MIPS).
5. **Making Predictive Models in Healthcare :** Introduction to Predictive Analytics – [8]
Obtaining and Importing the NHAMCS Dataset – Making the Response Variable -
Splitting the Data into Train and Test Sets - Preprocessing the Predictor Variables –
Building the Models – Using the Models to Make Predictions – Improving our Models
- 6 **Healthcare Analytics Applications :** Introduction - Descriptive Analytics Applications - [8]
Predictive Analytics Applications - Prescriptive Analytics Application, Healthcare and
Emerging Technologies Healthcare analytics and the internet - Healthcare and the Internet
of Things – Healthcare analytics and social media - Healthcare and deep learning -
Obstacles, ethical issues, and limitations.

Outcome(s):

At the end of the course, the student will be able to

- Explain the concepts of Healthcare Data Analytics and healthcare foundations.
- Apply machine learning techniques on healthcare data analytics.
- Measure and analyze the quality of health-care systems.
- Develop models for effective predictions in healthcare applications.
- Use modern day emerging technologies in healthcare data analytics process

Text Books:

1. Kumar, Vikas Vik. Healthcare Analytics Made Simple: Techniques in healthcare computing using machine learning and Python. Packet Publishing Ltd, 2018.
2. El Morr, Christo, and Hossam Ali-Hassan. Analytics in healthcare: a practical introduction. Springer, 2019.

Reference

1. Dinov, Ivo D. "Data Science and Predictive Analytics." Springer, Ann Arbor, MI, USA

Books:

- <https://doi.org/10.1007/978-3-319-77883-3>.
2. Yang, Hui, and Eva K. Lee, eds. Healthcare analytics: from data to knowledge to healthcare improvement. John Wiley & Sons, 2016.

CS	Software Project Management	Total Lectures: 40 Credit: 3-0-0-3
Prerequisite(s):	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. Introduction to Software Project Management (SPM) : Software 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] Project Evaluation: Strategic assessment, technical assessment, cost benefit analysis, cash flow forecasting, cost benefit evaluation techniques, risk evaluation [5] Activity Planning: Objectives, project schedule, sequencing and scheduling activities, networkplanning models, forward pass, backward pass, activity float, shortening projectduration, activity on arrow networks, risk management, nature of risk, types ofrisk, managing risk, hazard identification, hazard analysis, risk planning and control [8] 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] Managing people and Organizing teams:Introduction,understandingbehaviour, 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, becominga team, decision making leadership, organizational structures, stress, health and safety, case studies [8] 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:	- Bob Hughes, Mikecotterell, "Software Project Management", Fourth Edition, Tata McGraw Hill, 2009. - AshfaqAhmed,"Software Project Management: A Process-Driven Approach",CRC Press, 2016.	
Reference Books:	Ramesh, Gopalswamy, "Managing Global Projects", Tata McGraw Hill,2nd ed. 2005.	

CS 23.376

Network Security and Cryptography

Total Lectures: 40

Credits: 3-0-0-3

Prerequisite(s): Basic mathematics, Expertise in programming, Introduction to Algorithms.

- 1 **Introduction :** Introduction to Cryptography, Security Threats, Vulnerability, Active and Passive attacks, Security services and mechanism, Conventional Encryption Model, CIA model, Math Background : Modular Arithmetic, Euclidean and Extended Euclidean algorithm, Prime numbers, Fermat and Euler's Theorem [6]
- 2 **Classical Cryptography :** Dimensions of Cryptography, Classical Cryptographic Techniques, Block Ciphers (DES, AES) : Feistel Cipher Structure, Simplified DES, DES, Double and Triple DES, Block Cipher design Principles, AES, Modes of Operations [7]
- 3 **Public-Key Cryptography :** Principles Of Public-Key Cryptography, RSA Algorithm, Key Management, Diffie-Hellman Key Exchange, Elgamal Algorithm, Elliptic Curve Cryptography [7]
- 4 **Hash and MAC Algorithms :** Authentication Requirement, Functions, Message Authentication Code, Hash Functions, Security Of Hash Functions And Macs, MD5 Message Digest Algorithm, Secure Hash Algorithm, Digital Signatures, Key Distribution Techniques, Kerberos [7]
- 5 **Security in Networks :** Threats in networks, Network Security Controls – Architecture, Encryption, Content Integrity, Strong Authentication, Access Controls, Wireless Security, Honeypots, Traffic flow security, Firewalls – Design and Types of Firewalls, Personal Firewalls, IDS, Email Security –PGP, S/MIME [7]

Outcome(s): At the end of the course the students will be able to do following:

- Understand cryptography and network security concepts and application
- Apply security principles to system design
- Identify and investigate network security threat
- Analyze and design network security protocols
- Conduct research in network security

Text Books: [1] Cryptography And Network Security Principles And Practice Fourth Edition, William Stallings, Pearson Education
[2] Network Security Essentials: Applications and Standards, by William Stallings. Prentice Hall

Reference Books: [1] Modern Cryptography: Theory and Practice, by Wenbo Mao, Prentice Hall PTR
[2] Cryptography: Theory and Practice by Douglas R. Stinson, CRC press.

CS 23.477

Blockchain for Cyber Security

Total Lectures: 40

Credits: 3-0-0-3

Prerequisite(s): Expertise in programming, basic knowledge of computer security, cryptography, networking, concurrent or parallel programming would help a student to understand the topics.

Objective(s):

- Understand blockchain platforms and its terminologies.
- Understand the use of cryptography required for blockchain.
- Understand smart contracts, wallets, and consensus protocols.
- Design and develop blockchain applications
- Understand blockchain security issues for business applications.

- 1 **Introduction:** Need for Distributed Record Keeping, Modeling faults and adversaries, Byzantine Generals problem, Consensus algorithms and their scalability problems, Why Nakamoto Came up with Blockchain based cryptocurrency? Technologies Borrowed in Blockchain – hash pointers, consensus, byzantine fault-tolerant distributed computing, digital cash etc. , applications of blockchain and smart contract in healthcare, supply chain , finance [8]
- 2 **Basic Crypto primitives:** Hash functions, Puzzle friendly Hash, Collision resistant hash, digital signatures, public key crypto, verifiable random functions, Zero-knowledge systems [8]
- 3 **Blockchain Levels:** Bitcoinblockchain, the challenges, and solutions, proof of work, Proof of stake, alternatives to Bitcoin consensus, Bitcoin scripting language and their use, Ethereum and Smart Contracts, The Turing Completeness of Smart Contract Languages and verification challenges, Using smart contracts to enforce legal contracts, comparing Bitcoin scripting vs. Ethereum Smart Contracts, Hyperledger fabric, the plug and play platform and mechanisms in permissioned blockchain [8]
- 4 **Security of Blockchain Technology:** Technical risks of the blockchain technology, inherent risks, application of the blockchain technology to integrity and availability of the information, application of the blockchain technology to confidentiality and governance of the information [7]
- 5 **Privacy, Security issues in Blockchain:** Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains – such as Sybil attacks, selfish mining, 51% attacks - -advent of algorand, and Sharding based consensus algorithms to prevent these. [9]

Outcome(s): At the end of the course the students will be able to do following:

- Explain blockchain concepts.
- Apply cryptographic hash required for blockchain.
- Apply the concepts of smart contracts for an application.
- Design a public blockchain using Ethereum.
- Design a private blockchain using Hyperledger.
- Use different types of tools for blockchain applications.

Text Books:

- [1] 'Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming' Josh Thompson , Create Space Independent Publishing Platform, 2017.
- [2] Blockchain Technology, Chandramouli Subramanian, Asha A. George, Abhillash K. A and MeenaKarthikeyen, Universities Press.
- [3] Mastering Ethereum, Building Smart Contract and Dapps, Andreas M. Antonopoulos Dr. Gavin Wood, O'reilly.

**Reference
Books:**

- [1] Blockchain for Beginners, Yathish R and Tejaswini N, SPD
- [2] Blockchain Basics, A non Technical Introduction in 25 Steps, Daniel Drescher, Apress.

CS 23.499

Digital Forensics and Malware Analysis

Total Lectures: 40

Credits: 3-0-0-3

Prerequisite(s): Computer Network, Cryptography and System Security

Objective(s):

- To discuss the need and process of digital forensics and Incident Response Methodology.
- To explore techniques and tools used in digital forensics for Operating system and malware investigation.
- To explore techniques and tools used for Mobile forensics and browser, email forensics

- 1 Introduction to Digital Forensics: Digital Forensics Definition, Digital Forensics Goals, Digital Forensics Categories - Computer Forensics, Mobile Forensics, Network Forensics, Database Forensics, Computer Security Incident, Goals of Incident Response, CSIRT, Incident Response Methodology, Phase after detection of an incident [6]
- 2 Digital Evidence, Forensics Duplication and Digital Evidence Acquisition: Digital evidence, Types of Digital Evidence, Challenges in acquiring Digital evidence, Admissibility of evidence, Challenges in evidence handling, Chain of Custody, Digital Forensics Examination Process - Seizure, Acquisition, Analysis, Reporting. Necessity of forensic duplication, Forensic image formats, Forensic duplication techniques, Acquiring Digital Evidence - Forensic Image File Format, Acquiring Volatile Memory (Live Acquisition), Acquiring Nonvolatile Memory (Static Acquisition), Hard Drive Imaging Risks and Challenges, Network Acquisition [8]
- 3 Forensics Investigation: Analyzing Hard Drive Forensic Images, Analyzing RAM Forensic Image, Investigating Routers, Investigating Windows Systems - File Recovery, Windows Recycle Bin Forensics, Data Carving, Windows Registry Analysis, USB Device Forensics, File Format Identification, Windows Features Forensics Analysis, Windows 10 Forensics, Cortana Forensics, Investigating Unix Systems - Reviewing Pertinent Logs, Performing Keyword Searches, Reviewing Relevant Files, Identifying Unauthorized User Accounts or Groups, Identifying Rogue Processes, Checking for Unauthorized Access Points, Analyzing Trust Relationships [6]
- 4 Mobile Forensics: Android Forensics, Mobile Device Forensic Investigation – Storage location, Acquisition methods, Data Analysis, GPS forensics - GPS Evidentiary data, GPS Exchange Format (GPX), GPX Files, Extraction of Waypoints and TrackPoints, Display the Tracks on a Map. SIM Cards Forensics - The Subscriber Identification Module (SIM), SIM Architecture, Security, Evidence Extraction. [7]
- 5 Browser, Email Forensic & Forensic Investigation Reporting: Web Browser Forensics, Google chrome, Other web browser, Investigation Email forensics - Sender Policy Framework (SPF), Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC), Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report [6]
- 6 Malware Analysis: Web Browser Forensics, Google chrome, Other web browser, Investigation Email forensics - Sender Policy Framework (SPF), Domain Key Identified Mail (DKIM), Domain based Message Authentication Reporting and Confirmation (DMARC), Investigative Report Template, Layout of an Investigative Report, Guidelines for Writing a Report [7]

Outcome(s): At the end of the course the students will be able to do following:

- Discuss the phases of Digital Forensics and methodology to handle the computer

security incident.

- Describe the process of collection, analysis and recovery of the digital evidence.
- Explore various tools to analyze malwares and acquired images of RAM/hard drive.
- Acquire adequate perspectives of digital forensic investigation in mobile devices
- Analyze the source and content authentication of emails and browsers.
- Produce unambiguous investigation reports which offer valid conclusions.

Text Books:

- [1] Kevin Mandia, Chris Prosise, “Incident Response and computer forensics”, Tata McGrawHill, 2006
- [2] Digital Forensics Basics A Practical Guide Using Windows OS — Nihad A. Hassan, APress Publication, 2019
- [3] Xiaodong Lin, “Introductory Computer Forensics: A Hands-on Practical Approach”, Springer Nature, 2018

Reference Books:

- [1] M.Y. Iscan and S.R. Loth, The scope of forensic anthropology in, Introduction to Forensic Sciences, 2nd Ed., W.G. Eckert (Ed.), CRC Press, Boca Raton(1997).
- [2] D. Ubelaker and H. Scammell, Bones, M. Evans & Co., New York(2000).
- [3] S.Rhine, Bone Voyage: A Journey in Forensic Anthropology, University of Mexico Press, Mexico(1998)
- [4] Computer Forensics : Investigating Network Intrusions and Cyber Crime, EC-Council, ISBN-13: 978-1-4354-8352-1, ISBN-10: 1-4354-8352-9
- [5] Computer Forensics : Investigating Wireless Networks and Devices, EC-Council, ISBN-13: 978-1-4354-8353-8, ISBN-10: 1-4354-8353-7
- [6] Handbook of Digital Forensics and Investigations, Eoghan Casey ed., Elsevier Academic Press, ISBN 13: 978-0-12-374267-4

CS 23.341

Human-Robot Interaction

Total Lectures: 40

Credits: 3-0-0-3

Prerequisite(s): This is a graduate course meant for students interested in HRI research. It will be assumed that students have some background in AI, Robotics, or HCI and an interest in all three.

Objective(s):

- To provide basic concepts and issues of human robot interaction.
- To impart the knowledge of multifaceted nature of trust in HRI
- To develop a deeper understanding multi modal interface, standards and regulations.
- To provide knowledge about performance measurements and robot & human safety.

- 1 **Human Factors and Ergonomics Methods:** Definitions, Six Methods, Wilson's Five Basic Types of Design Data, Other Methods Challenges for Human Factors and Ergonomics Methods, Multidimensional concepts and measures, recent concepts and evaluations used in HRI, unique features of trust in intelligent autonomous systems. [8]
- 2 **Various influential factors , Standards and Regulations:** Influential factors that have known to affect trust in HRI, list of determinants of trust in HRI from the modelling, measurement, and prediction perspectives. Individual and social determinants of trust. Currently identified antecedents of trust. Role of standardization in technical regulations. Relationship between private standards and public policy making. Standard ontologies. Robot safety benchmarking and standards.ISO 13482 reference. [9]
- 3 **Ethics of Autonomous Robots:** AI & Robotics. Privacy & Surveillance. Opacity of AI systems. Automation and employment. Machine ethics. Artificial moral agents. Singularity and super intelligence. [8]
- 4 **Performance measurements** : Crandall's Neglect Tolerance model, Simultaneous measurements of body motion and electromyograms to assess biophysical information. Handedness as an important factor in designing tools and devices that are to be handled by people using their hands. Cueing capabilities facilitate multitasking [8]
- 5 **Robot & Human safety:** Safety and reliability of robotic systems. Six severity level design (SSLD).Effective hazard assessment and control. Safety of robotic work zones - intelligent safety sensors. Acceptable safety criteria for the robot implementations. [7]

Outcome(s): At the end of the course the students will be able to do following:

- Differentiate types, methods and challenges of human robot interaction.
- Validate the concepts, unique features, multifaceted nature of trust in HRI.
- Understand the role of ethics of autonomous robots.
- Explain the need of various criteria for the safety of humans and robots.

Text Books:

- [1] Neville Stanton, Alan Hedge, Karel Brookhuis, Eduardo Salas, Hal Hendrick. Handbook of Human Factors and Ergonomics Methods, CRC Press, 2004.
- [2] Chang S. Nam, Joseph B. Lyons, Trust in Human Robot Interaction, Academic Press, 2021.

Reference Books:

- [1] Mansour Rahimi, WaldemarKarwowski, Human-Robot Interaction, Taylor & Francis, 2004.
- [2] Paolo Barattini, Federico Vicentini, Gurvinder Singh Virk, and TamásHaidegger. Human–Robot Interaction Safety, Standardization, and Benchmarking, Taylor & Francis, 2019.

CS 23.441

Robotic Process Automation

Total Lectures: 40

Credits: 3-0-0-3

Prerequisite(s): Basic Programming Concepts

Objective(s):

- To provide insights on robotic process automation (RPA) technology and its value proposition
- To introduce different platforms for RPA
- To describe the different types of variables, Control Flow and data manipulation techniques in a RPA platform
- To describe automation to Email and various types of Exceptions and strategies to handle

- 1 **Introduction to Robotic Process Automation:** Emergence of Robotic Process Automation (RPA), Evolution of RPA, Future of RPA, Differentiating RPA from Automation, Defining Robotic Process Automation & its benefits, What RPA is Not, Types of Bots, Application areas of RPA, How Robotic Process Automation works, RPA development methodology and key considerations. [5]
- 2 **Overview of Robotic Process Automation Tools:** Introduction to Robotic Process Automation Tools, Basic components in a RPA platform, Installation details of RPA tools, Types of Templates, User Interface, Domains in Activities, Workflow Files in the RPA platform. [4]
- 3 **Process Components and Activities:** Process Components and Activities: User Interface Automation Activities, System Activities, Variables, Arguments, Imports Panel and User Events [6]
- 4 **App Integration, Recording and Scraping:** App Integration, Recording, Scraping, Selector, Workflow Activities. Example of Automate login to your (web)Email account, Recording mouse and keyboard actions to perform an operation, Scraping data from website and writing to CSV [6]
- 5 **Data Manipulation and PDF Automation:** Data Manipulation, Automation of Virtual Machines, Introduction to Native Citrix Automation, Text and Image Automation, PDF Automation, Computer Vision. [7]
- 6 **Programming, Debugging and Logging:** Programming, Debugging, Error Handling, Logging, Extensions, Project Organization [7]
- 7 **Workflow Management Automation:** RPA Orchestrator Overview, Orchestrator activities, Introduction to Orchestrator Community Edition (CE). [5]

Outcome(s): At the end of the course the students will be able to do following:

- Gain insights into Robotic Process Automation Technology
- Demonstrate the underlying logic/structure related to RPA
- Identify and understand Image, Text and Data Tables Automation
- Demonstrate Desktop, Web and Citrix Automation
- Design automation to Email and various types of Exceptions and strategies to handle

Text Books: [1] Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool - UiPath by Alok Mani Tripathi, Packt Publishing, Mumbai, 2018.

[2] Tom Taulli , “The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems”, Apress publications, 2020.

Reference Books: [1] Richard Murdoch, “Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become an RPA Consultant” (1st Edition), Independently published, 2018. ISBN 978-1983036835

[2] A GerardusBlokdyk, “Robotic Process Automation Rpa A Complete Guide “, 2020

CS 23.342

Privacy and Security in IoT

Total Lectures: 40

Credits: 3-0-0-3

Prerequisite(s): Knowledge of Microprocessor application, Programming Skills, Cryptography concept.

Objective(s):

- This course is designed to have students become acquainted with IoT security.
- Students will be able to understand or master IoT security related to hardware, system and networking.

- 1 **Internet of Things:** Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security [5]
- 2 **IoT- Security Overview:** IoT Reference Model – Introduction - Functional View, IoT Security Challenges-Hardware Security Risks -Hardcoded/Default Passwords - Resource Constrained Computations -Legacy Assets Connections - Devices Physical Security, Software Security Risks -Software Vulnerabilities [7]
- 3 **IoT- Security & Vulnerability Issues:** IoT-Vulnerabilities – Secret-Key, Authentication/Authorization for Smart Devices – Constrained System Resources –Device Heterogeneity – Fixed Firmware.IoT Attacks –Side-channel Attacks –Reconnaissance – Spoofing –Sniffing –Neighbor –Discovery –Rogue Devices-Man-in-Middle [8]
- 4 **Secured Protocols for IoT:** Infrastructure-Ipv6 –LowPAN , Identification-Electronic Product Code – uCode, Transport-Bluetooth –LPWAN, Data –MQTT –CoAP, Multi-layer Frameworks-Alljoyn,-IoTivity [7]
- 5 **Cloud Computing Security Issues:** Infrastructure Security: The Network Level, The Host Level, The Application Level, Data Security and Storage, Aspects of Data Security, Data Security Mitigation Provider Data and Its Security, Cloud Authorization Management [5]
- 6 **Securing Internet of Things Environment:** IoT Hardware –Test Device Range-Latency and Capacity – Manufacturability Test –Secure from Physical Attacks, IoT Software – Trusted IoT Application Platforms, -Secure Firmware Updating –Network Enforced Policy –Secure Analytics Visibility and Control [8]

Outcome(s): At the end of the course the students will be able to do following:

- Understand security and privacy issues in IoT
- Find vulnerabilities that endanger internet of things devices and infrastructure.
- Analyze different IoT protocols and their security measures.
- Figure out how to secure an IoT environment.

Text Books:

- [1] Vijay Madiseti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, Orient Blackswan Private Limited - New Delhi, 2015 1st Edition,
- [2] Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2014
- [3] CunoPfister, Getting Started with the Internet of Things, O’Reilly Media, 2011, ISBN: 978-1- 44939357-1

Reference Books:

- [1] Fei HU, “Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations”, CRC Press, 2016
- [2] Russell, Brian and Drew Van Duren, “Practical Internet of Things Security”, Packt Publishing, 2016.

CS 23.442 **Architecting Smart IoT Devices** **Total Lectures: 40**
Credits: 3-0-0-3

Prerequisite(s): Embedded hardware design.

Objective(s):

- To understand the architectural overview of the Internet of Things (IoT).
- To acquire skills on data acquisition and communication in IoT.
- To understand the threats of IoT.

- 1 **Design Principles of IoT:** Design principles of connected devices, data acquiring [6]
organizing and analytics in IoT, system architecture of IoT.
- 2 **Prototyping the Embedded Devices for IoT:** System hardware and prototyping, sensors [8]
and actuators for IoT, Radio module and wireless sensor network, gateways internet and
web, software components.
- 3 **Embedded Programming for IoT:** Programming connected devices, C and python for IoT, [6]
Case study: Temperature controller, Smart irrigation system.
- 4 **Embedded RTOS:** Program structure and real time, multitasking and scheduling, RTOS [8]
services, signals, semaphores, Nucleus SE, application timers, interrupts in nucleus ES,
Nucleus SE initialization and start1p.
- 5 **Tools for IoT:** Introduction, chef puppet, NETCONF - YANG case studies. [6]
- 6 **IoT physical Devices:** Basic building blocks of an IoT device and endpoints, family of IoT [6]
devices, pcDuino, Beagle bone black, cubie board, domain specific IoTs.

Outcome(s): At the end of the course the students will be able to do following:

- Understand how the IoT is different from traditional systems.
- Demonstrate the revolution of internet in mobile and cloud.
- Examine the architecture and operation of IoT.
- Explore various tools and programming paradigms for IoT applications.
- Develop an IoT prototype for real time scenario.
- Understand the building blocks of IoT and security aspects.

Text Books:

- [1] Raj Kamal, Internet of Things, Architecture and Design Principles, 1st edition, McGraw Hill Education, May 2017.
- [2] Arsheep Baga and Vijay Madiseti, Internet of Things: A Hands-On Approach, 1st Edition, Universities press, 2015.

Reference Books:

- [1] David Etter, IoT (Internet of Things Programming: A simple and fast way of Learning IoT, Kindle edition 2016.
- [2] Fei HU, Security and Privacy in Internet of Things (IoT): Models, Algorithms, and Implementations, 1st Edition, CRC Press, 2016.
- [3] Colin Walls, Embedded RTOS Design Insights and Implementation. 1st edition. Elsevier. December 2020.

CS 23.343

Designing Human Computer Interfaces

Total Lectures: 40

Credits: 3-0-0-3

Prerequisite(s): Knowledge of programming language such as Java, C#, HTML. UNIX.

Objective(s): To gain an overview of Human-Computer Interaction (HCI), with an understanding of user interface design in general, and alternatives to traditional "keyboard and mouse" computing; become familiar with the vocabulary associated with sensory and cognitive systems as relevant to task performance by humans; be able to apply models from cognitive psychology to predicting user performance in various human-computer interaction tasks and recognize the limits of human performance as they apply to computer operation; appreciate the importance of a design and evaluation methodology that begins with and maintains a focus on the user; be familiar with a variety of both conventional and non-traditional user interface paradigms, the latter including virtual and augmented reality, mobile and wearable computing, and ubiquitous computing; and understand the social implications of technology and their ethical responsibilities as engineers in the design of technological systems. Finally, working in small groups on a product design from start to finish will provide you with invaluable team-work experience.

- 1 **Introduction:** Importance of user Interface – definition, importance of good design. [8]
Benefits of good design. A brief history of Screen design. The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface.
- 2 **Design process:** Human interaction with computers, importance of human characteristics [8]
human consideration, Human interaction speeds, understanding business junctions. Screen Designing: Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully – information retrieval on web – statistical graphics – Technological consideration in interface design.
- 3 **Interfaces:** Types – Natural User Interfaces, Data Gathering: Key Issues – Data Recording [8]
– Interviews – Questionnaires – Observation – Choosing and Combining Technique. Data Analysis, Interpretation and Presentation: Qualitative and Quantitative – Simple Analysis – Tools -Theoretical Frameworks – Presenting the Findings
- 4 **Process of Interaction Design:** Introduction. Establishing Requirements: Data Gathering [8]
for Requirements – Task Description – Task Analysis, Design, Prototyping and Construction: Prototyping and Construction – Conceptual Design and Physical Design – Using Scenarios, Prototypes in Design. Evaluation: Introduction – Evaluation Framework.
- 5 **Cognitive models Goal and task hierarchies Design Focus:** GOMS saves money [8]
Linguistic models The challenge of display-based systems Physical and device models Cognitive architectures Ubiquitous computing and augmented realities Ubiquitous computing applications research Design Focus: Ambient Wood – augmenting the physical Virtual and augmented reality Design Focus: Shared experience Design Focus: Applications of augmented reality Information and data visualization Design Focus: Getting the size right.

Outcome(s): At the end of the course the students will be able to do following:

- Describe and apply fundamental theories and methodologies from the HCI domain.
- Ability to apply HCI and principles to interaction design.
- Design, implement and evaluate effective and usable computer interfaces.

- Ability to design certain tools for blind or PH people.

Text Books:

- [1] Sharp, H., Rogers, Y., and Preece, J, “Interaction Design: Beyond Human – Computer Interaction”, Third Edition, John Wiley & Sons, Inc., 2011.
- [2] The essential guide to user interface design, Wilbert O Galitz, Wiley Dream Tech.
- [3] Human – Computer Interaction. Alan Dix, Janet Finlay, Gregory D. Abowd, Russell Beale, Pearson Education

Reference Books:

- [1] Alan Dix, Janet E. Finlay, Gregory D. Abowd and Russell Beale, “Human – Computer Interaction”, Pearson Education, Third Edition, 2004.
- [2] Wilbert O. Galitz, “The Essential Guide to User Interface Design: An Introduction to Gui Design Principles and Techniques”, Third Edition, John Wiley Sons, 2002.
- [3] Benyon, D., Turner, P., and Turner, S, “Designing Interactive Systems: People, Activities, Contexts, and Technologies”, Addison-Wesley, 2005.
- [4] Designing the user interface. 3rd Edition Ben Shneidermann, Pearson Education Asia.
- [5] Interaction Design Preece, Rogers, Sharps. Wiley Dreamtech.
- [6] User Interface Design, Soren Lauesen, Pearson Education.
- [7] Human –Computer Interaction, D. R. Olsen, Cengage Learning.
- [8] Human –Computer Interaction, Smith - Atakan, Cengage Learning.

CS 23.443

Game Design & Asset Creation

Total Lectures: 40

Credits: 3-0-0-3

Prerequisite(s): Knowledge of programming language such as Java, C#, HTML.

Objective(s): To enable the students to,

- Develop competence necessary for graduate students to be employed in the areas of information technology and the industry of game development.
- Enable students to develop games individually and in teams.
- Develop creativity and individuality in problem solving and in performing tasks.

- 1 **Games and Video Games:** What Is a Game? Conventional Games Versus Video Games, Games for Entertainment, Serious Games Designing and Developing Games: An Approach to the Task, Key Components of Video Games, The Structure of a Video Game, Stages of the Design Process, Game Design Team Roles, Game Design Documents, The Anatomy of a Game Designer [8]
- 2 **The Major Genres** : What Is a Genre? The Classic Game Genres Understanding Your Player: VandenBerghe's Five Domains of Play, Demographic Categories, Gamer Dedication, The Dangers of Binary Thinking Understanding Your Machine: Home Game Consoles, Personal Computers, Portable Devices Other Devices [8]
- 3 **Game Concepts:** Getting an Idea, From Idea to Game Concept Game Worlds: What Is a Game World? The Purposes of a Game World, The Dimensions of a Game World, Realism Creative and Expressive Play: Self-Defining Play, Creative Play, Other Forms of Expression, Game Modifications Character Development: The Goals of Character Design, The Relationship Between Player and Avatar, Visual Appearances, Character Depth, Audio Design [8]
- 4 **Storytelling:** Why Put Stories in Games? Key Concepts, The Storytelling Engine, Linear Stories, Nonlinear Stories, Granularity, Mechanisms for Advancing the Plot, Emotional Limits of Interactive Stories, Scripted Conversations and Dialogue Trees, When to Write the Story. [8]
- 5 **General Principles of Level Design:** What Is Level Design? Key Design Principles, Layouts, Expanding on the Principles of Level Design, The Level Design Process, Pitfalls of Level Design Design Issues for Online Gaming: What Are Online Games? Advantages of Online Games, Disadvantages of Online Games, Design Issues, Technical Security, Persistent Worlds, Social Problems [8]

Outcome(s): The student will be able

- To learn Game Essentials, Types of Games, Stages of Design process
- To understand requirements of designing a game
- To learn how a concept turns into a game, and game world
- To understand what a storytelling is, various components of storytelling
- To learn general principles of level design and design issues of online gaming

Text Books: [1] Fundamentals of Game Design, Third Edition, by Ernest Adams, Released December 2013, Publisher(s): New Riders, ISBN: 9780133435726

Reference Books: [1] Designing Games, A Guide to Engineering Experiences by Tynan Sylvester.
[2] Game Design Essentials by Briar Lee Mitchell.

CS 23.381

Blockchain & Cryptocurrency

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Programming Language

Objective(s):

- to understand Blockchain and its main application cryptocurrency. Students will learn how this system works and how can they utilize and what application can be build.

1. **Introduction:** Distributed Database, Two General Problem, Byzantine General problem [4]
and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC
resistance, Turing Complete.
2. **Cryptography and Blockchain** : Hash function, Digital Signature - ECDSA, Memory [10]
Hard Algorithm, Zero Knowledge Proof , Advantage over conventional distributed
database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle
Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of
Blockchain application, Soft & Hard Fork, Private and Public blockchain.
3. **Distributed Consensus:** Nakamoto consensus, Proof of Work, Proof of Stake, Proof of [10]
Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.
4. **Cryptocurrency:** History, Distributed Ledger, Bitcoin protocols - Mining strategy and [8]
rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks,
Sidechain, Namecoin
5. **Cryptocurrency Regulation:** Stakeholders, Roots of Bitcoin, Legal Aspects - [8]
Cryptocurrency Exchange, Black Market and Global Economy.

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

- Students will be familiar with blockchain and cryptocurrency concepts.
- Students can build their own application using the learned concepts.

Text Books: 1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder,
Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University
Press (July 19, 2016).

Reference Books:

1. Andreas M. Antonopoulos , Mastering Bitcoin , O.Reily media, 2015, ISBN: 978-1-449-37404-4
2. Bikramaditya Singhal, Gautam Dhameja, Priyansu Sekhar Panda , Beginning Blockchain
A Beginner's Guide to Building Blockchain Solutions, Apress,2018.

CS 23.482

Cyber Security with Blockchain

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s):

Programming Language

Objective(s):

- To articulate the cyberthreat landscape and Security Challenges.
- To build Blockchain-based apps for authentication and for storing DNS entries.
- To implement various decentralized applications using blockchain to provide various security services.

1. **Introduction:** Cyber Security, Internet Governance – Challenges, Constraints, Threats, [4]
Cyber Warfare, Cyber Crime, Terrorism, Espionage, Need for a Cyber Security Policy, Nodal Authority requirement, Requirement of an International Convention on Cyberspace, CIA model, Cyber Security vulnerabilities, Cyber Security attacks.
2. Security services, Blockchain on the CIA Security Triad, Authentication mechanisms, [10]
Two-Factor Authentication with Blockchain, PKI Infrastructure, Deploying PKIBased Identity with Blockchain, IPNS, Blockchain-Based DNS Security Platform, Deploying Blockchain-Based DDoS Protection, EIP Block for DDoS attacks, Security related issues in smart contracts development, Smart contract testing.
3. Exception handling, debugging of applications, Formal verification, smart contracts [10]
security Oyente, why3 for smart contracts, Solgraph based formal verification, implications of blockchain technology for digital privacy, implication for Security, Membership and Access control in Fabric, authentication in fabric network.
4. Privacy in Fabric, Channel encryption, Blockchain Security (Fabric SideDB), Security of a [8]
ledger, anonymity, pseudonymity, blockchain Implementation Challenges, privacy law applicability, startups in blockchain based cyber security applications.
5. [8]

Outcome(s):

On the successful completion of the course, the student will be able to:

- Students will be familiar with blockchain and Cyber Security concepts.
- Students can build their own application using the learned concepts.

Text Books:

1. R. Gupta, Hands-on cybersecurity with blockchain (1 ed.), Packt Publishing, 2018. ISBN 978-788990189.

Reference Books:

1. Yassine Maleh, Mamoun Alazab, Mohammad Shojafar, Imed Romdhani, Blockchain for Cybersecurity and Privacy: Architectures, Challenges, and Applications (1 ed.), CRC Press, 2020. ISBN 9781000060164.

CS 23.390

Digital Marketing and Trend Analysis

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s):

Programming Language

Objective(s):

- To articulate online applications based on recent digital marketing trends.
- To examine digital marketing and its applications.
- To make use of state-of-the-art tools for digital marketing and trend analysis.

1. **Introduction:** Digital Marketing, CRM, Affiliate Marketing, P-O-E-M Framework, [6]
Online vs offline retail, Customer profile analysis, Factors influencing consumer behavior, Traffic source analysis, Multi-channel analysis, On-site merchandising analysis, Digital Advertising Market, Growth of e-commerce, Social media monitoring vs listening, Competitor and Website Analysis, Structure of online conversations,
2. Methods of gathering data, Unlocking actionable insights from e-commerce, Adwords, [6]
Link Tagging, Exit rate and bound rate, Online advertising optimization, Measuring Performance and Quality Control, Crisis management.
3. Online content, Content Creation, Types of Content, Content optimization, Content [8]
Management & Distribution, Recommendation system for e-commerce, User-User and User Item, Study of popular recommendation platforms, Market basket analysis, Predicting product adoption.
4. Conversation modeling, Campaign optimization, Clickstream Analytics, Traffic Analytics, [10]
Customer segmentation, Search Engine Optimization techniques, Expertise Authority and Trustworthiness, Featured Snippets, Site architecture optimization, Long-Tail Keyword Phrases, Keyword Planner, Google rankings, Link Building, Steps to optimize the website.
5. Mobile Advertising, Mobile Marketing tool Kit, Mobile Marketing Features, Brand Health [10]
Management, Surrogate advertising, Fake news propagation models, Fake news identification, Social Media Monitoring, Digital data treasure, Digital rights.

Outcome(s):

On the successful completion of the course, the student will be able to:

- understand consumer behavior, buying pattern and other analytics to promote the marketing needs of an organization.
- Understand online content creation, analytics power in differentiating e-commerce business, analyzing the latest trends in the marketing, and usage of domain marketing tool kits.

Text Books:

1. Gary P Schneider, Electronic commerce (13 ed.), Cengage Learning, Inc, 2019. ISBN 9781285425436.

Reference Books:

1. Simon Kingsnorth, Digital Marketing Strategy: An Integrated Approach to Online Marketing (4 ed.), Pearson, 2019. ISBN 0749484225.

CS 23.391

Blockchain Components and Architecture

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s):

Basic concepts in blockchain and networking.

Objective(s):

- To described implementation and architecture of blockchain
- To implement Blockchain in Financial Software and Systems.
- To introduce the Blockchain history, Digital Money, Hash, Signature and Blockchains design goals.

1. Introduction to Blockchain history: Digital Money to Distributed Ledgers Design Primitives: Protocols, Security, Consensus, Permissions, Privacy, Blockchain Architecture and Design. Basic crypto primitives: Hash, Signature, Hashchain to Blockchain, Basic consensus mechanisms
2. Consensus, Requirements for the consensus protocols, Proof of Work (PoW) Scalability aspects of Blockchain consensus protocols
3. Permissioned Blockchains, Design goals, Consensus protocols for Permissioned Blockchains Hyperledger, Decomposing the consensus process Hyperledger fabric components Chaincode Design and Implementation Hyperledger Fabric beyond Chain code fabric SDK and Front End, Hyperledger composer tool
4. Blockchain in Financial Software and Systems (FSS):Settlements, KYC, Capital markets, Insurance Use case II: Blockchain in trade supply chain: Provenance of goods, visibility, tradesupply chain finance, invoice management discounting, etc
5. Blockchain Cryptography Privacy and Security on Blockchain, Blockchain consensus protocols, Various recent works on scalability

Outcome(s):

On the successful completion of the course, the student will be able to:

- To described implementation and architecture of blockchain
- To design & implement blockchain as a digital asset properly.
- To become an efficient blockchain developer.

Text Books:

Blockchain Technology Explained, by Alan T. Norman

Reference

1. Blockchain: Ultimate guide to understanding blockchain, bitcoin, cryptocurrencies, smart contracts and the future of money.

Books:

2. The Bitcoin Standard: The Decentralized Alternative to Central Banking by Saifedean Ammous

CS 23.382

E-Customer Relationship Management

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To Implement various technological tools for data mining and also successful implementation of CRM in the Organizations
- To design customer relationship management strategies by understanding customers' preferences for the long-term sustainability of the Organizations.

1. Customer Relationship Management Fundamentals: Theoretical perspectives of relationship, Evolution of relationship marketing, Stages of relationship, Issues of relationship, Purpose of relationship marketing, Paradigm shift from transactional to relationship approach, CRM Definitions, Emergence of CRM practice, CRM cycle Stakeholders in CRM, Significance of CRM, Types of CRM, Success Factors in CRM [8]
2. Operational CRM: Marketing automation, Meaning, benefits, some software applications Sales force automation, Meaning, SFA ecosystem, SFA adoption, CRM in Services: Service automation, benefits, software applications Analytical CRM: Database Management: Developing a customer related database , Analytics for CRM strategy and tactics , Big data analytics in CRM , Data Mining procedures , Use of AI, machine learning and deep learning [8]
3. Technological Tools for CRM and Implementation: Data Mining for CRM - Some Relevant Issues ; Changing Patterns of e-CRM Solutions in the Future; Structuring a Customer Focused IT Organization to Support CRM; Organizational Framework for Deploying Customer Relationship; measuring profitability CRM implementation –set by step process. [8]
4. Customer Relationship Management: Technology Dimensions, E- CRM in Business CRM: A changing Perspective , Features of e-CRM , Advantages of e-CRM , Technologies of e-CRM ,Voice Portals, Web Phones, BOTs, Virtual Customer Representative, Customer Relationship Portals [8]
5. CRM in Services :Status of Customer Relationship Management in service industry in India; Relevance of CRM for Hospital Services; Customer Relationship Management in Banking and Financial Services; CRM in Insurance Sector, SupplyDemand Mismatches and their impact on CRM; The Past, Present and Future of CRM;CRM vs Digital Marketing ,Future of CRM [8]

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

- Critically review and interpret the theoretical aspects of CRM across the main areas of sales, services and marketing.
- Investigate, analyse, demonstrate and present the salient aspects of a CRM implementation or CRM innovation in a work-related environment.
- Implement various technological tools for data mining and also successful implementation of CRM in the Organizations

Text Books: 1.Jagdish N Sheth, Parvatiyar Atul, G Shainesh, Customer Relationship Management: Emerging Concepts, Tools and Applications, 1st Edition, Tata McGraw Hill, June 2008

Reference Books: 1.Alok Kumar Rai. CRM: Concepts and Cases, PHI
2.H.Peeru Mohamed , A Sagadevan, Customer Relationship Management, A Step by Step Approach, Vikas Publishing House

CS 23.483

Enterprise Resource Planning

Total Lectures: 40

Credit:3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To understand the business process of an enterprise
- To grasp the activities of erp project management cycle
- To understand the emerging trends in erp developments

1. **INTRODUCTION** [8]
Overview of enterprise systems – Evolution - Risks and benefits - Fundamental technology –Issues to be consider in planning design and implementation of cross functional integrated ERP systems.
2. **ERP SOLUTIONS AND FUNCTIONAL MODULES** [10]
Overview of ERP software solutions- Small, medium and large enterprise vendor solutions, BPR,and best business practices - Business process Management, Functional modules.
3. **ERP IMPLEMENTATION** [10]
Planning Evaluation and selection of ERP systems - Implementation life cycle - ERP implementation, Methodology and Frame work- Training – Data Migration. People Organization in implementation-Consultants, Vendors and Employees.
4. **POST IMPLEMENTATION** [8]
Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation.
5. **EMERGING TRENDS ON ERP** [9]
Extended ERP systems and ERP add-ons -CRM, SCM, Business analytics - Future trends in ERP systems-web enabled, Wireless technologies, cloud computing.

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

- Knowledge of ERP implementation cycle
- Awareness of core and extended modules of ERP

Text Books:

1. S. Sadagopan, “Enterprise Resource Planning”, Tata McGraw Hill 2000
2. Bajaj, Kamlesh K. and Nag, Debjani, E-Commerce: The Cutting Edge of Business, Tata McGraw-Hill Publishing Company

Reference Books:

- 1.Sinha P. Magal and Jeffery Word, Essentials of Business Process and Information System, Wiley India.
2. Jagan Nathan Vaman, ERP in Practice, Tata McGraw-Hill.
3. Alexis Leon, Enterprise Resource Planning, second edition, Tata McGraw-Hill.
4. Mahadeo Jaiswal and Ganesh Vanapalli, ERP Macmillan India.
5. Alexis Leon, ERP demystified, second Edition Tata McGraw-Hill

CS 23.383

Introduction to Data Science

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To Building the fundamentals of data science. Imparting design thinking capability to build big-data
- To Developing design skills of models for big data problems
- To Gaining practical experience in programming tools for data sciences
- To Empowering students with tools and techniques used in data science

1. Introduction: Big Data and Data Science - Big Data Analytics, Business intelligence vs Big data, big data frameworks, Current landscape of analytics, data visualization techniques, visualization software
2. Basic Statistical Inference: Data Analytics Lifecycle, Developing Initial Hypotheses, Identifying Potential Data Sources, EDA case study, testing hypotheses on means, proportions and variances
3. Regression models and Linear Algebra Basics: Regression models: Simple linear regression, least-squares principle, MLR, logistic regression, Multiple correlation, Partial correlation, Matrices to represent relations between data, Linear algebraic operations on matrices – Matrix decomposition: Singular Value Decomposition (SVD) and Principal Component Analysis (PCA).
4. Data Pre-processing and Feature Selection: Data cleaning - Data integration - Data Reduction - Data Transformation and Data Discretization, Feature Generation and Feature Selection, Feature Selection algorithms: Filters- Wrappers - Decision Trees - Random Forests
5. Basic Machine Learning Algorithms: Classifiers - Decision tree - Naive Bayes - k-Nearest Neighbors (k-NN), k-means – SVM Association Rule mining.

Outcome(s):

On the successful completion of the course, the student will be able to:

- Apply data visualisation in big-data analytics
- Utilise EDA, inference and regression techniques
- Utilize Matrix decomposition techniques to perform data analysis
- Apply data pre-processing techniques
- Apply Basic Machine Learning Algorithms

Text Books:

- 1 . Mining of Massive Datasets. v2.1, Jure Leskovek, Anand Rajaraman and Jeffrey Ullman., Cambridge University Press. (2019). (free online)
- 2.Big Data Analytics, paperback 2nd ed., Seema Acharya, Subhasini Chellappan, Wiley (2019).

Reference

Books:

1. Introduction to Machine Learning with Python: A Guide for Data Scientists, Andreas C. Müller and Sarah Guido,Oreilly

CS 23.484

Big Data Analysis

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Should have knowledge of one Programming Language (Java preferably), Practice of SQL (queries and sub queries), exposure to Linux Environment

Objective(s):

- To Understand the Big Data Platform and its Use cases
- To Provide an overview of Apache Hadoop
- To Provide HDFS Concepts and Interfacing with HDFS
- To Understand Map Reduce Jobs
- To Provide hands on Hadoop Eco System
- To Apply analytics on Structured, Unstructured Data.
- To Exposure to Data Analytics with R.

1. INTRODUCTION TO BIG DATA AND HADOOP Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere BigInsights and Big Sheets. [10]
2. HDFS(Hadoop Distributed File System) The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures. [8]
3. Map Reduce Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features. [5]
4. Hadoop Eco System Pig : Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. Hive : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. Hbase : HBasics, Concepts, Clients, Example, Hbase Versus RDBMS, NoSQL: What is it?, Where It is Used Types of NoSQL databases, Why NoSQL?, Advantages of NoSQL [10]
5. Data Analytics with R Machine Learning : Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR. [7]

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

- Identify Big Data and its Business Implications.
- List the components of Hadoop and Hadoop Eco-System
- Manage Job Execution in Hadoop Environment
- Develop Big Data Solutions using Hadoop Eco System
- Analyze Infosphere BigInsights Big Data Recommendations.
- Apply Machine Learning Techniques using R.

Text Books: 1.Tom White “ Hadoop: The Definitive Guide” Third Edit , O’reily Media, 2012.

2.Seema Acharya, Subhasini Chellappan, "Big Data Analytics" Wiley 2015.

Reference

Books:

1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.

2. Jay Liebowitz, “Big Data and Business Analytics” Auerbach Publications, CRC press (2013)

3. Tom Plunkett, Mark Hornick, “Using R to Unlock the Value of Big Data: Big Data Analytics with Oracle R Enterprise and Oracle R Connector for Hadoop”, McGraw-Hill/Osborne Media (2013), Oracle press.

4. Anand Rajaraman and Jef rey David Ulman, “Mining of Massive Datasets”, Cambridge University Press, 2012.

CS 23.385

IT Service Management

Total Lectures: 40

Credit:3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To understand service management.
- To understand Business Process, Principles of Service management, Specialization and Coordination.
- To understand Principles of systems, The service Life Cycle and Functions and processes across the life cycle.

1. Service Strategy Principles: Value creation, Service Assets, Service Provider Service Structures, Service Strategy Principles. [8]
Service Strategy: Define the market, Develop the offerings, Develop Strategic Assets, Prepare for execution. Challenges, Critical Success factors and risks: Complexity, Coordination and Control, Preserving value, Effectiveness in measurement, Risks.
2. Service Design: Fundamentals [8]
Service Design Principles: Goals, Balanced Design, Identifying Service requirements, identifying and documenting business requirements and drivers, Design activities, Design aspects, Subsequent design activities, Design constraints, Service oriented architecture, Business Service Management, Service Design Models, Service Design Processes: Service Catalogue Management, Service Level Management, Capacity Management, Availability Management, IT Service Continuity Management, Information Security Management, Supplier Management, Challenges, Risks
3. Service Transition: Fundamentals [8]
Service Transition Principles: Principles Supporting Service Transition, Policies for Service Transition, Service Transition Processes: Transition planning and support, Change Management, Service Asset Configuration Management, Service and Deployment Management, Service Validation and Testing, Evaluation, Knowledge Management. Challenges, Critical Success factors and risks: Challenges, Critical Success factors, Risks, Service Transition under difficult Conditions.
4. Service Operation: Fundamentals [8]
Service Operation Principles: Functions, groups, teams, departments and divisions, Achieving balance in service operations, Providing service, Operation staff involvement in service design and service transition, Operational Health, Communication, Documentation, Service Operation Processes: Event Management, Incident Management, Request fulfillment, Problem Management, Access Management, Operational activities of processes covered in other lifecycle phases. Challenges, Critical Success factors, Risks.
5. Continual Service Improvement(CSI) Principles: CSI Approach, CSI and organizational change, Ownership, CSI register, External and Internal drivers, Service level management, Knowledge management, The Deming cycle, Service Measurement, IT governance, Frameworks, models, standards and quality Systems, CSI inputs and outputs. [8]
CSI Process: The seven step improvement process
Organising for CSI: Organisational development, Functions, roles, Customer Engagement, Responsibility model - RACI, Competence and training.
Technology considerations: Tools to support CSI activities
Implementing CSI: Critical Considerations for implementing CSI, The start, Governance, CSI and organisational change, Communication Strategy and Plan

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

- Understand service management
- Understand Business Process
- Understand Principles of systems

Text Books:

- 1 . It Infrastructure & Its Management, Phalguni Gupta, Tata McGraw-Hill Education

**Reference
Books:**

CS 23.395

IT infrastructure Management

Total Lectures: 40

Credit:3-0-0-3

Prerequisite(s): Nil

Objective(s):

- Progressive enterprises have always faced challenges while managing and designing IT infrastructure, which will meet the business needs. Emerging technologies such as unified communications, enterprise wide networks, and next generation intelligent network solutions are expected to be used in unison to meet the growing needs of organizations.

- IT infrastructure Introduction**, challenges, design issues in IT organization and IT infrastructure, Determining customer's requirements, IT systems, management process, IT service management process, Information system design process, patterns for IT systems management, IT infrastructure library, Service delivery process Service level management, financial management, IT service continuity management, capacity management, availability management, Service support process: Configuration management, incident management, problem management, change management, release management [10]
- Networking and Security**: Protocols : OSI Model, TCP/IP model, Different Protocols, Network Address Translation (NAT), WAN Protocols, Wireless Protocols, Network Security:Firewall voice traversal, ICMP inspection, Access lists – Extended, advanced, named, Monitoring Access lists, Wild card – masking, Security Management: Computer and Internet Security, Physical Security, Identity Management, Access Management, Intrusion Detection, Security Information Management, IT Ethics: Cyber Ethics, Intellectual Property, Privacy and Law, Computer Forensics, Ethics and Internet, Cyber Crimes [7]
- Server Configuration Management**: Linux: Shell scripting for managing hardware devices and networking, X-Windows, Linux commands advanced, IP Address Configuration for Linux, Boxes, SAMBA, Linux kernel – Module installation, Creating & managing user accounts, Creating & managing group accounts, Configuration of User system policies, Configuration of Group system policies [7]
- Data Center Infrastructure**: Data Center Infrastructure Architecture Overview - Data Center –site location and site configuration, Various Elements in a Data centre-their functions, Hardware and Software Recommendations, Software Recommendations, Data Center Multi-Layer Design, Network Management [7]
- Back-up and recovery**: Disaster Recovery, Alternate site, Data Center Security: Security aspects in a DataCentre, Packet Filtering: Aggregation Layer, Packet Filtering: Access Layer, Security for Multi-Tier Server Farms, Intrusion Detection Sensors, Virtual Data Centre: What is a Virtual data Centre, Virtual Data Centre management, Remote Management [9]

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

- Understand data security to application level security 2) Understand installation, Configuration & Management of Linux OS and its other features. 3) Understand basic aspects of architecture, design and security of Data Center

Text Books: 1. It Infrastructure & Its Management, Phalguni Gupta, Tata McGraw-Hill Education

Reference Books: 1. IT Infrastructure and Management (For the GBTU and MMTU) (Paperback) Author :Choubey M K Publisher :PEARSON EDUCATION(SINGAPORE) PTE. LTD.-DELHI

2.CCNA Cisco Certified Network Associate Study Guide - Richard Deal

CS 23.384

Introduction to IoT

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To understand the basics of Internet of things and protocols.
- To introduces some of the application areas where Internet of Things can be applied.
- To learn about the middleware for Internet of Things.
- To understand the concepts of Web of Things

1. **IOT** - What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues [10]
2. **IOT PROTOCOLS** - Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols – IEEE802.15.4, BACNet Protocol, Modbus, KNX, Zigbee, Network layer, 6LoWPAN, APS layer Security [10]
3. **IOT ARCHITECTURE** - IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity : An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction. [10]
SENSOR & ACTUATORS WITH ARDUINO - Overview of Sensors working, Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor with Arduino, Interfacing of Actuators with Arduino., Interfacing of Relay Switch and Servo Motor with Arduino
4. **WEB OF THINGS** - Web of Things versus Internet of Things, Two Pillars of the Web, Architecture Standardization for WoT, Platform Middleware for WoT, Unified Multitier WoT Architecture, WoT Portals and Business Intelligence. [6]
5. **IOT APPLICATIONS** - IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc [4]

Outcome(s):

On the successful completion of the course, the student will be able to:

- Understand IoT Architecture
- Demonstrate various sensor interfacing
- Analyze various Physical Computing Techniques.
-

Text Books:

1 . Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014

Reference Books:

1. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.

2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.

3. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

CS 23.394

Wireless Sensor Networks & IoT Standards

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To identify and expose the students to the central elements in the design of communication protocols for the WSNs.
- To get the perception of mobile ad hoc networks, design, implementation issues, and solutions based on different algorithms and protocols
- To associate, hardware platforms and software frameworks used to realize dynamic Wireless sensor network

1. Network for embedded systems and Embedded wireless communication: RS232, RS485, [10]
SPI, I2C, CAN, LIN, FLEXRAY, Bluetooth, Zigbee, Wifi, UWB
2. Wireless sensor network (WSN): Characteristic and challenges, WSN vs Adhoc Networks, [10]
Sensor node architecture, Physical layer and transceiver design considerations in WSNs,
Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling,
Antenna considerations.
3. WSN (Medium access control): Fundamentals of MAC protocols - Low duty cycle [10]
protocols and wakeup concepts, Contention Based protocols, Schedule-based protocols -
SMAC – BMAC, Traffic-adaptive medium access protocol (TRAMA), The IEEE 802.15.4
MAC protocol.
4. Sensor Network Architecture: Data Dissemination, Flooding and Gossiping-Data gathering [7]
Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for
WSNs- Gateway Concepts, Need for gateway, WSN and Internet Communication, WSN
Tunneling
5. IP based WSN and Tiny OS: Circuit switching, packet switching, concept of IPV4, IPV6, [3]
6LOWPAN and IP, IP based WSN, 6LOWPAN based WSN, IOT Tiny OS for WSN and
IOT, M2M communication

Outcome(s):

On the successful completion of the course, the student will be able to:

- Assess the applicability and limitations of communication protocols for a real time WSN application.
- Proactive in understating the routing protocols function and their implications on data transmission delay and bandwidth
- Contribute appropriate algorithms to improve existing or to develop new wireless sensor network applications.
- Familiarize the protocol, design requirements, suitable algorithms, and the state-of-the-art cloud platform to meet the industrial requirement.

Text Books:

- 1 Holger Karl, Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks" 2011, 1st ed., John Wiley & Sons, New Jersey
- 2 Pethuru Raj and Anupama C. Raman "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by (CRC Press)

Reference Books:

1. Jun Zheng, Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", 2014, 1st ed., Wiley-IEEE Press, USA.
2. Waltenegus W. Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor

Networks: Theory and Practice", 2014, 1st ed., John Wiley & Sons, New Jersey.

CS 23.485

IoT for Industries

Total Lectures: 40

Credit: 3-0-0-3

Prerequisite(s): Nil

Objective(s):

- To provide students with good depth of knowledge of Designing Industrial IOT Systems for various application.
- To provide Knowledge for the design and analysis of Industry 4.0 and Industry 5.0 Systems.

1. Introduction to Industrial IoT (IIoT) Systems: The Various Industrial Revolutions, Role of Internet of Things (IoT) & Industrial Internet of Things (IIoT) in Industry, Industry 4.0 revolutions, Support System for Industry 4.0, Industry 5.0, Smart Factories. [10]
2. Implementation systems for IIoT: Sensors and Actuators for Industrial Processes, Sensor networks, Process automation and Data Acquisitions on IoT Platform, Microcontrollers and Embedded PC roles in IIoT, Wireless Sensor nodes with Bluetooth, Wi-Fi, and LoRa Protocols and IoT Hub systems. [10]
3. IIoT Data Monitoring & Control: IoT Gate way, IoT Edge Systems and It's Programming, Fog Computing, Cloud computing, Real Time Dashboard for Data Monitoring, Data Analytics and Predictive Maintenance with IIoT technology. [10]
4. Cyber Physical Systems: Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis [7]
5. Industrial IoT- Applications: Smart cities, Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management. [3]

Outcome(s): On the successful completion of the course, the student will be able to:
Knowledge of theory and practice related to Industrial IoT Systems.
Identify, formulate and solve engineering problems by using Industrial IoT.
Implement real field problem by gained knowledge of Industrial applications with IoT capability.

Text Books:

1. Industry 4.0: The Industrial Internet of Things Alasdair Gilchrist Publications: Apress
2. The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications

**Reference
Books:**

1. Inside the Internet of Things (IoT), Deloitte University Press
2. Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821- 140-7, Willy Publications Olivier Hersent, David Boswarthick, Omar Elloumi,

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING



B.TECH (INFORMATION TECHNOLOGY) FOUR YEAR PROGRAM CURRICULUM STRUCTURE & SYLLABI (2023-2027 BATCH ONWARDS)



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