B.Tech (Mechanical Engineering)
Four Year Program
Academic Curriculum (2025-2029 Batch Onwards)

Curriculum Components

Component	Credits	Courses	
1. University Core (3 Courses)	06	UC 23.101 Human Values & Professional Ethics UC 23.102 Pragmatic English Communication UC 25.202 Entrepreneurship Development and Management Leadership	
2. University Elective (2 Courses)	06	Mody University Elective I Mody University Elective II	
3. Basic Science (10 Courses)	29	MA 23.101 Mathematics I CY 23.101 Engineering Chemistry CY 23.111 Chemistry Laboratory CY 23.102 Environmental Sciences MA 23.102 Mathematics II PY 23.101 Engineering Physics PY 23.111 Physics Laboratory MA 23.201 Mathematics-III ME 23.205 Material Science ME 23.308 Optimization Techniques	
4. Engineering Science (11 Courses)	23	ME 25.101 Applied Mechanics EC 25.101 Basics of Electronics Engineering EC 23.111 Electronics Laboratory ME 23.111 Computer Aided Engineering Drawing EE 25.101 Basics of Electrical Engineering EE 23.111 Electrical Laboratory CS 23.101 Programming for Problem Solving CS 23.111 Programming Laboratory ME 23.112 Mechanical Workshop CS 23.205 General Purpose Programming CS 23.255 General Purpose Programming laboratory	
5. Program Core (27 Courses)	61	ME 25.207 Basics of Sensors and Processing Techniques ME 23.201 Mechanics of Solids ME 23.203 Engineering Thermodynamics ME 23.215 Mechanics of Solids Laboratory ME 23.217 Thermodynamics Laboratory ME 23.219 Computer Aided Machine Drawing ME 23.202 Kinematics of Machines ME 23.204 Fluid Mechanics ME 23.206 Design of Machine Elements I ME 23.208 Production Technology I ME 23.216 Fluid Mechanics Lab ME 23.218 Design of Machine Elements Practice I ME 23.220 Production Laboratory ME 23.301 Dynamics of Machines ME 23.303 Fluid Machinery ME 23.305 I C Engines	ME 23.307 Production Technology II ME 23.309 Thermal Engineering System ME 23.317 Fluid Machinery Lab ME 23.319 IC Engine Laboratory ME 23.302 Heat and Mass Transfer ME 23.304 Refrigeration and Air Conditioning ME 23.306 Advanced Production Technology ME 23.310 Design of Machine Elements II ME 19.312 CAD/CAM ME 23.320 Design of Machine Elements Practice II ME 23.322 Advanced Production Technology Lab
6. Program Elective / MOOCs (5 Courses)	15	MOOC – 01 Program Elective – 04	
7. Project / Summer Internship Project/Colloquium (11 Courses)	21	Project Based Learning (PBL)-04 Summer Internship Project – 02 Colloquium – 01 Project – 02 Capstone Project – 02	
8. Proficiency (Non-Credit / Non-Graded) (6 Courses)	00	SEFS – 06	
Total	**161**	**75 Courses**	

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First Year - Autumn Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	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
CY 23.101	Engineering Chemistry	3	0	0	3	3	10	40	50
ME 25.101	Applied Mechanics	3	0	0	3	3	10	40	50
EC 25.101	Basics of Electronics Engineering	3	0	0	3	3	10	40	50
CY 23.102	Environmental Sciences	2	0	0	2	3	10	40	50
ME 23.111	Computer Aided Engineering Drawing	0	0	4	2	2	50		50
CY 23.111	Chemistry Laboratory	0	0	2	1	2	50		50
EC 23.111	Electronics Laboratory	0	0	2	1	2	50		50
PB 25.101	Project Based Learning	0	0	2	1		50		50
SF 101	Personal Grooming and Fine Dinning (Non Grade)	0	0	2	1	2	50		50
	Total	16	1	12	**22**				

First Year –Spring Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	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
PY 23.101	Engineering Physics	3	0	0	3	3	10	40	50
EE 25.101	Basics of Electrical Engineering	3	0	0	3	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	50		50
EE 23.111	Electrical Laboratory	0	0	2	1	2	50		50
CS 23.111	Programming Laboratory	0	0	4	2	2	50		50
ME 23.112	Mechanical Workshop	0	0	2	1	2	50		50
PB 25.102	Project Based Learning	0	0	2	1		50		50
SF 102	Social Grooming, Home & Décor and Business Communication (Non Grade)	0	0	2	1	2	50		50
	Total	14	1	14	**21**				

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Second Year – Autumn Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	ETE
ME 25.207	Basics of Sensors and Processing Techniques	2	0	0	2	3	10	40	50
MA 23.201	Mathematics-III	3	1	0	4	3	10	40	50
CS 23.205	General Purpose Programming	3	0	0	3	3	10	40	50
ME 23.201	Mechanics of Solids	3	0	0	3	3	10	40	50
ME 23.203	Engineering Thermodynamics	3	0	0	3	3	10	40	50
ME 23.205	Material Science	3	0	0	3	3	10	40	50
ME 23.215	Mechanics of Solids Laboratory	0	0	2	1	2	50		50
ME 23.217	Thermodynamics Laboratory	0	0	2	1	2	50		50
CS 23.255	General Purpose Programming laboratory	0	0	2	1	2	50		50
ME 23.219	Computer Aided Machine Drawing	0	0	2	1	2	50		50
PB 25.201	Project Based Learning	0	0	2	1		50		50
SF 201	Personal Grooming Fine Dining and Home Safety (Non Grade)	0	0	2	1	2	50		50
	Total	17	1	12	**23**				

Second Year –Spring Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	ETE
UC 25.201	Management and Entrepreneurship	2	0	0	2	3	10	40	50
UE	University Elective-I	3	0	0	3	3	10	40	50
ME 23.202	Kinematics of Machines	3	0	0	3	3	10	40	50
ME 23.204	Fluid Mechanics	3	0	0	3	3	10	40	50
ME 23.206	Design of Machine Elements I	4	0	0	4	3	10	40	50
ME 23.208	Production Technology I	3	0	0	3	3	10	40	50
ME 23.216	Fluid Mechanics Lab	0	0	2	1	2	50		50
ME 23.218	Design of Machine Elements Practice I	0	0	2	1	2	50		50
ME 23.220	Production Laboratory	0	0	2	1	2	50		50
PB 25.202	Project Based Learning	0	0	2	1		50		50
SF 202	Social Grooming and Professional Skills (Non Grade)	0	0	2	1	2	50		50
		18		10	**22**				

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Third Year – Autumn Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	ETE
ME 23.301	Dynamics of Machines	3	0	0	3	3	10	40	50
ME 23.303	Fluid Machinery	3	0	0	3	3	10	40	50
ME 23.305	I C Engines	3	0	0	3	3	10	40	50
ME 23.307	Production Technology II	3	0	0	3	3	10	40	50
ME 23.309	Thermal Engineering System	3	0	0	3	3	10	40	50
ME 23.317	Fluid Machinery Lab	0	0	2	1	2	50		50
ME 23.319	IC Engine Laboratory	0	0	2	1	2	50		50
	Program Elective-1*	0	0	0	3		Based on MOOC Exam Score		
ME 23.323	Summer Internship – I**	0	0	0	2		100		
ME 23.325	Project I	0	0	4	2		50		50
GE 25.301	Proficiency (Non Credit Non Grade)	0	0	0	1		100		
	Total	15		8	**24**				

Third Year -Spring Semester									
Course Code	Course Title	Contact Hours Per Week			Credits	ETE Duration (Hours)	Weightage		
		L	T	P			CW	MTE	ETE
ME 23.302	Heat and Mass Transfer	3	0	0	3	3	10	40	50
ME 23.304	Refrigeration and Air Conditioning	3	0	0	3	3	10	40	50
ME 23.306	Manufacturing Technology and Quality Control	3	0	0	3	3	10	40	50
ME 23.308	Optimization Techniques	3	1	0	4	3	10	40	
ME 23.310	Design of Machine Elements II	3	0	0	3	3	10	40	50
ME 23.312	CAD/CAM	3	0	0	3	3	10	40	50
ME 23.320	Design of Machine Elements Practice II	0	0	2	1	2	50		50
ME 23.322	Advanced Production Technology Lab	0	0	2	1	2	50		50
ME 23.326	Colloquium	0	0	2	1		100		
ME 23.328	Project II	0	0	4	2		50		50
GE 25.302	Proficiency (Non Credit Non Grade)	0	0	0	1		100		
	Total	18	1	10	**24**				

*

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

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

Proficiency (Non-Credit/Non Grade) shall be measured through level of participation in skill development programs i.e., sports, Yoga, Life skills, Music, Fine Arts or decided by Departmental academic Committee

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	10	40	50
	Program Elective-2	3	0	0	3	3	10	40	50
	Program Elective-3	3	0	0	3	3	10	40	50
ME 23.421	Summer Internship -II***	0	0	0	2		100		
ME 23.423	Capstone Project-I	0	0	4	2		100		
	Total	9		4	**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-4	3	0	0	3	3	10	40	50
	Program elective-5	3	0	0	3	3	10	40	50
ME 23.422	Capstone Project-II	0	0	0	6		100		
	Total	6			**12**				

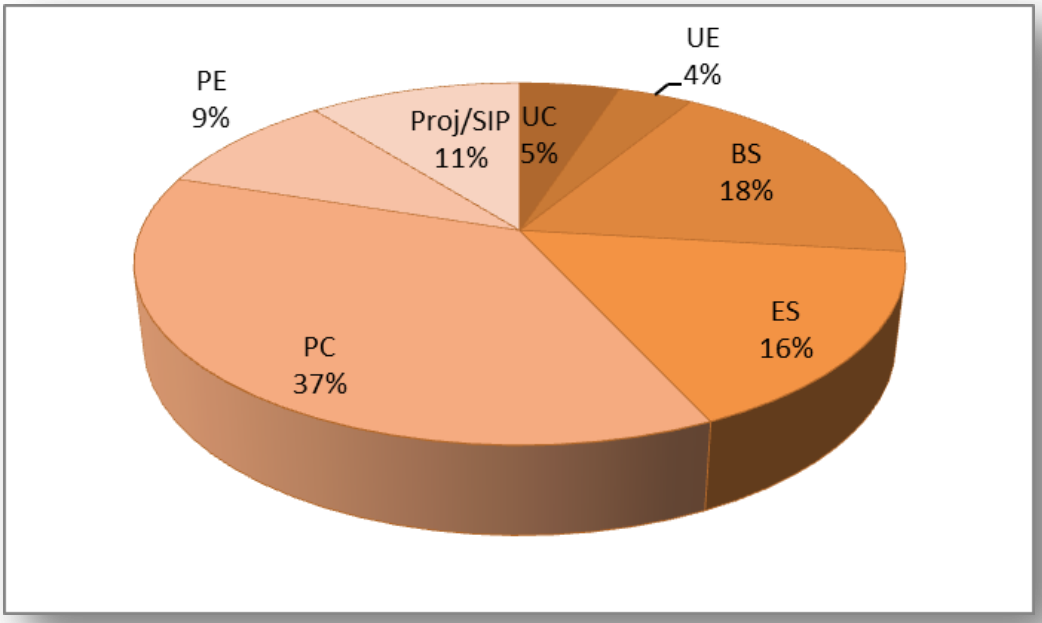
*** Summer Internship-II must be performed in an Industry between summer vacation of end of Third Year and start of Fourth Year.

List of Program Elective Options

Code	PROGRAM ELECTIVE
PROGRAM ELECTIVE- 1	
ME 23.311	Mechatronics
ME 23.313	Robotics Engineering
ME 23.315	Automobile Engineering
PROGRAM ELECTIVE-2	
ME 23.401	Vibration Engineering
ME 23.403	Maintenance Engineering
ME 23.405	Turbomachinery
PROGRAM ELECTIVE- 3	
ME 23.407	Work System Design
ME 23.409	Machine Tool Design
ME 23.411	Gas Turbine and Jet Propulsion
PROGRAM ELECTIVE- 4	
ME 23.402	Manufacturing Management
ME 23.404	Finite Element Method
ME 23.406	Tribology in Design
PROGRAM ELECTIVE- 5	
ME 23.408	Product Design and Development
ME 23.410	Advance Metal Casting and Welding
ME 23.412	Renewable Energy

Credit Distribution across all Components								
Semester	UC	UE	BS	ES	PC	PE	Proj/SIP	Total
First	2	0	10	9	0	0	1	22
Second	2	0	8	10	0	0	1	21
Third	0	0	7	4	11	0	1	23
Fourth	2	3	0	0	16	0	1	22
Fifth	0	0	0	0	17	3	4	24
Sixth	0	0	4	0	17	0	3	24
Seventh	0	3	0	0	0	6	4	13
Eighth	0	0	0	0	0	6	6	12
Total	6	6	29	23	61	15	21	161

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



UC 23.101 **Human Values and Professional Ethics** **Total Lectures: 26**
2-0-0-2

Objective: To create an awareness on professional ethics and human values, To instill moral and social values and loyalty and to appreciate the rights of others.

Pre-requisite:

1. **Introduction to Human Values:** Morals, Values and Ethics – Happiness & Prosperity Truth, Rights Conduct (Righteousness), Love, non-violence and peace, Humility and character. Core areas of ethics: Social ethics, Personal ethics Integrity and Trustworthiness, Honesty, Loyalty, Courage, Prudence, Confidence, Confidentiality. **[5]**
2. **Understand the Harmony:** Understanding the harmony as co-existing of self and body. Understanding my self, harmony in the family and society harmony in nature. **[4]**
3. **Professional Ethics:** Introduction, meaning of work ethics, professional ethics for Journalists, Physicians, Lawyers, Engineers and Accountants. Intellectual property Rights, scope of ethics, code of conduct, business values and inner consciousness, Ethics at the workplace cybercrime, plagiarism, misconduct, fraudulent use of institutional resources, etc. **[7]**
4. **Corporate Social Responsibility:** Evolution of Corporate Social Responsibility (CSR) in India, CSR models, CSR to different stakeholders, Corporate Social Responsibility Initiatives of Major Companies of India, Promoting value based governance in organization. Whistle blower policy. **[6]**
5. **Ethics and Environment:** Introduction to environmental Issues- Industry and Environmental Pollution, Ethics of Controlling environmental pollution – Impact of environmental pollution on human health – Rights, Duties and care in environmental protection - Sustainable development. **[4]**

Outcome: The students will understand the basic perception of profession, professional ethics, various moral issues and uses of ethical theories.

Text Books:

1. B.N Ghosh “Business Ethics and Corporate Governance”, McGraw Hill Education, Chennai, 2016
2. John R Boatright, “Ethics And The Conduct Of Business”, Pearson Education, New Delhi, 2013.

Reference Books:

1. Raju Ramachandran, “Professional Ethics: Changing Profession and Changing Ethics”, LexisNexis, Butterworths, 2nd Edition 2014.
2. Andrew Crane and Dirk Matten, “Business Ethics”, Oxford University Press, 2nd Edition, 2015.
3. S.K Mandal “Ethics in Business and Corporate Governance” McGraw Hill Education, New Delhi, 2013.
4. R. Subramanian “Professional Ethics”, Oxford University Press, 2015.

MA 23.101 **Mathematics I** **Total Lectures: 40**

3-1-0-4

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

Pre-requisite: (10+2) Higher Secondary Mathematics

1. **Differential Calculus I:** Review of basic concepts, partial differentiation, different chain rules, second and higher order partial derivatives, Euler's theorem (with proof) on homogeneous functions and applications, Jacobians, properties of Jacobians. [07]
2. **Differential Calculus II:** Maxima and minima of functions of two variables, asymptotes (parallel and oblique), Tracing of simple Cartesian curves and standard polar curves. [07]
3. **Integral Calculus:** Basics of Beta and Gamma functions, Length of plane curves (Cartesian and polar), area bounded by the curves (Cartesian and polar), multiple integrals (double and triple), change of order of integration, physical interpretations and applications. [10]
4. **Matrix Theory**: Rank of matrix(elementary row transformations), linear dependence and independence of vectors, Solution of system of simultaneous linear equations, Eigen values, Eigen vectors of a matrix, Cayley-Hamilton theorem (without proof) and applications, diagonal and quadratic form of matrix.. [08]
5. **Three-dimensional Geometry:** Direction cosines and direction ratios of a straight line, equation of a plane, plane passing through intersections of two planes, equations of straight line, shortest distance between two skew lines, equation of a sphere, intersection of plane and sphere. [08]

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

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, McGraw Hill Education, July, 2017.
2. Bali N. P. and Goyal Manish , A Text Book of Engineering Mathematics, Ninth Edition, Laxmi Publication, January 2016..

Reference Books:

1. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Pal and Bhunia, Engineering Mathematics, Oxford University Press, 2015.
3. Dass and Verma, Higher Engineering Mathematics, S.Chand, 2019.

CY 23.101 **Engineering Chemistry** **Total Lectures: 39**

3-0-0-3

Prerequisite(s): NIL

Objective(s):
- To purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers their preparation, properties and uses.
- To develop the basics of protecting engineering materials from the natural forces.
- To understand the present day up-to-date knowledge of the contemporary energy sources.
- To build up the basis of the future Engineering materials like superconductors, conducting organic polymers, Nano materials etc.

1. **Water treatment:** Hardness, types of hardness, degree of hardness and its estimation (EDTA methods). Numerical problems on degree of hardness. Boiler troubles: sludge and scale formation, Prevention of sludge and scale formation in boilers. Softening of hard water (Lime-Soda, Permutit, Ion Exchange and calgon methods). Numerical problems based on water treatment (Lime-Soda process). [8]
2. **Polymers and Phase Rule:** Industrial applications of Inorganic and organic polymers. Phase Rule and its application to water and Sulfur system. [8]
3. **Electrochemistry and Corrosion:** Electrochemical Changes, Electrochemical cell and its classifications (Galvanic cell, electrolytic cell). Types of electrodes. Origin of electrode potential, Electrochemical Series. Electromotive force, Nernst equation of electrode potential. [8]
   Corrosion: Definition and its significance, Theories of corrosion, Mechanism of corrosion, types of corrosion, Corrosion control (Corrosion inhibitors, Cathodic protection - sacrificial anodic and impressed current cathodic protection).
4. **Fuels and Lubricants:** Introduction - Importance of fuels in Industries. Classifications of fuels, Comparison of solid, liquid & solid fuels, Calorific value of a fuel. Determination of calorific value by Bomb calorimeter. Refining and cracking of petroleum, knocking. Octane Number and Cetane Number. L.P.G., Coal gas and Producer gas. [9]
   Lubricants: Introduction and Classification of Lubricants. Properties of Lubricants, Lubricant Oil, Grease, Emulsions.
5. **New Engineering Materials:** Introduction: Superconductors, high and low temperature superconductors, organic electronic materials, Fullerenes and Nano materials, Industrial applications of fullerenes and Nano materials. [6]

Outcome(s): The student will be able to understand the basis of the future Engineering materials like of lubricants, superconductors, conducting polymers, Nano materials etc and purification of the most valuable natural resource of the future-water.

Text Books:
1. Jain and Jain, "Engineering Chemistry," 16th Edition, Dhanpat Rai Publishing Company, 2015.
2. S.S. Dara, "A Text Book of Engineering Chemistry," 12th Edition, S. Chand & Company Limited, 2014.

Reference Books:
1. Peter Atkins, Julio de Paula, and James Keeler, "Atkins' Physical Chemistry" Eleventh Edition, Oxford University Press, 2017.
2. William D. Callister, "Materials Science and Engineering: An Introduction, Eighth Edition, John Wiley & Sons, Inc., 2010.

ME 25.101 **Applied Mechanics** **Total Lectures: 40**
3-0-0-3

Prerequisite Basic Mathematics and Physics

Objectives:

- This course will help the student to acquire knowledge of basic engineering mechanics concepts and enhance their ability to solve open ended engineering problems.
- To provide the student with a clear and thorough understanding of the theory and applications of engineering mechanics, covering both statics and dynamics.

1. **Introduction:** Idealization of Mechanics, concept of Rigid Body, External Forces, Laws of Mechanics. Force systems, Moment of force, Moment of a couple, Equivalent system, Free Body Diagram, Equations of equilibrium and their applications to various systems of forces. **[12]**
2. **Distributed Forces and Moment Of Inertia:** Centroid of Composite figures, Area Moment of Inertia, Mass Moment of Inertia, and Principle Moment of Inertia. **[7]**
3. **Friction:** Introduction of friction, Laws of friction, wedge, screw, belt friction. **[7]**
4. **Tension, Compression and Shear:** Normal stress and strain, Hooke's Law and Poisson's Ratio, Stress-Strain diagram, Shear stress and shear strain, **[9]**
   Beams: Different support & load conditions, SFD and BMD of different beams
5. **Kinematics of Particles:** Introduction, Rectilinear motion, Plane curvilinear motion**,** Rectangular coordinates, Relative motion **[5]**
   Kinetics of Particles: Introduction, Force, Mass and acceleration, Newton's second law of motion, Equation of motion and solution of problems, Work and Energy, Impulse and Momentum.

Outcome:

1 Evaluate forces in various frames of structural members
2 Understand and Apply the concept of drawing free body diagram
3 Apply the concept of friction in engineering applications
4 Calculate the centroid and moment of inertia in various sectional components and apply this to real life examples
5 Understand and evaluate for internal forces
6 Understand the importance of kinetics and kinematics in mechanics and apply the principles to various frames

Text Books:

1. Hibbeler, Gupta R. C., "Engineering Mechanics," 11th ed., Pearson India, 2010.
2. Merian, J.L, Kraige, L.G., "Engineering Mechanics Vol I & II," 5th edition, Wiley India 2010.

Reference Books:

1. Timoshenko, S, Young, D.H, Rao, J.V, "Engineering Mechanics," 4th edition TMH, 2010.
2. Irving. H. Shames, "Engineering Mechanics," Prentice Hall Book Company, 1966.

EC 25.101 **Basics of Electronics Engineering** **Total Lectures: 40**

3-0-0-3

Prerequisite Basic Knowledge of Engineering and Applied Physics

Objective: To learn the fundamental principle and applications of electronics and communication engineering and devices.

1. **Introduction:** Brief history of major inventions in ECE, Electronic test and measurement equipment's, Specifications for electronic components. **[3]**

2. **Semiconductors**: Material and its properties, Formation of energy band diagram, Currents in semiconductors, Fermi-Dirac energy distribution, Types of semiconductors – Intrinsic and Extrinsic, Mass action law, Hall effect. **[7]**

3. **Diodes**: Introduction, Characteristic of ideal and real diode, Current components in diode, load characteristics, Breakdown in diode, Zener diode, Varactor diode, Tunnel diode, Clippers and Clampers, Rectifiers – Half and Full-wave rectifiers. **[10]**

4. **Transistors:** Introduction to pnp and npn transistors, current components, active, cutoff and saturation regions, CC, CB and CE configuration, Operating point, Biasing circuits, Bias Stability, Thermal runway and thermal stability. **[10]**

5. **Introduction to Signals and Communication Systems**: Definition, Classification of signals – Analog and Digital, Deterministic and Random signals, Power and Energy of signals, Bandwidth, Bit and Baud rate. Block representation of communication system, Modulation – Definition, Need of modulation, Types of modulation. **[10]**

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

1. Distinguish between conductors, semiconductors and insulators based on energy band theory and classify different types of semiconductors.
2. Employ the concept of Energy Band Theory and Fermi Levels to explain the operating principle of semiconductors.
3. Demonstrate the operating principle and characteristics of p-n junction diodes, different diode circuits and Transistors.
4. Understand various types of communication signals and its characteristics parameters.
5. Understand the basic concepts of communication system and modulation techniques..

Text Books:

1. George Kennedy, Bernard Davis, "Electronics Communication Systems", Tata McGraw-Hill, 3rd Edition, 2007.
2. Behrouz Forouzan, "Data Communication and Networking", McGraw-Hill, 4th Edition, 2006.

Reference Books:

1. David A. Bell, "Electronics Devices and Circuits", PHI, 4th edition, 2008.
2. Wayne, Tomasi, "Advanced Electronic Communication Systems", PHI, 6th edition, 2013.
3. Robert L. Boylestad, Louis Nashelsky, "Electronics Devices and Circuits Theory", Prentice Hall, 10th Edition, 2009.

ME 23.111 **Computer Aided Engineering Drawing** **Total Hours: 26**
0-0-4-2

Objective:
- To improve the visualization skills.
- To enable the students with various concepts like dimensioning, conventions and standards related to working drawings, projections in order to become professionally efficient.
- To impart the knowledge on understanding and drawing of simple engineering products.

1. **Introduction to Computer Aided Sketching:** Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and free hand practice. Board Drawing vs. Computer- Aided Drawing. Introduction to Solid works Environments. Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools. Co-ordinate system and reference planes. Definitions of HP, VP, RPP &LPP. Creation of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, dimensioning, line conventions, material conventions and lettering. [8]
2. **Orthographic Projections** : Horizontal planes, Vertical planes, Front view, Top view, Side view, Projections, First and Third angle of projection, Projections of points, Principles of orthographic projections, Sketching of different views of given objects. Introduction to sketching in Solid works : 2-Dimenional Sketching, Sketching in Solid works, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity. [12]
3. **Projections of Lines, Planes and Solids:** Lines inclined to both the principal planes, projection of Lamina inclined to both principal planes, Projections of solids: Axis inclined to both the reference planes and Intersection of solids. Introduction to part module in Solid works: Extrude, Revolve, Sweep, Hole, Filleting, and Chamfering features. [12]
4. **Sections of solids and sectional orthographic views:** Sectional orthographic projections - Full, Half, Partial, revolved and removed surfaces. Introduction to drawing module in Solid works: Standard 3 views, Auxiliary view, Section View, Projected view. [12]
5. **Isometric Projection:** Terminology, Isometric scale, Box method, Coordinate or offset method, Four-center method, isometric projection of arcs. Solid models practice using Solidworks part module. [8]

Outcomes:
1. Students will be able to improve their visualization skills so that they can apply these skills in developing new products.
2. Students will be able to know and understand the conventions and the methods of engineering drawing using Solid works.
3. Students will be able to prepare simple drawings of engineering products.

Text Books:
1. N.D. Bhatt, "Engineering Drawing", Charotar Publishing House, 2013.
2. Prof. Sham Tickoo, Sandeep Prem Dass “Solid works 2013 for Engineers and Designers” Wiley Publication, 2013.

Reference Books:
1. Randy H. Shih, “Solid works 2013 and Engineering Graphics: An Integrated Approach”, SDC Publications. 2013

CY 23.111 **Chemistry Laboratory** **Total Hours:26**
0-0-2 - 1

Prerequisite(s): NIL

Objective(s):
- To introduce students to water chemistry and purify the most valuable natural resource of the future-water.
- To understand one of the most versatile Engineering Materials: Polymers, lubricants, fuel and their properties and uses.

LIST OF EXPERIMENTS

Choice of 10-12 experiments from the following

1. To determine the temporary and permanent hardness in the given water sample by complexometric titration using EDTA as standard solution.
2. To determine the percentage of Available Chlorine in the given sample of Bleaching powder. Iodometrically.
3. To determine the alkalinity of water sample.
4. To prepare urea formaldehyde resin.
5. To determine the strength of given HCl solution by titrating it against NaOH solution using pH meter.
6. To determine the strength of given acid solution by titration it against sodium hydroxide solution using conductometer.
7. To determine molecular weight of a polymer using Ostwald viscometer.
8. Determination of viscosity of given lubricating oil by Redwood viscometer.
9. Determination of cloud and pour point of given lubricating oil.
10. Determination of the flash and fire point of given lubricating oil.
11. Determination of phase diagram of water system.
12. To determine the calorific value (HCV) of a sample of fuel.

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Outcomes The students will learn to:
- Estimate the Hardness of water, alkalinity of water.
- Familiar with the important practical applications of electrochemistry, lubricants, solids, their properties and applications, and the polymer materials.

EC 23.111 **Electronics Laboratory** **Total Hours: 26**

0-0-2-1

Objective:

- To gain practical knowledge by applying the experimental methods to correlate with the theory of Electronics Engineering.
- To apply the analytical techniques and graphical analysis to the experimental data.
- To enable the students to simulate and test the Electronics circuits using Multisim software.

Prerequisite: Basic Understanding of Engineering Physics and Electronics

Practical to be performed on Hardware:

1. Familiarity of Soldering/de-soldering process, Component identification, testing and their verification using multimeter.
2. To plot V-I characteristics of junction diode and Zener diode.
3. To design a half wave rectifier with and without filter circuit and find the ripple factor.
4. To design a full wave rectifier with and without filter circuit and find the ripple factor.
5. Study of clipper and clamper circuits and their implementation on breadboard.
6. To plot the characteristics of Transistor under Common Emitter configuration

Practical to be performed using Multi-Sim Software:

7. To verify Ohm's law and Kirchhoff's law
8. To Simulate half wave and full wave bridge rectifier.
9. To plot V-I characteristics of p-n junction diode.
10. To plot V-I characteristics of Zener diode.
11. Study of Clipper circuit and its implementation on Multisim.

Outcome: After performing the above experiments, Student will be able to :

1 Identify and describe basic electronic components used in circuits.
2 Build and configure basic electronic circuits using breadboards.
3. Analyze the voltage-current characteristics of p-n junction diodes , Zener diodes and Transistor.
4 Develop clipper and clamper circuits to achieve desired voltage waveforms.
5 Utilize Multisim software to simulate and validate circuit designs.

CY 23.102 **Environmental Sciences** **Total Lectures: 26**
2-0-0-2

Objective:
• To teach the principal resources, renewable energy systems and biosphere.
• To explore the environmental impact of various energy sources and also the effects of different types of pollutants.

Pre-requisite: Nil

1. **Basic concepts of Environmental Studies:** Definition, scope and importance**,** Multidisciplinary nature of environmental studies, Need for public awareness. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. [4]
2. **Natural Resources:** Renewable and non-renewable resources. **Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources, case studies. **Forest resources:** Use and over exploitation, deforestation, case studies. **Land resources:** Land as a resource, land degradation, man induced landslides, soil erosion and desertification. **Food resources:** World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, [6]
3. **Ecosystems & Biodiversity:** Concept and Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow and nutrient cycling in the ecosystem. Food chains, food webs and ecological pyramids.
   Biodiversity and its conservation: Introduction – Definition, genetic, species and ecosystem diversity. Threats to biodiversity: habitat loss, illicit poaching, man-wildlife conflicts. [5]
4. **Environmental Pollution :** Definition, cause, effects and control measures of: Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear Radiation.
   Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides. [6]
5. **Social Issues, Population and impacts of Environmental impacts:**Urban problems related to energy, Resettlement and rehabilitation of people, Global Climate Change, global warming, acid rain, ozone layer depletion. Wasteland reclamation. Population growth, variation among nations. Population explosion, Environment and human health. Human Rights. Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health. Case Studies. Environment Protection Acts. [5]

Outcome: At the end of this course, students will demonstrate the ability to

- Evaluate local, regional and global environmental topics related to resource use and management
- Propose solutions to environmental problems related to resource use and management.
- Describe threats to global biodiversity, their implications and potential solutions.

Text Books:

1. Erach Bharucha “Environmental Studies”, University Grants Commission, 2004.
2. Anubha Kaushik, C P Kaushik “ Perspectives In Environmental Studies” New Age International Publishers. 2018

Reference Books:

1. C. William, P. Saigo, B Woodworth, “Environmental Science: A Global Concern”, Sixth Edition McGraw-Hill Higher Education, 2001.
2. Botkin, and Keller, “Environmental Science” Wily Publication, 2012.
3. R.T. Wright, D.F. Boorse, “Environmental Science” 11th Edition, PHI, 2010.

UC 19.102 **Communication Skills** **Total Lectures: 26**
2-0-0-2

Objective: This Course aims to develop and enhance the linguistic and communicative competence of the students. The students will be exposed to various forms of personal and professional communication. The self-learning tasks designed will facilitate to enhance effective communication skills.

Pre-requisite:

1. **Introduction to Communication:** Need for Effective Communication, The Process of Communication, Use of language in communication; Barriers to Communication: Types of barriers (Semantic, Intrapersonal, Interpersonal, And Organizational); Miscommunication; Noise; Overcoming measures. **Technology-based Communication:** Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software. [5]
2. **Listening and Reading Skills :** Listening as an active skill; Types of Listeners; Listening for general content; Listening to fill up information; Intensive Listening; Listening for specific information; Developing effective listening skills; Barriers to effective listening skills. **Reading Skills**: Previewing techniques; Skimming; Scanning; Understanding the gist of an argument; Identifying the topic sentence; recognizing coherence and sequencing of sentences; Improving comprehension skills. [6]
3. **Writing Skills**: Sentence formation; Use of appropriate diction; Paragraph and Essay Writing; Coherence and Cohesion. Common Errors. **Letter Writing:** Formal, informal and demi-official letters; **Job Application:** Cover letter, Differences between bio-data, CV and Resume. **Report Writing**: Basics of Report Writing; Structure of a report; Types of reports. [6]
4. **Non-verbal Communication and Body Language:** Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language. [3]
5. **Interview Skills:** Types of Interviews; Ensuring success in job interviews; Appropriate use of non-verbal communication. **Group Discussion:** Differences between group discussion and debate; Ensuring success in group discussions. **Presentation Skills:** Oral presentation and public speaking skills. [6]

Outcome: The students would hone the skills of reading, writing, listening, and speaking and become adept at communicating in the current modern context.

Text Books:

1. Raman, M., & Singh, P. (2017). Business Communication (2nd edition.). New Delhi: Oxford University Press.
2. Lesikar, Raymond V and Marie E. Flatley. Basic Business Communication: Skills for Empowering the Internet Generation: Ninth Edition. New Delhi: Tata McGraw-Hill,

Reference Books:

1. Prasad, H. M. How to Prepare for Group Discussion and Interview. New Delhi: Tata McGraw-Hill Publishing Company Limited
2. Bonet, Diana. The Business of Listening: Third Edition. New Delhi: Viva Books, 2004.

MA 23.102 **Mathematics II** **Total Lectures: 40**

3-1-0-4

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

Pre-requisite: Mathematics I (MA 23.101)

1. **Computational Methods:** Calculus of finite differences, Forward, Backward and Shift operators and their relationship, Fundamental theorem of difference calculus (without proof), Factorial function, Interpolation schemes for equal intervals (Newton's forward and backward interpolation formulae), divided difference, interpolation for unequal intervals (Newton's divided difference and Lagrange interpolation formulae), Approximation of one real root of Algebraic and Transcendental equations by Newton-Raphson method.. [12]
2. **Ordinary Differential Equations I:** Definition, order and degree of differential equation, first order and first degree differential equations (variable separable, homogeneous, reducible of homogeneous, linear, Bernoulli and exact differential equations). [07]
3. **Ordinary Differential Equations II:** Linear differential equations of second order with constant and variable coefficients, general and particular solutions (complementary functions and particular integrals), and applications. [07]
4. **Partial Differential Equations:** Formation of partial differential equations, Lagrange's multipliers method for solution of first order differential equations, separation of variables for nonlinear differential equations(general and particular solutions) and applications. [06]
5. **Vector Calculus:** Vector and scalar point functions, conservative fields, gradient of scalar point functions, divergence and curl of vector point functions (Solenoidal and irrotational vectors), directional derivative of scalar point functions, line integral (work done), surface integral, volume integral, interpretations and applications. [08]

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

Text Books:

1. Ramana B.V., Higher Engineering Mathematics, McGraw Hill Education, July, 2017.
2. Bali N. P. and Goyal Manish , A Text Book of Engineering Mathematics, Ninth Edition, Laxmi Publication, January 2016.

Reference Books:

1. Erwin Kreyszig Advanced Engineering Mathematics, 9th Edition, Reprint 2011.
2. Pal and Bhunia, Engineering Mathematics, Oxford University Press, 2015.
3. Ram Babu, Engineering Mathematics, Pearson Education, First Edition, January 2009.

PY 23.101 **Engineering Physics** **Total Lectures: 40**

3-0-0-3

Pre-requisite: Fundamental knowledge of Basic Physics

Objective:
1. To provide students with a basic understanding of the Physics that may be required by engineers in the course of their careers
2. To enhance knowledge related to lasers and its different components to make it suitable for various purposes
3. To introduce the learners to the basics of modern physics and Quantum Mechanics

1. **Modern Physics**: Introduction to Black body radiation spectrum, Photo-electric effect, Compton effect. Wave particle Dualism. de Broglie hypothesis – de Broglie wavelength. Davisson and Germer Experiment. Matter waves and their Characteristic properties, Phase velocity, group velocity and Particle velocity, Relation between phase velocity and group velocity, Relation between group velocity and particle velocity. **[8]**

2. **Quantum Mechanics:** Heisenberg's uncertainty principle and its physical significance. Application of uncertainty principle (Non-existence of electron in the nucleus, explanation for decay and kinetic energy of electron in an atom). Wave function, Properties and physical significance of wave function, Probability density and Normalization of wave function. Setting up of one-dimensional time independent Schrodinger wave equation. Eigen values and Eigen functions. Application of Schrodinger wave equation – Energy Eigen values for a free particle. Energy Eigen values and Eigen functions for a particle in a potential well of infinite depth. **[7]**

3. **Electrical Conductivity in Metals**: Free–electron concept. Classical free-electron theory – Assumptions. Drift velocity, Mean collision time and mean free path. Relaxation time. Expression for drift velocity. Expression for electrical conductivity in metals. Effect of impurity and temperature on electrical resistivity of metals. **[8]**

Quantum free-electron theory – Assumptions. Fermi – Dirac Statistics. Fermi-energy, Fermi factor. Density of states (No Derivation). Expression for electrical resistivity / conductivity. Temperature dependence of resistivity of metals. electron in a periodic potential, origin of the energy gap, band theory of solids, distinction of solids into metals, semi-conductors and insulators.

4. **Dielectric & Magnetic Properties of Materials**: Dielectric constant and polarization of dielectric materials. Types of polarization. Equation for internal field in liquids and solids (one dimensional). Ferro and Piezo electricity. Frequency dependence of dielectric constant. Important applications of dielectric materials. Classification of dia, para and ferro-magnetic materials. Hysterisis in ferromagnetic materials. Soft and Hard magnetic materials. Applications. **[7]**

5. **Lasers and Optical Fibers**: Einstein's coefficients (expression for energy density). Requisites of a Laser system. Condition for laser action. Principle, Construction and working of CO2 laser and semiconductor Laser. Applications of Laser – Laser welding, cutting and drilling. Propagation mechanism in optical fibers. Angle of acceptance. Numerical aperture. Types of optical fibers and modes of propagation. Attenuation. Applications–Block diagram discussion of **[10]**

point to point communication.

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

1. Understand the experimental evidence supporting the de Broglie hypothesis and the wave-particle duality of matter.
2. Explain fundamentals of quantum mechanics and apply to one dimensional motion of particles.
3. Describe the band theory of solids.
4. Understand material properties to use in engineering applications and studies.
5. Illustrate the working of lasers and optical fibers.

Text Books:

1. S. O. Pillai, “Solid State Physics”, New Age International, Sixth Edition, 2009
2. V. Rajendran, “Engineering Physics,” TMH, Fifth Edition , 2013

Reference Book:

1. G. K. Shivkumar, “Engineering Physics,” Prism Book Pvt. Ltd.
2. Stephen T. Thornton, “Modern Physics for Scientists and Engineers”,Cengage Learning, 4th ed.,2013

EE 25.101 **Basics of Electrical Engineering** **Total Lectures: 40**
3-0-0-3

Objective: This course facilitates the students to get a comprehensive exposure to various concepts and devices of electrical engineering.

Pre-requisite: Nil

1. **DC Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, Ohm's law, Kirchhoff current and voltage laws, analysis of simple circuits with dc excitation using mesh and nodal method. Network Theorems - Superposition, Thevenin, Norton and Maximum power transfer Theorems. Time-domain analysis of first-order RL and RC circuits. Star-Delta Conversion [8]
2. **AC Circuits:** Basic terminologies, representation of sinusoidal waveforms, average, rms and peak values of a.c. quantities, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel). [8]
3. **Three Phase A.C. Circuits:** Three phase supply, phase sequence, star connection, delta connection, relationship between phase and line quantities in 3-phase circuits, measurements of three phase power under balanced condition. [6]
4. **Transformers:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, Transformer testing: open circuit and short circuit test, losses in transformers, regulation and efficiency. Basics of auto-transformer and three-phase transformer connections. [10]
5. **Electrical Machines:** DC Machines – construction, functions of each part, working principle, EMF and torque equations, types of dc machines. Single Phase AC machines, AC machines – classification (Split phase machines, universal machines), construction, operating principles of ac machines. [8]

Outcome: At the end of this course, students will demonstrate the ability to

- To understand and analyse basic electric and magnetic circuits.
- To study the working principles of electrical machines.

Text Books:

3. Kothari, D. P., and I. J. Nagrath, "Theory and Problems of Basic Electrical Engineering," PHI Learning Pvt. Ltd., 1998.
4. Fitzgerald, Arthur Eugene, David E. Higginbotham, and Arvin Grabel, "Basic electrical engineering," McGraw-Hill Series in Electrical Engineering, Auckland: McGraw-Hill, 1981, 5th ed.(1981).

Reference Books:

4. H.Cotton, "Advanced Electrical Technology," CBS Publication. 1967.
5. Vincent Del Toro, "Electrical Engineering Fundamentals," 2nd Edition PHI Publication. 1972.
6. Smarajit Ghosh, "Fundamentals of Electrical and Electronics Engineering", PHI Publication, 1st Edition, 2007.

CS 23.101 **Programming for Problem Solving-I** **Total Lectures: 40**

3-0-0-3

Prerequisite(s): NIL

Objective(s):
1. To learn principles of programming by the structured native language 'C'.
2. To comprehend the rudiments, constructs, syntax, and statements with essentials of efficient compiling, running and debugging processes.

1. **Introduction:** The role of programming languages, programming paradigms, language description and syntax structure, basics of structured and object-oriented programming, functional programming, logic programming, concurrent programming. [5]
2. **Fundamentals of 'C' language**: Character set, variables data types constants, arithmetic, relational and logical operators, type conversion,increment,decrement, bitwise and assignment operators, conditional expressions, statements and blocks, *if-else*, *switch*, loops-*do-while*, *while*, *for*; *break*, *continue* and *goto* statements, labels. [10]
3. **Functions, pointers and Arrays**: Basics of functions, storage classes, scope rules, and header files, recursion and C preprocessor, arrays, pointers and addresses, types of pointers, pointers and arrays address arithmetic, character pointers and functions, pointer arrays, pointers to functions, function returning pointer, pointer to array, array of pointers, and multidimensional arrays, command line arguments, dynamic memory allocation-malloc(), calloc(), realloc(), free() [13]
4. **Structures and unions:** Basics of structures and functions, arrays of structures, pointers to structures, passing structure to function, function returning structure, union, self-referential structures. [6]
5. **I/O and File Processing:** Concept of files, standard input and output, formatted output, file access in different modes, reading from and writing to a file, random access file operations. [6]

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

Text Books:
1. Brain W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second edition, Pearson Education.
2. Ravi Sethi & K.V.Viswanatha, Programming Languages-Concepts, and Constructs, Second edition, Pearson Education,

Reference Books:
1. Herbert Schildt, C: The Complete Reference, Fourth Edition, McGraw-Hill Education,
2. E Balagurusamy, Programming in ANSI C, Tata McGraw - Hill Education,

PY 23.111 **Physics Laboratory** **Total Hours: 26**
0-0-2-1

Pre-requisite: Nil

Objective:
1. To gain practical knowledge by applying the experimental methods to correlate with the Physics theory.
2. To apply the analytical techniques and graphical analysis to the experimental data.

List of Experiments:

1. To study of material constant, temperature coefficient of current and planck's constant.
2. To determine the specific resistance of a given wire by using the Carey Foster's bridge.
3. To measure the numerical aperture of an optical fiber.
4. To measure the cylindrical object of diameter with help of Screw gauge and Vernier caliper.
5. To study the variations of resistivity with temperature and hence determines the energy band gap of the given semiconductor with help of four probe method.
6. To convert a galvanometer into a voltmeter of a given range.
7. To convert a galvanometer into an ammeter of a given ranges.
8. To plot graph showing the variation of magnetic field with distance along the axis of a circular coil carrying current and to estimate from it the radius of the coil.

Outcome:
1. Students will be convergent with operation of equipment and verify the principle of Physics by doing the experiments.
2. Understand the concepts and principles related to material constants, temperature coefficients, and Planck's constant.
3. Analyze the collected data to determine the specific Resistance using Carey Foster's Bridge.
4. Perform measurements and data analysis to determine the numerical aperture of the optical fiber accurately.
5. Gain hands-on experience in measuring and plotting the magnetic field variation along the axis of a circular coil carrying current.
6. Develop the ability to convert a galvanometer into an ammeter and voltmeter.

EE 23.111 **Electrical Laboratory** **Total Hours: 26**

0-0-2-1

Objective: The objective is to provide a basic exposure of installation and operation of electrical equipment.

Prerequisite: Nil

Perform any ten of the list.

1. To Study of the various apparatus used in Electrical Engineering.
2. To perform residential house wiring using fuse, indicator, switch, Socket, plug and lamp.
3. To design a Tunnel wiring for illuminating three lamps.
4. To conduct the open circuit tests on the given single phase transformer and to determine equivalent circuit parameters.
5. To conduct the short circuit tests on the given single phase transformer and to determine equivalent circuit parameters.
6. To construct a fluorescent tube and to measure voltage across tube rod, voltage across choke and current.
7. To conduct the polarity test on the given transformer.
8. To control the speed of DC machine by field current control method.
9. To control the speed of DC machine by Armature Voltage control method.
10. To measure three phase power by using two wattmeter methods.
11. To verify Superposition Theorem using resistive circuit.
12. To verify Thevenin's Theorem using resistive circuit.

Outcome: Students will be convergent with installation and operation of electrical equipment.

ME 23.112 **Mechanical Workshop** **Total Hours:26**
0-0-2-1

Objectives:

1. Practice on manufacturing of components using workshop trades including fitting, carpentry, sheet metal and welding.
2. Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping.
3. Study and practice on machine tools and their operations.

List of Jobs:

1. **Fitting Shop:** Prepare job that contain various fitting operation like filing, marking, measuring, cutting, drilling etc.
2. **Carpentry Shop:** Prepare job that contain various carpentry operations and making of carpentry joint (T joint).
3. **Sheet Metal Shop:** Prepare job that contain various sheet metal operations and making job from sheet (funnel, tray etc).
4. **Machine Shop:** Perform various operations like, turning, step turning, facing, chamfering, knurling etc. on Lathe.
5. **Welding Shop:** Prepare a weld bead using arc welding process.

Outcomes:

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

1. To acquire skills in basic engineering practice.
2. To identify the hand tools and instruments.
3. To acquire measuring skills.
4. To provides the knowledge of job materials in various shops.
5. Students will be able to analyze the material on the basis of their properties and thus assigning different weight age to their use for technical purposes.

Text Books:

1. Hajara Chaudhary, Workshop Technology Vol I & II, Media Promoters and Publishers PVT. LTD, Mumbai.
2. B.S. Raghuvanshi, Workshop Technology, Dhanpat Rai & Sons. New Delhi.

Reference Books:

1. H S Bawa, Workshop Technology, TMH. New Delhi.

CS 23.111 **Programming Laboratory- I** **Total Hours: 26**

0-0-4-2

Objective:
- To make students familiar with syntax and structure of C-programming.
- To learn problem solving techniques using C programs implementation.

Prerequisite: Nil

1. Implement the logic of Data Types & Operators.
2. Implement the logic of Type Conversions.
3. Implement the logic of Arithmetic, Relational, and logical operators.
4. Implementation of Bitwise, unary, assignment operators.
5. Implementation of Increment and Decrement operators.
6. Implementation of Conditional operators.
7. Implement the logic of Increment and Decrement operators.
8. Implement programs in order to cover Control Structure, If-Else statements, Nested If-Else statements, Switch-case statement, Loops- For, While, Do-While, Break Continue, Go-To Statements, and Labels.
9. Implement programs in order to cover processing an array, passing arrays to functions, Multidimensional arrays.
10. Implement programs to cover all possible String operations.
11. Implement programs in order to cover Function prototypes and passing arguments to a function, Recursion.
12. Implement programs in order to cover Pointers declaration, operations on pointers, Array of pointers, pointers to arrays.
13. Implementation of structure and union programs.
14. Implement the use of Storage classes in C programming.
15. Implement programs for Reading and writing from/to a file.
16. Implement random access file operation

Outcome: On completion of this course student will be able to:
- Apply learning and knowledge of C language analytically, critically and logically to solve mathematical, scientific and real-life problems in an efficient manner

ME 25.207 BASICS OF SENSORS AND PROCESSING TECHNIQUES **2-0-0-2**

Objectives

At the end of the course, the student will be able to:
1. Understand the working principles and analysis of sensors.
2. Understand the characteristics and response of micro sensors.
3. Apply a suitable sensor for a particular instrumentation task
4. Create sensor materials for fabrication for different applications

Prerequisite: Basic electronics, Physics

Unit. 1. FUNDAMENTALS AND TEMPERATURE SENSORS

Difference between sensor, transducer and Actuators- Classification of sensors: Proprioceptive and Exteroceptive – Active and Passive– Contact and Non-contact, selection and characteristics: Range; resolution, Sensitivity, error, repeatability, linearity and accuracy, Primary sensing elements.

Temperature sensors: Principle of operation, construction details, characteristics and applications of bimetallic thermometer, Resistance thermometer, Thermistor, Thermocouples and Total radiation Pyrometers.

Unit. 2. STRAIN, FORCE, TORQUE AND PRESSURE SENSORS

Strain gauges, strain gauge beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo resistive and capacitive pressure sensor, Manometer, vacuum sensors, Pirani gauge.

Unit. 3. DISPLACEMENT, LEVEL AND FLOW SENSORS

Displacement Sensors: LVDT, RVDT, eddy current, transverse inductive, Hall Effect, magneto resistive, magnetostrictive sensors.

Liquid level sensor: Fabry Perot sensor, ultrasonic sensor, capacitive liquid level sensor.

Flow sensors: pressure gradient technique, ultrasonic, electromagnetic sensors and Hot wire anemometer.

Micro flow sensor, Coriolis mass flow and drag flow sensor.

Unit. 4. MICRO MACHINING TECHNOLOGIES

Overview of silicon processes techniques, Photolithography, Ion Implantation, and Diffusion, Chemical Vapor Deposition, Physical vapor Deposition, Epitaxy, Etching, Bulk micromachining, Surface Micromachining, LIGA and other techniques.

Outcome:

At the end of the course the students will be able to
CO.1. Analyze the basics and design the resistive sensors.
CO.2. Identify the materials and designing of inductive and Capacitive Sensors.
CO.3. Apply a suitable sensor for a particular instrumentation task
CO.4. Implement fabrication process and technologies and compare various Micro machining processes.

TEXT BOOKS

1. Patranabis.D, “Sensors and Transducers”, Wheeler publisher, 1994.
2. Sergej Fatikow and Ulrich Rembold, “Microsystem Technology and Microbotics”, First edition, Springer –Verlag NEwyork, Inc, 1997.
3. Jacob Fraden, “Hand Book of Modern Sensors: Physics, Designs and Application” Fourth edition, Springer, 2010.

REFERENCE BOOKS

Thomas. G. Bekwith and Lewis Buck.N, “Mechanical Measurements”, Oxford and IBH publishing Co. Pvt. Ltd.,
Robert H Bishop, “The Mechatronics Hand Book”, CRC Press, 2002.

MA 23.201 **Mathematics III** **Total Lectures: 40**

3-1-0-4

Pre-requisite: Mathematics I and Mathematics II

Objective: To acquire fundamental knowledge of Linear programming, Numerical Methods, Probability, Statistics and Integral Transform and apply in engineering disciplines.

1. **Linear Programming:** Introduction to linear programming problems, Graphical solution, Simplex method, Artificial variable technique (Two phase method, Big –M method). [8]
2. **Numerical Methods:** Solution of system of equations (Gauss elimination and Gauss - Seidel methods); Solution of algebraic and transcendental equations (Bisection and Regula Falsi methods); Solution of ordinary differential equation (Euler's modified, Milne's predictor & corrector, Runge -Kutta method of order four). [8]
3. **Integral Transform:** Basics of Laplace transform and inverse Laplace transform; First and Second Shifting theorems; Convolution theorem (without proof); Solution of ordinary differential equations with initial conditions by Laplace transforms. [8]
4. **Probability Theory:** Recapitulation of basics of permutation, combination and probability theory; Law of addition and law of multiplication; Conditional probability; Total probability; Baye's theorem (with proof) and it's applications. [8]
5. **Correlation and Regression:** Concept of least square technique , fitting of least square straight line and quadratic curve (Parabola)**,** correlations analysis, different types, Simple, partial and multiple correlations, correlation of bivariate frequency distribution. [8]

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

Text Books: 1. Ramana B.V., Higher Engineering Mathematics, TMH, 2016.

2. P. K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.

Reference Books: 1. Sastry S.S., Introductory Methods of Numerical Analysis, 5th Edition, Pearson.

2 Jain R.K. and S.R.K. Iyenger, Advanced Engineering Mathematics, Narosa Publishing House, 2003.

CS 23.205 **General Purpose Programming** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): CS 23.101 (Programming for Problem Solving -I)

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

1. **Introduction**: The basic elements of python, python syntax, python operators, basic input, branching programs, control structures, data types, strings, tuples, lists, sets, dictionaries, bytes, bytearray and input iteration, Mutability with different types, ranges and iterators [7]
2. **Functions and Module**: Functions and scoping flow of execution, specifications, recursion, global variables, variable arguments, default arguments, system functions and parameters, input and output, modules , making your own module, importing modules, decorators, generators, command line argument. [7]
3. **Classes and Object-Oriented Programming**: Abstract data types and classes, class attribute, instances, object overhead, constructor, self, inheritance, encapsulation and information hiding, polymorphism, getter & setter, abstract class, duck typing, monkey patching, operator overloading, method overloading using multiple dispatch decorator. [8]
4. **Testing and Debugging**: Exceptions and assertions, types of testing – black-box and glass-box, debugging, handling exceptions, assertions. [6]
5. **Advance Python:** Regular expressions – REs and Python, plotting using matplotlib and Multithreaded Programming, GUI & event handling programming using Tkinter & pygame. Introduction to machine learning and deep learning [12]

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

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

Text Books:

1. John V Guttag, Introduction to Computation and Programming using Python, Prentice Hall of India, 2nd Edition, 2013.
2. Martin C. Brown, Python: The Complete Reference,Mc Graw Hill, 2018

Reference Books:

1. Zed A. Shaw ,Learn Python the hard way: a very simple introduction to the terrifyingly beautiful world of computers and code, 3rd edition, 2014.
2. Richard L. Halterman,Learning to Program with python, 2011.
3. Allen Downey ,Think Python How to Think Like a Computer Scientist, Version 2.0.17, Green Tea Press Needham, Massachusetts,2012.

ME 23.201 **Mechanics of Solids** **Total Lectures: 40**
Credit 3-0-0-3

Objective(s):
- To acquaint with the basic concepts of stress and deformation in solids.
- To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

Prerequisite(s): ME 23.101, MA 23.101

1. **Compound Stress and Strains:** Introduction, objective of the course, stresses on inclined sections, strain energy, impact loads and stresses, state of plane stress, principal stress and strain, maximum shear stress, Mohr's stress circle, three dimensional state of stress & strain, generalized Hook's law. **[6]**
2. **Beams:** Axial force, shear force and bending moment diagrams for statically determinate (uniform and variable loading) beams including beams with internal hinges for different types of loading. Pure Bending**,** normal stresses in beams, shear stresses in beams due to transverse and axial loads, composite beams. Equation of elastic curve, cantilever and simply supported beams, Macaulay's method, area moment method, fixed and continuous beams, combined bending & torsion of solid & hollow shafts. **[12]**
3. **Columns, Struts and Trusses:** Buckling and stability, slenderness ratio, combined bending and direct stress, struts with different end conditions, Euler's theory for pin ended columns, effect of end conditions on column buckling, Rankine Gordon formulae, examples of columns in mechanical equipments and machines. Truss- Introduction, simple truss and solution of simple truss, method of joints and method of sections. **[10]**
4. **Thin and Thick cylinders:** Introduction, difference between thin walled and thick walled pressure vessels, Thin walled cylinders, hoop and axial stresses and strain, volumetric strain. **[6]**
5. **Curved Beams:** Bending of beams with large initial curvature, position of neutral axis for rectangular and circular cross sections, stress in crane hooks, stress in circular rings subjected to tension or compression. **[6]**

Outcome(s):
- Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems
- Solve problems relating to pure and non-uniform bending of beams and other simple structures.
- Solve problems relating to torsional deformation of bars
- Understand the concept of buckling and be able to solve the problems related to isolated bars.

Text Books:
1. R.K. Bansal, "A textbook of strength of materials", New Delhi: Laxmi Publications, 2010
2. Khurmi, R. S., "Strength of Materials: Mechanics of Solids". S. Chand Limited, 2005

Reference Books:
1. Popov, Egor Paul, and Toader A. Balan. "Engineering mechanics of solids" Vol. 2. Englewood Cliffs, NJ: Prentice Hall, 1990
2. Gere, J. M., and S. P. Timoshenko. "Mechanics of materials PWS." 1990

ME 23.203 **Engineering Thermodynamics** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):
- State and illustrate the first and second laws of thermodynamics
- Identify and explain the concept of entropy, enthalpy, specific energy, reversibility and irreversibility
- Apply the first and second laws of thermodynamics to formulate and solve engineering problems for (i) closed systems, (ii) open systems, and (iii) power cycles
- Use thermodynamic (steam) tables, charts, and equation of state (e.g. the ideal gas law) to obtain appropriate property data to solve thermodynamics problems

Prerequisite(s): MA 23.101

1. **Basic Concepts and Definitions:** Introduction and definition of thermodynamics, dimensions and units, systems, surroundings, property, energy, thermodynamic path, process and cycle, thermodynamic equilibrium, quasi static process, energy and its forms, work and heat, gas laws. **[8]**
   Zeroth and First Law of Thermodynamics: Zeroth law of thermodynamics, temperature scale, First law of thermodynamics, calculation of work in various processes and sign convention, first law of thermodynamics applied to open systems, steady flow systems and their analysis, steady flow energy equations for boilers, condensers, turbine, compressors, pumps and throttling process, etc., PMM-I.

2. **Second Law of Thermodynamics:** Limitations of first law of thermodynamics, thermal reservoir, heat engine, heat pump and refrigerator, statement and equivalence of the Kelvin Plank and Clausius statements, reversible and irreversible processes, Carnot cycle, Carnot engine, Carnot theorem and its corollaries, thermodynamic temperature scale, PMM-II. **[10]**
   Entropy: Clausius inequality, concept of entropy, calculation of entropy change, principle of entropy increase, temperature-entropy diagram, Second law analysis of a control volume, statement of third law of thermodynamics, available and unavailable energy, availability and irreversibility, second law efficiency.

3. **Properties of Steam**: Pure substance, property of steam, triple point, critical point, sub-cooled liquid, saturation states, superheated states, phase transformation process of water, graphical representation of P-V-T data, Properties of steam. Steam tables and Mollier chart. **[8]**
   Ideal Gas and Real Gas: Ideal gas, Real gas, Internal energy, enthalpy and specific heats of an ideal gas, equations of state, Dalton's law of partial pressures, Gibbs Dalton law, Thermodynamic properties of gas mixtures.

4. **Thermodynamic Relations:** Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation**.** **[8]**
   Power Cycles: Otto cycle, Diesel cycle, Dual cycle, Brayton cycle and Ericsson cycle.

5. **Vapour Power Cycle:** Rankine cycle, comparison of Carnot and Rankine cycle, modified Rankine cycle, effect of operating conditions on its efficiency, properties of ideal working fluid in vapour power cycle, Reheat cycle, regenerative cycle, bleeding extraction cycle, feed water heating co-generation cycle. **[6]**

Outcome(s):

- Understand and apply basic energy conservation equations for kinetic, potential and flow energies.
- Understand the concepts of enthalpy, entropy and the basic laws of thermodynamics.
- Understand and solve thermodynamic cycle problems, including the Carnot ideal cycle, the Otto cycle, the Diesel Cycle, Rankine and Brayton
- Understand thermodynamic tables, charts, and equation of state (e.g. the ideal gas law) to obtain appropriate property data to solve thermodynamics problems

Text Books:

1. Nag, P.K, "Engineering Thermodynamics", Tata McGraw-Hill, 5th Edition. 2013
2. Cengel Y.A and Boles M.A, "Thermodynamics: An Engineering Approach", Tata McGraw Hill, 7th Edition 2011.

Reference Books:

1. Sonntag, R. E, Borgnakke C. and Van Wylen G.J, "Fundamentals of Thermodynamics", John Wiley, 7th Edition. 2009
2. Moran, M. J and Shapiro H. N, "Fundamentals of Engineering Thermodynamics", John Wiley & Sons, 6th Edition. 2010.

ME 23.205 **Material Science** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):
- To acquaint students with the basic concepts of Material Science.
- To impart the knowledge on mechanical behavior of materials.
- To acquire knowledge in various class of materials (like Ferrous, Non-Ferrous Alloys and Advanced Materials) and their applications.
- To impart knowledge on Heat Treatment, Microstructure and Phase diagrams.
- To acquire knowledge in destructive and non-destructive testing of materials.

Prerequisite(s): PY 23.101

1. **Introduction to Materials:** Introduction to engineering materials, development in materials science, classification of material, crystal structures (BCC, FCC and HCP systems), imperfections in crystals, point defects, line defects, surface and bulk defects, slip, twinning. **[8]**

2. **Phase Diagrams:** Solid solutions, binary alloy system, lever rule, Iron-carbon equilibrium diagram, TTT diagrams**.** **[8]**

3. **Heat Treatment:** Annealing, normalizing, tempering, hardening (case hardening and surface hardening). **[8]**

4. **Engineering Materials:** Ferrous metals, alloy steels, tool steels, stainless steels, cast irons, effect of alloying elements on mechanical properties of steel. Copper and its alloys, aluminium and their alloys, bearing materials. Polymers, polymer types, polymer synthesis and processing; ceramics, their crystal structures and properties, composites, particle reinforced composites, fibre reinforced composites, structural composites, nanoparticle composites. **[8]**

5. **Mechanical Properties and Their Testing:** Destructive Testing**,** tensile test, engineering stress-strain curve, true stress-strain curve, types of stress-strain curves, compression test, formability, hardness testing, different hardness tests, Vickers, Rockwell, Brinell, impact test, ductile and brittle fracture, creep, generalized creep behaviour. Non-destructive testing (NDT), visual Inspection, magnetic particle inspection, dye penetrant inspection, ultrasonic inspection, Selection of NDT. **[8]**

Outcome(s):
- The students will be able to understand the knowledge of materials & their applications.
- Students will be able to design the alloy system of ferrous and non-ferrous metals based on their knowledge of phase diagrams and metal characteristics.

Text Books:
1. V. Raghavan, "Material Science & Engineering", Prentice Hall India Ltd., 6th Edition.
2. A. K. Bhargava, C.P. Sharma. "Mechanical Behaviour & Testing of Materials", PHI Learning Private Ltd., 2014

Reference Books:

1. Avner S. H, "Introduction to Physical Metallurgy", Tata-McGraw Hill Publishing Co., New Delhi, 26th Edition 2009.
2. Dieter G. E, "Mechanical Metallurgy", McGraw Hill Publishing Co., New York, Latest Edition.

ME 23.215 **Mechanics of Solids Laboratory** **Total Hours: 26**
Credit: 0-0-2-1

Objective(s):

- To acquaint with the basic concepts of stress and deformation in solids.
- To practise the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.
- Learn the fundamental concepts of the method of superposition, flexibility method, and stiffness method as applied to problems involving statically determinate and indeterminate axial and torsional members, and beams.

Prerequisite(s): ME 23.101, MA 23.101

List of Experiments

1. To determine the Impact toughness (strain energy) through Izod test. [**2]**
2. To determine the tensile strength of specimen using Universal Testing Machine. **[4]**
3. To find the modulus of rigidity using torsion testing equipment. **[4]**
4. To find the values of bending stresses and Young's modulus of the material of a beam (say a wooden or steel) simply supported at the ends and carrying a concentrated load at the centre using Universal Testing Machine **[4]**
5. To find the shear strength of given specimen using Universal Testing Machine. **[4]**
6. To find the compressive strength of given specimen using Universal Testing Machine. **[4]**
7. To determine the stiffness of the spring and modulus of rigidity of spring wire using spring testing machine. **[4]**

Outcome(s):

- Understand the fundamental concepts of stress and strain and the relationship between both through the strain-stress equations in order to solve problems for simple tri-dimensional elastic solids.
- Solve problems relating to pure and non-uniform bending of beams and other simple structures.
- Solve problems relating to torsional deformation of bars and other simple tri-dimensional structures.
- Understand the concept of buckling and be able to solve the problems related to isolated bars.

ME 23.217 **Thermodynamics Laboratory** **Total Hours: 26**
Credit: 0-0-2-1

Objective(s):
- Apply the first and second laws of thermodynamics to formulate and solve engineering problems for (i) closed systems, (ii) open systems, and (iii) power cycles
- Application of the first and second laws of thermodynamics

Prerequisite(s): MA 23.101

List of Experiments:

1. To measure temperature using different types of measurement devices and compare measurement methods for accuracy and ease of use. **[10]**
   a. J and K type thermometer
   b. NTC thermistor
   c. PT 100 platinum resistance thermometer (four wire)
   d. 2 x liquid in glass thermometers
   e. Bimetal and gas (vapour) pressure thermometer
2. To measure the humidity using different type of humidity measurement devices and compare the measurement methods for accuracy and ease of use. **[8]**
   a. Hair hygrometer
   b. Wet and dry bulb hygrometer
   c. Whirling hygrometer
3. To study and determine the various properties of steam with steam generator **[8]**

Outcome(s):
- Understand the thermodynamics implication and thermodynamics explanation for the states of matter.
- Understand the concepts of enthalpy, entropy and the basic laws of thermodynamics.

ME 23.219 **Computer Aided Machine Drawing** **Total Hours: 26**
Credit: 0-0-2-1

Objective(s):
- Understanding limits, Fits and Tolerances, various joints.
- Understanding CAD software
- Explaining and Sketching Valves, Cocks and Plugs.
- Various parts of Machinery

Prerequisite(s): ME 19.111

List of Experiments:

1. **Drawing Standards:** Code of practice for engineering drawing, BIS specifications–welding symbols, riveted joints, keys, fasteners. Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. **[4]**

2. **2-D Drawings:** Limits, Fits -Tolerance of individual dimensions, specification of fits, manual preparation of production drawings and reading of part and assembly drawings. **[8]**

3. **CAD Practice:** Drawing, Editing, dimensioning, plotting commands, layering concepts, hatching, detailing, assembly, basic principles of GD&T (geometric dimensioning & tolerancing) **[6]**

4. **Assembly Drawing (using CAD software):** Manual parts drawing and preparation of assembled views given part details for components followed by practicing the same using CAD packages. **[8]**

   Suggested Assemblies: Shaft couplings, Plummer block, screw jack, lathe tailstock, universal joint, machine vice, stuffing box, safety valves, non-return valves, connecting rod, piston and crank shaft, multi plate clutch. Preparation of bill of materials.

Outcome(s):
- Understand the machine parts drawing conventions
- Gain sufficient knowledge on Limits, Fits and Tolerances and their representation in the drawing
- Have sufficient knowledge in CAD softwares and their use.
- Draw and read the Machine drawing used in the Industry**.**

Text Books:
1. Gill P.S, "A Textbook of Machine Drawing", SK Kataria & Sons; 17th Edition 2013.
2. Prof. Sham Tickoo, Sandeep Prem Dass "Solidworks 2014 for Engineers and Designers" Wiley Publication, 2nd Edition 2014.

Reference Books:
1. K.C John, 'Textbook of Machine Drawing', PHI Learning Pvt. Ltd., 2nd Edition 2009.
2. Randy H. Shih, "Solidworks 2013 and Engineering Graphics: An Integrated Approach", SDC Publications. 2nd Edition 2013

UC25.201 **Management and Entrepreneurship** **Contact Hours: 26**
2-0-0-2

Objectives: This course introduces students to the principles of Entrepreneurship and Management practices. It acquaints students with the methods managers use to: assess the environment in which the organization operates; design, build, and implement the organization's capacity to serve; make decisions; and evaluate the efficacy of those decisions. It also provides students with a solid foundation in terms of the vital role played by entrepreneurs and entrepreneurship in the 21st century global economy.

1 **Introduction to Management**: Meaning and importance, Concept of industrial management, Levels of management, Management theories-classical, neo-classical and modern, Managerial roles (Mintzberg), Managerial competencies, Managers and environment. **[5]**

2 **Management Functions**: ***Planning*** – Concept, types, Strategic planning, Types of strategy, Decision making, Techniques for individual and group decision-making; ***Organizing* –** Concept, Design of organization structures, Departmentalization, Power and authority, Conflict and coordination; ***Staffing*** – Concept, Human resource planning, Recruitment and selection. **[5]**

3 **Contemporary Issues in Management**: Management challenges of the 21st Century, Factors reshaping and redesigning management purpose, Performance and reward perceptions, Internationalization, Digitalization, Entrepreneurship, Values and Ethics. **[5]**

4 **Entrepreneurship**: Definition and concept of entrepreneurship, Entrepreneur Characteristics, Classification of Entrepreneurs, Role of Entrepreneurship in Economic Development, Start-ups. **[5]**

5 **Idea Generation and Project Formulation**: Ideas in entrepreneurships, Sources of new ideas, Techniques for generating ideas, Guidelines for report preparation, Project appraisal techniques, EDP organizations - MDI, EDII, Industrial Sickness and Role of BIFR, Meaning of project, project identification, formulation, feasibility analysis. **[6]**

Outcome Students will describe the various levels of management and applicability of management Principles, demonstrate various types of authority, delegation and decentralization in authority, demonstrate various types of leadership styles and identify the motivation techniques used by leaders, and discuss the impact of emerging issues in management.

Text Books

1. L.M. Parasad, "Principles & practice of management", Sultan Chand & Sons, New Delhi, (Latest edition).
2. Stephen P.Robbins "Organizational Behavior" Pearson Education, New Delhi (Latest edition).
3. Khanna, S. S., Entrepreneurial Development, S. Chand, New Delhi.

Reference Books

1. T.N. Chhabra, "Business Organization and Management", Sun India Publications. New Delhi.
2. P.C. Tulsian, and V. Pandey, "Business Organization & Management", Pearson Education, India.

ME 23.202 **Kinematics of Machines** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- To provide basic concept of kinematics and kinetics of machine elements.
- Know different machine elements and mechanisms.
- Select Suitable Drives and Mechanisms for a particular application.
- Develop ability to come up with innovative ideas.

Prerequisite(s): ME 23.101

1. **Basics Of Mechanisms:** Terminology and definitions - degree of freedom mobility, Kutzbach criterion, Grashoff's law, kinematic inversions of 4-bar chain and slider crank chains, mechanical advantage, transmission angle, description of common mechanisms- single, double and offset slider mechanisms, quick return mechanisms, straight line mechanism. **[8]**

2. **Kinematics:** Displacement, velocity and acceleration analysis in simple mechanisms- Graphical Method of velocity and acceleration analysis for different mechanisms- instantaneous centre of velocity - angular velocity ratio theorem. coriolis acceleration. **[8]**

3. **Kinematics of Cam:** Classifications, displacement diagrams, parabolic simple harmonic and cycloidal motions, layout of plate cam profiles, derivatives of follower motion, high speed cams, circular arc and tangent cams, standard cam motion, pressure angle and undercutting. **[8]**

4. **Friction drives:** Introduction, belt and rope drives, open and crossed belt drives, velocity ratio, slip, power transmission, effect of mass of belt on power transmission, maximum power transmission, initial tension and maximum tension, pivots and collars, uniform pressure and uniform wear. **[8]**

5. **Gears:** Spur gear terminology and definitions, fundamental law of toothed gearing and involutes gearing, inter changeable gears, gear tooth action, terminology, interference and undercutting , non-standard gear teeth , helical, bevel, worm, rack and pinion gears (basics only), gear trains , parallel axis gear trains, epicyclic gear trains, differentials , automotive transmission gear trains. **[8]**

Outcome(s):

- Identify mechanisms and predict their motion
- Calculate the degrees of freedom of mechanisms.
- Draw velocity and acceleration diagrams of various mechanisms.
- Construct CAM profile for the specific follower motion.
- Select appropriate power transmission mechanism.

Text Books:

1. Rattan S. S, “Theory of Machines”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Edition 2014.
2. Shigley J. E and Uicker J.J, “Theory of Machines and Mechanisms”, Oxford University Press, 5th Edition 2017.

Reference Books:

1. Thomas B, “Theory of Machines”, Pearson Education India, 3rd Edition 2010.
2. Norton R. L, “Kinematics and dynamics of machinery”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1st Edition 2009.

ME 23.204 **Fluid Mechanics** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):
- To calculate hydrostatic forces on submerged surfaces.
- To apply Bernoulli equations.
- To calculate friction losses in pipes.
- To apply conservation of mass, momentum & energy principle.

Prerequisite(s): ME 23.101

1. **Introduction:** Physical properties of fluids, concept of shear stress, Newtonian and Non-Newtonian fluids **[8]**
   Fluid Statics: Pressure-density-height relationships, manometers, force on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform acceleration and uniform rotation about the axis.
2. **Kinematics of Fluid Flow:** Types of fluid flow, stream lines, streak lines, path lines, stream tubes, stream function and velocity potential, flow nets. **[10]**
   Dynamics of Fluid Flow: Euler's equation of motion along a streamline and its integration, Bernoulli's equation and momentum equation. Boundary Layer Analysis, Boundary Layer Thickness, Boundary Layer over a flat plate.
3. **Dimensional Analysis And Hydraulic Similitude:** Dimensional analysis, Buckingham's pi theorem, important dimensionless numbers and their significance, geometric, kinematic and dynamic studies. **[8]**
   Flow Past Immersed Bodies: Lift and drag, expressions for lift and drag.
4. **Flow Through Pipes:** Laminar and turbulent flow in pipes, general equation for head loss-Darcy-Weisbach and Fanning's equations, Moody's diagram, energy losses through pipe fitting, flow through network of pipes, power transmission through pipelines. **[7]**
5. **Fluid Flow Measurements:** Introduction, venturimeter, orifice meter, Pitot tube, notches and weirs. **[7]**
   Introduction To Compressible Flow: Velocity of sound in a fluid, Mach number, propagation of pressure waves in a compressible fluid

Outcome(s):
- An understanding of fluid mechanics fundamentals, including concepts of mass and momentum conservation.
- An ability to apply the Bernoulli equation to solve problems in fluid mechanics.
- An ability to apply control volume analysis to problems.
- An ability to use potential flow theory to solve problems.
- An ability to perform dimensional analysis for problems.
- Knowledge of laminar and turbulent boundary layer fundamentals.

Text Books:
1. Bansal R. K., "Fluid Mechanics and Hydraulic Machines" Laxmi Publication Pvt. Ltd. 2005.
2. Som S and Biswas G, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw-Hill, 2nd Edition, 2007.

Reference Books:

1. Young D. F, Munson B, Okiishi T. H and Huebsch W. W, “Fundamentals of Fluid Mechanics”, John Wiley, 6th Edition, 2009.
2. Modi, P. N., and S. M. Seth. Hydraulics and Fluid Mechanics: Including Hydraulic Machines (in SI Units). Standard Book House, 14th Edition, 2002
3. Cengal Y. and Cimbala J, “Fluid Mechanics”, Tata McGraw Hill, 6th Edition, 2010.
4. Douglas J. F, Gasoriek, J. M, Swaffield, J. and Jack, L, “Fluid Mechanics” Pearson Education, 5th Edition, 2008

ME 23.206 **Design of Machine Elements - I** **Total Lecture 40**
Credit: 3-0-0-3

Objective(s):

- To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
- To develop an ability to identify, formulate, and solve engineering problems.
- To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Prerequisite(s): ME 19.101, ME 19.201

1. **Introduction:** Engineering design - an applied decision theory with respect to functional requirements, aesthetic consideration and ergonomic consideration-traditional design methods-synthesis in design, standardization, preferred numbers, derived series of preferred numbers, types of Fits, tolerance with respect to Indian standard, calculation examples, interchangeability, surface Roughness and its designation on drawing. **[4]**

2. **Design against Static and Fluctuating Load:** Factor of safety, design of simple machine parts, design of Cotter Joint, knuckle Joint and Hooke's Joint, theories of Failures, maximum principal stress theory, maximum shear stress theory, distortion-energy theory of failures. Methods to reduce stress concentration. Fluctuating stresses, fatigue failure, endurance limit, low cycle and high cycle fatigue, notch sensitivity, reversed stress-design for finite and infinite life, cumulative damage in fatigue, Soderberg and Goodman lines, modified Goodman's diagram, Gerber equation, fatigue design under combined stresses. **[11]**

3. **Shaft, Keys and Couplings:** Transmission shafts, shaft design on strength basis, shaft design on torsional rigidity bases, ASME code for shaft design, design of hollow shaft, design of keys, design of couplings- muff coupling, rigid flange coupling, flexible coupling, design of shaft for lateral rigidity. **[6]**

4. **Welded, Riveted and Threaded Joints:** Design of riveted joints and simple welded connections under concentric loads only, eccentric load in plane of weld, welded joints subjected to bending moment, Welded joints subjected to torsional moment, welded joints subjected to fluctuating forces. Basic type of screw fastening, terminology of screw thread, ISO metric screw thread, materials and manufacture, simple analysis of bolted joints, eccentrically loaded bolted joints in shear, eccentric load perpendicular to the axis of the bolt, eccentric load circular base, elastic analysis of bolted joints, bolted joints under fluctuating load. **[9]**

5. **Power Screw and Springs:** Forms of threads, multiple threaded screws, terminology of power screw, torque requirement for lifting of load and for lowering of load, self-locking screw, design of screw jack, differential and compound screws. Types of springs, style of end, stress and deflection equation, series and parallel connections, spring material, design of helical springs, concentric springs, multi-leaf spring, design of load spring. **[10]**

Outcome(s):

- Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.
- Demonstrate knowledge on basic machine elements used in machine design.
- Be able to approach a design problem successfully, taking decisions when there is not a unique answer.

Text Books:

1. Bhandari, V. B. “Design of machine elements”. Tata McGraw-Hill Education, 2010
2. Gupta, J. K., and R. S. Khurmi. "A textbook of machine design." SI Edition 2005

Reference Books:

1. Norton, Robert L. "Machine design: an integrated approach", Prentice-Hall Inc: NJ, USA, 1996
2. Shigley, Joseph E., and Charles R. Mischke. "Machine Engineering Design.", McGraw-Hill Book Company, 1989
3. Spotts, Merhyle Franklin. “Design of machine elements”. Vol. 730. Englewood Cliffs: Prentice-Hall, 1985.

ME 23.208 **Production Technology-I** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 23.112

Objective(s):
- To analyze and understand the metal cutting phenomenon.
- To study the conventional machining processes such as lathe, drilling, milling, shaping.
- To select process parameters and tools for obtaining desired machining characteristic.

1. **Metal Cutting Theory:** Introduction to manufacturing, classification of manufacturing processes. Tool materials, tool geometry, mechanics of metal cutting, tool failures, tool wear in metal cutting, tool life, cutting forces and power, machinability, cutting fluids. **[10]**
2. **Turning Operations:** Introduction, center lathe, cutting tools, operations performed on a center lathe, taper turning methods, thread cutting methods, special attachments, limitations of a center lathe, capstan and turret lathes, turret indexing mechanism, tool layout of turret and capstan machines, automatic lathes, machining time estimation. **[8]**
3. **Hole Making and Milling Process:** Introduction, constructional features of a drilling, types of drilling machines, drill geometry, reaming, boring, tapping, other hole making operations, machining time estimation, boring machine. Introduction, types of milling machines, constructional features of a milling, cutters, milling operations, dividing head, milling mechanics, machining time estimation, machining center. **[8]**
4. **Other Machining processes:** Introduction to shaper, planner, slotter and broaching. Gears types and gear making, machining of gears, gear finishing. **[8]**
5. **Abrasive Machining:** Grinding machines, various grinding operations; Grinding wheels, preparation for wheel operation. Lapping, honing, super finishing **[6]**

Outcome(s): At the end of the course, the student will be able to understand working of lathe, shaper, planer, drilling, and milling and machines. Comprehend speed and feed mechanisms of machine tools. Estimate machining times for machining operations on machine tools. Be able to select proper metal removing processes for the typical application.

Text Books:
1. Rao P. N, "Manufacturing Technology", Tata McGraw-Hill, Fourth Edition.
2. Lindberg Roy A, "Processes and Materials of Manufacture", PHI, Fourth edition.

Reference Books:
1. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Fourth Edition, John Wiley & Sons.
2. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, 7th Edition, Pearson.

ME 23.216 **Fluids Mechanics Laboratory** **Total Hours: 26**
Credit: 0-0-2-1

Objective(s):
- To provide practice in estimating friction losses.
- To impart training to use various flow measuring devices for making engineering judgments.

Prerequisite(s): ME 23.101

List of Experiments:

1. To Study Bourdon tube pressure gauge. [2]
2. To calibrate pressure gage. **[2]**
3. Study of Venturimeter. **[6]**
   a. To measure complete static head distribution along a horizontal Venturitube.
   b. To compare experimental results with theoretical results.
   c. To measure the meter coefficient of discharge at various flow rates.
4. To study discharge over a notch. **[8]**
   a. To investigate head against discharge over a notch.
5. To study friction loss in pipe . **[8]**
   a. To investigate laminar and turbulent flow in pipe. .
   b. To verify Poiseulle's Equation and the coefficient of viscosity for water in the laminar flow region.
   c. To demonstrate and measure the change in friction factor from laminar to turbulent.

Outcome(s):
- Estimate the friction and measure the frictional losses in fluid flow.
- Experiment with flow measurement devices like venturimeter and orifice meter.
- Predict the coefficient of discharge for flow through pipes.

ME 23.218 **Design of Machine Elements Practice -I** **Total Hours: 26**
Credit: 0-0-2-1

Objective(s):

- Develop an ability to apply knowledge of mathematics, science, and engineering
- To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.
- To develop an ability to identify, formulate, and solve engineering problems.
- To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Prerequisite(s): ME 19.101, ME 19.201

List of Experiments

1.	Design and drawing of a cotter joint, knuckle joint, hooke's joint	**[4]**
2.	Application of theories of failure to design machine members subjected to combined loadings	**[4]**
3.	Design of machine elements against fluctuating loads.	**[4]**
4.	Design and drawing of rigid and flexible couplings.	**[4]**
5.	Design and drawing of a riveted joint & welded joint	**[4]**
6.	Design and drawing of threaded joints.	**[2]**
7.	Design and drawing of power screws.	**[2]**
8.	Design and drawing of springs.	**[2]**

Outcome(s):

- Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.
- Demonstrate knowledge on basic machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.
- Be able to approach a design problem successfully, taking decisions when there is not a unique answer.

ME 23. 220 **Production Laboratory** **Total Hours: 26**
Credit: 0-0-2-1

Prerequisite(s): ME 23.112

Objective(s): *To study and practice the various operations that can be performed in lathe, shaper, milling machines and drilling and to provide with the practical knowledge requisite in the core industries.*

List of Experiments

1. Job – I: Facing, Plain turning, Step turning, External taper turning, External threading, Knurling, Parting off.
2. Job – II: To cut multi slots on shaper.
3. Job – III: Slotting on milling machine.
4. Job IV: To cut gear teeth on milling machine using dividing head.
5. Job V: Job on Centre less grinding
6. Job VI: Job on Surface grinding
7. Job VII: Job on Radial Drilling machine
8. Job VIII: Job on Capstan and Turret lathe

Outcome(s): Upon completion of this course, the students can able to demonstrate and manufacture different types of components using the basic machine tools.

ME 23.301 **Dynamics of Machines** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- Understand Kinematics and Dynamics of different machines and mechanisms.
- To facilitate students to understand the function of flywheels, the concept of balancing of rotating and reciprocating masses.
- To understand the principles in mechanisms used for governing of machines
- To give awareness to students on the phenomenon of vibration and its effects.

Prerequisite(s): ME 23.101, ME 23.202

1. **Static and Dynamic force analysis:** Constraint and applied forces, static Equilibrium of two and three forces members, principle of virtual work, and friction in mechanisms. Dynamic analysis of 4-bar linkage and slider-crank mechanism, velocity and acceleration of a piston, angular velocity and angular acceleration of connecting rod, Engine force analysis, Dynamically equivalent system, inertia of connecting rod, Inertia force in reciprocating engine, crank shaft torque. **[10]**
   Engine dynamics and flywheel: Turning moment diagram of an I. C engine, Fluctuation of crankshaft-speed, flywheel and its effect on cyclic fluctuation of speed of an engine.
2. **Balancing:** Static balancing & dynamic balancing, Balancing of several masses, rotating in different planes, Balancing of reciprocating mass, Balancing of in-line engine, Balancing of V-engines, Balancing of radial engines. **[8]**
3. **Governors:** Types of governors, analysis of Watt, Porter , Proell, Hartnell, Hartung governor, Sensitiveness of a governor, hunting, isochronisms and stability of a governor, effect and power of a governor, effect of friction on dynamics of governor. **[8]**
4. **Gyroscope:** Angular velocity, angular acceleration and gyroscopic torque, gyroscopic effect on aeroplanes, naval ships, two wheelers and four wheelers. **[6]**
5. **Mechanical Vibrations:** Types of vibrations, Single degree free & damped vibrations, Logarithmic decrement, Forced vibration of single degree system under harmonic excitation, vibration isolation. **[8]**

Outcome(s):

- Students will have an understanding of static force relationships and inertia forces and their effect that exist in machines.
- Students will demonstrate the dynamics of flywheel and their motion.
- Analyse balancing of rotating masses in a single and several planes.
- Understand concepts of vibrations in various machineries, their harmful effects and remedies

Text Books:

1. Rattan S. S, "Theory of Machines", Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Edition 2014.
2. Shigley J. E and Uicker J.J, "Theory of Machines and Mechanisms", Oxford University Press, 5th Edition 2017.

Reference

1. Thomas B, "Theory of Machines", Pearson Education India, 3rd Edition 2010.

Books:

2. Norton R. L, "Kinematics and dynamics of machinery", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1st Edition 2009.

3. Bhave S., " Mechanical Vibrations: Theory and Practice ", Pearson India Ltd., 1st

ME 23.303 **Fluid Machinery** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):

- To impart the knowledge on pumps and turbines.
- To understand the basic principles of pneumatics and hydraulics.
- To identify pneumatic and hydraulic components and their functions
- To understand different types of turbine and its applications.
- To compute the efficiency of different types of turbine and pumps.

Prerequisite(s): ME 23.204

1. **Introduction:** Introduction, Application of momentum and momentum equation to flow through hydraulic machinery, Euler's fundamental equation. **[6]**
   Impact of Jet: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), effect of inclination of jet with the surface.

2. **Hydraulic Turbines:** Classification of turbines. **[15]**
   Impulse Turbines: Pelton turbine, constructional details, velocity triangles, power and efficiency calculations, governing of Pelton wheel.
   Reaction Turbines: Fransis and Kaplan turbines, constructional details, velocity triangles, power and efficiency calculations, degree of reaction, draft tube, cavitation in turbines, principles of similarity, unit and specific speed, performance characteristics, selection of water turbines.

3. **Centrifugal Pumps:** Classifications of centrifugal pumps, vector diagram, work done by impellor, efficiencies of centrifugal pumps, specific speed, model testing, cavitation and separation, performance characteristics. **[6]**

4. **Positive Displacement Pumps:** Reciprocating pump theory, slip and coefficient of discharges, indicator diagram, effect and acceleration, work saved by fitting air vessels, comparison of centrifugal and reciprocating pumps, positive rotary pumps, Gear and Vane pumps, performance characteristics. **[8]**

5. **Other Machines:** Hydraulic accumulator, Intensifier, Hydraulic press, Lift and Cranes, theory of hydraulic coupling and torque converters, performance characteristics, Hydraulic ram, Jet pumps, Airlift pumps. **[5]**

Outcome(s):

- Able to identify hydraulic problem.
- Able to learn any possible improvements on fluid machinery.
- Able to compute efficiency of various fluid machineries.

Text Books:

1. Bansal R. K., "Fluid Mechanics and Hydraulic Machines" Laxmi Publication Pvt. Ltd., 2005.
2. Modi, P. N., and S. M. Seth. Hydraulics and Fluid Mechanics: Including Hydraulic Machines (in SI Units). Standard Book House, 14th ed., 2002.

Reference Books:

1. Sayres A. T, "Hydraulic and Compressible Flow Turbomachines", Tata McGraw Hill, 1990.
2. Sawhney G. S. "Thermal And Hydraulic Machines", PHI Learning Pvt. Ltd.,

ME 23.305 **I. C. Engines** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- To teach students the fundamentals, operations, and performance of internal combustion engines and their different types.
- To provide students with the theoretical and experimental ability to operate, analyse, and design internal combustion engines.
- To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emissions

Prerequisite(s): ME 23.203, ME 23.204

1. **Introduction to I C Engine:** Two and four stroke engines, SI and CI engines, Valve timing diagram, Rotary engines, Stratified charge engine, Scavenging in 2 Stroke engines. **[9]**
   Spark Ignition Engines: Spark ignition engine mixture requirements, Carburetion, Theory of carburettor, SP and MPFI, Combustion in SI engine, Flame speed, Ignition delay, Abnormal combustion and it's control, combustion chamber design for SI engines.
2. **Compression Ignition Engines:** Combustion in CI engine, Ignition delay, Knock and its control, Combustion chamber design of CI engine, Turbocharging, Supercharging. **[6]**
3. **Engine Systems and Components:** Ignition systems- Battery, Magneto and Electronic, Lubrication systems, Engine starting system, Engine cooling system, Intake and exhaust system, Drive train- Cam shaft and Valves. **[7]**
4. **Pollutant Formation Control:** Pollutant, Sources and types, Nox formation, Hydrocarbon emission mechanism, Carbon monoxide formation, Particulate emissions, Effect of pollutant, Emission standards, Catalytic converters and particulate traps, Method of measurement **[12]**
   Alternate Fuels: Methanol, Ethanol, Hydrogen, Natural gas, Biogas, Bio diesel, Liquefied petroleum gas, Properties, suitability, Engine Modifications, Merits and Demerits.
5. **Performance Characteristic and Testing of I C Engine:** Standards for testing of I.C. Engine, Mean effective pressure, Mean effective pressure, indicated power, brake power, friction power, Methods to determine power and efficiencies, Variables affecting performance of engine, characteristic curves, heat balance sheet, Methods of improving engine performance. **[6]**

Outcome(s):

- Demonstrate a basic understanding of different types of internal combustion engines and their operations.
- To analyze the ideal models of engine cycles.
- To understand the effect of supercharging and turbocharging on engine performance.
- To understand fuel-metering systems: carburetors and fuel injectors, in SI and CI engines.

Text Books:

1. Ganesan V, “Internal combustion Engines”, Tata McGraw Hill, 3rd Edition, 2007.
2. Mathur M. L. and Sharma R. P, “Internal Combustion Engines”, Dhanpat Rai & Sons, 2005.

Reference Books:

1. Heywood John B, “Internal combustion Engines Fundamentals”, McGraw Hill, 2nd Edition, 2018.
2. Pulkrabek W. W, “Engineering Fundamentals of the Internal Combustion Engine, Pearson Education Limited, 2nd Edition, 2013.

ME 23.307 **Production Technology-II** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisite(s): ME 23.205, ME 23.208, ME 23.112

Objective(s):
- To understand the basic principles of metal forming, welding and casting processes
- To know the various types of melting practices
- To broaden the understanding of casting design principles

1. **Metal Forming:** Plastic deformation, deformation mechanism, hot and cold working, rolling principal, rolling stand arrangement, roll passes, sheet metal working processes bending, bend force, press work tool and types of dies. **[10]**
   Forging, Extrusion and other Processes: Forging operations, forging design, drop forging die design; Extrusion-principle, forward and backward extrusion, impact extrusion, hydrostatic extrusion, extruding tubes; Wire drawing- rod and tube drawing, swaging.
2. **Metal Fabrication Process:** Introduction to fabrication process, gas welding and cutting. Electric arc welding-principle of arc, arc welding equipment, electrodes, carbon arc welding, TIG GMAW, SAW, Resistance welding, Other welding process: Thermit welding, electro slag welding, EBW, laser beam welding, forge welding, friction welding, diffusion welding, explosion welding, Welding design: heat input, heat flow, distortion, metallurgy of welding, defects in welding, brazing, braze welding and soldering **[8]**
3. **Metal Casting Process:** Introduction, Casting terms Patterns: Pattern allowance-pattern materials-types of patterns- colour codes Moulding materials: Moulding sand composition-testing sand properties-sand preparation-moulding sand properties-types of sand moulds-moulding machines Cores: Core sand, types of cores, core prints, chaplets, forces acting on the moulding flasksGating system: Elements of gating system, gates, pouring time, sprue, gating ratio, slagtrap system, risering design-caine's method, modulus method, chills-feeding aids. **[9]**
4. **Powder Metallurgy & Rapid Prototyping:** Introduction, basic process, powder manufacturing, powder mixing and blending, composting, sintering. Introduction to rapid prototyping, role of rapid prototyping & rapid tooling, features and classifications. **[5]**
5. **Non Traditional Machining:** AJM, WJM, EDM, ECM, USM: working principle, components of set up, field of application, Parameters affecting machining characteristics, Material removal mechanism. **[8]**

Outcome(s):
- Student will be able to Choose forming techniques for various applications
- Develop welding techniques for various alloys
- Develop welding application concepts
- Develop suitable casting techniques for specific applications
- Design of gates and risers in castings

Text Books:

1. Rao P. N, "Manufacturing Technology", Tata McGraw-Hill, Fourth Edition.
2. Lindberg Roy A, "Processes and Materials of Manufacture", Fourth edition PHI Latest Edition.

Reference Books:

1. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Fourth Edition, John Wiley & Sons.
2. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, 7th Edition, Pearson.

ME 23.309 **Thermal Engineering System** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):

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

Prerequisite(s): ME 19.203

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

Outcome(s):

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

- To the design analysis of auxiliary fluid and thermal energy components and systems representative of the systems encountered in the practice of electrical, industrial, and related disciplines of engineering.

Text Books:

1. Yadav R, "Steam & Gas Turbines and Power Plant Engineering", Central Publishing House, 7th Edition, 2009.
2. Kearton W. J, "Steam Turbine Theory and Practice", CBS Publisher & Distribution Pvt. Ltd, 2011.

Reference Books:

1. Ballaney P. L, "Thermal Engineering", Khanna Publishers, 24th Edition, 2007.
2. Chattopadhyay P, "Boiler Operation Engineering", Tata McGraw Hill, 11th Edition, 2008.

ME 23.317 **Fluid Machinery Laboratory** **Total Hours: 26**
Credit: 0-0-2-1

Objective(s):
- To impart the knowledge on pumps and turbines.
- To understand the basic principles of pneumatics and hydraulics.
- To identify pneumatic and hydraulic components and their functions
- To understand different types of turbine and its applications.

Prerequisite(s): ME 23.204

List of Experiments:

1. To study and determine the performance characteristic of a Pelton wheel. [**6]**
   a. To plot a graph between inlet pressure, flow rate, torque and power against speed for a set of nozzle opening.
   b. To analyze the plotted graph between inlet pressure, flow rate, torque and power against speed for a set of nozzle opening.
   c. To determine the overall conversion efficiency of fluid to mechanical energy, over a range of condition.
   d. To compare experimental results with theoretical results

2. To study and determine the performance characteristics of Francis Turbine **[6]**
   a. At different flow rates
   b. At different guide vane setting
   c. To determine the overall conversion efficiency of fluid to mechanical energy
   d. To compare experimental results with theoretical results

3. To study and determine the performance characteristics of Centrifugal Pump. **[6]**
   a. To plot a graph between head v/s flow.
   b. To plot a graph between efficiency v/s flow
   c. To study non dimensional characteristics
   d. To demonstrate Cavitations

4. To study and determine the performance characteristics of positive displacement pumps **[8]**
   a. Piston pump
   b. Gear pump
   c. Vane pump
   d. Swash plate pump

Outcome(s):
- Able to identify hydraulic problem.
- Able to learn any possible improvements on fluid machinery.
- Able to compute efficiency of various fluid machineries.

ME 23.319 **I.C. Engines Laboratory** **Total Hours: 26**
Credit: 0-0-2-1

Objective(s):

- To provide knowledge on testing of properties of fuels and lubricating oils
- To demonstrate and conduct experiments, interpret and analyse data and report results of IC Engine testing
- To make the student understand about the various components of petrol engine and diesel engine by dismantling and assembling the parts like carburettor, alternator, water pump etc.

Prerequisite(s): ME 23.203, ME 23.204

List of Experiments:

1. To Study the performance characteristics of single cylinder four stroke petrol engine. **[6]**
   a. To investigate torque speed and power relationship
   b. To study mean effective pressure
   c. To plot different engine performance curve
   d. To determine volumetric and thermal efficiency

2. To Study the performance characteristics of single cylinder four stroke diesel engine. **[8]**
   a. To investigate torque speed and power relationship
   b. To study mean effective pressure
   c. To plot different engine performance curve
   d. To determine volumetric and thermal efficiency
   e. To plot a Willans line

3. To Study the performance characteristics of Reciprocating Compressor **[6]**
   a. To investigate compressor performance with variation in pressure and speed
   b. To determine mechanical, volumetric and isothermal efficiency of compressor
   c. To investigate energy balance and thermodynamics of compressor

4. To Study the performance characteristics of Centrifugal Compressor **[6]**
   a. To investigate compressor performance with variation in speed.
   b. To investigate non dimensional characteristics.
   c. To compare the performance of centrifugal compressor with ideal system

Outcome(s):

- Compute the property of fuels and lubricating oils using suitable tests.
- Demonstrate the performance of internal combustion engines and air compressors.
- Interpret the emission characteristics of internal combustion engines**.**

PROGRAM ELECTIVE- 1

ME 23.311 **Mechatronics** **Total Lecture 40**
Credit: 3-0-0-3

Objective(s)

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

Prerequisite(s) EC 23.101

1. **Introduction**: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach. Review of fundamentals of electronics. Data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs. **[12]**
2. **Drives:** stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer **[8]**
3. **Hydraulic systems**: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps. Design of hydraulic circuits. **[8]**
4. **Pneumatics:** production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description **[6]**
5. Description of PID controllers. CNC machines and part programming. Industrial Robotics. **[6]**

Outcome(s)

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

Text Books:

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

Reference Books:

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

PROGRAM ELECTIVE- 1

ME 23.313 **Robotics Engineering** **Total Lecture 40**
Credit: 3-0-0-3

Objective(s)

- To provide fundamental knowledge of the various sub-disciplines such as kinematics, dynamics, controls, sensors, actuators, etc.
- To provide adequate background in both analysis and design of robots.
- To provide basic understanding of application of robotics in various applications.
- To understand economics behind application of robotics

Prerequisite(s) EC 19.101

1. **Introduction**: Classification of robots, basic robot components, manipulator end effectors, controller, power unit, sensing devices, specification of robot systems, accuracy precision and repeatability. **[8]**
Robot Motion Analysis: Manipulator Kinematics, Inverse Manipulator Kinematics, Manipulator Dynamics-Newton-Euler and Lagrange formulation, Trajectory generation.

2. **Robotic sensing devices**: Position, velocity and acceleration sensors, proximity and range sensors, touch and slip sensors, tactile sensors, force and torque sensors. **[8]**

3. **Robotic vision system**: Imaging components, picture coding, object recognition, training and vision systems, and review of existing vision systems. **[8]**

4. **Robotics programming:** Methods of robot programming, types of programming, robotics programming languages, artificial intelligence. **[8]**

5. **Robot applications**: Material transfer and machine loading /unloading, processing applications, welding and painting assembly and inspection, future robotic applications and related technologies developments. **[8]**
Economics analysis of robotics: Robotics project analysis, life cycle costs, data required for economic analysis, methods of economic analysis.

Outcome(s)

- Be able analyze and design robot for automation purpose.
- Be able to understand concept of sensors and actuators. Identify sensors and actuators required for specific applications.
- Understand programming principles for robot control.
- Implement hardware and software to build a robot that can perform a task.

Text Books:

1. M.P. Groover, M.Weiss, P.N.Nagal, and N.G Odrey, Industrial Robotics, McGraw Hill. 2nd Edition 2012
2. K.S. Fu, R.S. Gonzalez, C.S.G. Lee, Robotics Control, Sensing Vision and Intelligence, Tata McGraw Hill Publishing Company Ltd. 2nd Edition 2008.

Reference Books:

1. Harry H. Poole, "Fundamentals of Robotics Engineering", Springer Science & Business Media, 2nd Edition 2012
2. Zhang D, Wei B, editors. "Mechatronics and Robotics Engineering for Advanced and Intelligent Manufacturing". Springer International Publishing;

PROGRAM ELECTIVE- 1

ME 23.315 **Automobile Engineering** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- To identify various automotive systems & subsystems
- To explain working & construction of various automotive systems & subsystems.

To introduce students to engine auxiliary systems like heating, ventilation and air-conditioning.

Prerequisite(s):

1. **Introduction** - Introduction of automobile, classification of automobile, parts of an automobile, performance of automobile, tractive efforts. Chassis - Introduction, classification of chassis, frame types & nomenclature of car body. **[4]**
2. **Fuel Supply, Lubrication and Cooling System** - Fuel feed system in spark ignition engine, types, gravity & pump feed system, layout of spark ignition engine fuel pump system, function of each component. Fuel supply system in compression ignition engine, layout, components, function, types, working & line diagram of common rail, individual pump system, fuel injectors, single orifice, multiple orifices. Engine friction, lubrication system, areas of heat flow in engines, temperature distribution and temperature profiles, cooling air and water requirements, cooling systems. **[10]**
3. **Suspension, Wheels and Tyres** - Introduction, Macpherson struts, Ball joint and torsion bars, Electronic ride control and air suspension systems, Sonar shock absorber and active suspension system. Introduction, Requirement & types of wheels , wheel balancing, wheel alignment
   Introduction, requirements & types of tyre, tyre construction, tyre materials, tyre shape, tread patterns, tyre inflation pressure, causes of wear. **[10]**
4. **Steering, Gears and Controls** - Purpose, function, general arrangements of steering systems, steering gears, steering ratio, drag link, power steering. Clutch- Types, necessity, construction & working, torque-converters. Gear Box- Types of gear box, construction & working of constant mesh gear box, synchromesh gear box, propeller shaft & differential, Axle- Type of rear axles, front axles & their applications, stub axles **[10]**
5. **Automotive Electrical & Auxiliary Systems** - Electrical circuit component, symbol and wiring diagrams, battery, starting motor, dynamo, alternators, lighting. Auxiliary systems like heating, ventilation and air-conditioning. **[6]**

Outcome(s):

- Develop non-working models of automobile sub- systems
- Formulate steering, braking and suspension systems
- Select a suitable conventional and automatic transmission system
- Identify the usage of automotive systems & hybrid vehicles.

Text Books:

1. William. H. Crouse, "Automotive Mechanics", McGraw-Hill, 10th Edition 2006.
2. Singh Kirpal, "Automobile Engineering", Vol.1&2, Standard Publications, 2008.

Reference Books:

1. Sethi H.M., "Automotive Technology", Tata McGraw-Hill, 1st Edition 2001.
2. Duffy James E., Modern Automotive Technology, Goodheart-Willcox Company,

ME 23.325 **Project I** **Credit: 2**

Prerequisite (s): -

Objective (s):

- To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.
- To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.
- To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.
- To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.

Each student / group has to work on research topics with hardware design and fabrication or advanced design and analysis projects. The projects must be in different specialization topics (Heat Power/Fluid Mechanics/Machine Design/ Applied Mechanics/ Production) from a list of topics offered by the department.

Students have to submit a project report to the respective supervisors and give a presentation of the work done in front of a specialization specific evaluation board. For each project, distribution of marks will be: 50 marks to be evaluated by the supervisor and 50 marks to be evaluated by the specialization specific evaluation board.

The project provides students with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project should demonstrate the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project should affirm students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

Outcome(s):

- Knowledge of discipline or content area
- Ability to think critically
- Ability to communicate effectively
- Ability to use contemporary technology
- Commitment to ethical and social responsibilities
- Commitment to learning as life-long endeavour

ME 23.302 **Heat and Mass Transfer** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- Identify and understand the various mechanisms of heat and mass transfer that characterize a given physical system.
- Formulate models for heat conduction processes. Apply analytical and numerical methods to solve one- and two-dimensional conduction problems.
- Analyze and design complex heat transfer applications, such as heat exchangers.
- Combine thermodynamics and fluid mechanics principles to analyze heat convection processes.
- Integrate radiation aspects into real-world global heat transfer problems.

Prerequisite(s): MA 19.201, ME 19.203, ME 19.204

1. **Basics Concepts:** Heat transfer in engineering, Mechanisms of heat transfer, temperature field and temperature gradient, conduction, convection and radiation heat transfer, concept of driving potential, combined mechanism of heat transfer. **[10]**
   Fundamental equations of conduction: General different equation of heat conduction in Cartesian, cylindrical and spherical coordinate system, one dimensional steady state heat conduction, systems without internal heat generation, systems with variable thermal conductivity, composite systems, critical radius of insulation, Special one dimensional steady state situations – heat generation, pin fins
2. **Transient heat conduction:** Introduction, systems with negligible internal resistance – lumped parameter method, systems with negligible surface resistance, heat flow in an infinitely thick plate, systems with finite surface and internal resistance. **[6]**
3. **Fundamental of convective heat transfer:** Introduction, convective heat transfer coefficient, basic equation, boundary layer concept, laminar heat transfer over flat plate, fully developed heat transfer through smooth pipes, the case of contact heat flux and constant wall temperature boundary condition, dimensional analysis, Correlation of heat transfer in turbulent flow, use of hydraulic diameter, free convection heat transfer phenomena. **[12]**
   Heat Exchangers: Types of heat exchangers; Fouling factors; Overall heat transfer coefficient; Logarithmic mean temperature difference (LMTD) method; Effectiveness-NTU method.
4. **Thermal Radiation:** Basic concept, Theory of thermal radiation, electromagnetic spectrum, Wien's displacement law, Stefan-Boltzmann equation, Concept of black, gray bodies without participating media, radiation shields, View factors, Equivalent emissivity of grooved surfaces electrical network analogies. **[10]**
5. **Mass Transfer**: Analogy between heat and mass transfer, mass diffusion, Fick's law of diffusion, boundary conditions, steady mass diffusion through a wall, transient mass diffusion, mass convection, limitations of heat and mass transfer analogy. **[2]**

Outcome(s):

- Analyze problems involving steady state heat conduction in simple geometries.
- Develop solutions for transient heat conduction in simple geometries.

- Understand the fundamentals of convective heat transfer process.
- Analyze heat exchanger performance by using the method of heat exchanger effectiveness.
- Calculate radiation heat transfer between black body surfaces.

Text Books:

1. Holman J. P, "Heat Transfer", McGraw Hill Higher Education., 10th Edition 2010
2. Nag P. K, "Heat & mass transfer", Tata McGraw Hill Publishing Company Ltd., 3rd Edition 2005.

Reference Books:

1. Yunus Cengel, "Heat and Mass Transfer: Fundamentals and Application", Tata McGraw Hill Publishing Company Ltd., 4th Edition 2011
2. Bergman TL, Incropera FP, DeWitt DP, Lavine AS. "Fundamentals of heat and mass transfer". John Wiley & Sons; 7th Edition 2011

ME 23.304 **Refrigeration and Air Conditioning** **Total Lectures: 40**
Credit: 3-0-0-3

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

Prerequisite(s): ME 23.203, ME 23.309

1. **Introduction:** Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP). **[6]**
   Air Refrigeration System: Carnot refrigeration cycle; Temperature Limitations; Brayton refrigeration or the Bell Coleman air refrigeration cycle; Necessity of cooling the aero plane; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems.
2. **Vapor Compression Refrigeration Systems:** Simple Vapor Compression Refrigeration systems-Limitations of Reversed Carnot cycle with vapor as the refrigerant; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP. **[11]**
   Multistage Vapor Compression Refrigeration Systems: Necessity of multistage compression, Compound VC cycle, Inter cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves.
3. **Vapor Absorption Refrigeration Systems:** Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; **[6]**
   Refrigerants: Definition, Classification, Nomenclature, Desirable properties, Comparative study, secondary refrigerants, Introduction to eco-friendly Refrigerants.
4. **Psychrometry:** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer. **[7]**
5. **Air Conditioning:** Classification; factors affecting air conditioning systems; comfort air-conditioning system; winter air conditioning system; summer air-conditioning system; year round air conditioning; unitary air-conditioning system; central air conditioning system; room sensible heat factor; Grand sensible heat factor; effective room sensible heat factor; Inside design conditions; comfort conditions; components of cooling loads; internal heat gains; system heat gain: external heat gain; Transport air conditioning. **[10]**

Outcome(s):

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

Text Books:

1. Stocker W. F. and Jones J.W., "Refrigeration & Air conditioning", Tata McGraw-Hill, New Delhi, 2nd Edition, 1982.
2. Arora C. P., "Refrigeration & Air conditioning", Tata McGraw-Hill, New Delhi, 7th Edition, 2006.

Reference Books:

1. Prasad M, "Refrigeration & Air conditioning", New Age International (P) Limited, New Delhi, 3rd Edition, 2006.

2. Rajput, R. K. Refrigeration and Air-Conditioning. SK Kataria & Sons, 1st Edition, 2009.

ME 23.306 **Manufacturing Technology and Quality Control** **Total Lectures: 40**

3-0-0-3

Prerequisite(s): ME 23.208, ME 23.307

Objective(s):
- *Describe various instruments and their characteristics.*
- *Solve the problems on angle measurements.*
- *Explain the types of control chart to use, depending on given data.*
- *Solve problems based on quality control and acceptance sampling.*

1. **Advanced Manufacturing Technology:** Jigs and Fixtures, Additive Manufacturing, Micro & Nano manufacturing processes, Fabrication of electronics products and IC. **[8]**

2. **Introduction to Metrology:** Principles of Engineering metrology, Measurement standards, Types and sources of errors, Accuracy and Precision, Linear and angular measuring instruments. Principles and Methods of straightness – Flatness measurement – Thread measurement, Gear measurement, Interferometry, Types of Interferometer, Flatness, Roundness measurement - Applications. Control Gauges and Comparators. Surface texture measurement with stylus type instruments, Tomlinson surface meter, Talysurf and profilograph. **[12]**
3. **Advancements in Metrology**: Introduction & applications of: Co-ordinate Measuring Machine, Universal Measuring Machine, Laser in Metrology, Automatic inspection system, Machine vision for online-offline inspection. **[4]**

4. **Quality Management:** Concept of Quality and quality control, elements of quality & its growth, purpose, setup, policy & objective, factors controlling & quality of design and conformance, balance between cost and quality and value of quality. Specification of quality, planning through trial lots and for essential information. QMS (ISO 9000, TS16949, ISO14000), Quality Audit, FMECA, Zero defects, TPM. Six Sigma. **[8]**

5. **Statistical Quality Control:** Importance of statistical method in quality control, measuring of statistical control variables and attributes. Measurement/inspection, different types of control charts (X Bars, R, P. charts) and their constructions and their application. **[8]**

   Acceptance Sampling: Sampling inspection & percentage inspection, basic concept of sampling inspection, operating characteristic curves, conflicting interests of consumer and producer, producer and consumers risks, AWQL, LTPD, ADGL, single and double sampling plans.

Outcome(s): *After successful completion of this course the student will be able to:*
- *Make various comparative measurements.*
- *Understand fundamentals of gears, thread measurements and measurements of surface finish.*
- *Control chart techniques in quality control.*
- *Purpose and use of sampling and its benefit.*

Text Books:
1. Groover, "Fundamentals of Modern Manufacturing", Wiley India. Latest Edition
2. Anand Bewoor & Vinay Kulkarni, "Metrology and Measurement", McGraw –Hill, 2009.
3. Mahajan M., "Statistical quality Control",Dhanpat Rai & Sons, Latest Edition.

Reference Books:
1. Jain R. K, "Engineering Metrology", Khanna Publishers, Latest Edition.
2. Gupta I. C, "Engineering Metrology", Dhanpatrai Publications, Latest Edition

ME 23.308 **Optimization Techniques** **Total Lectures: 40**
Credit: 3-1-0-4

Objective: To acquire fundamental knowledge of optimization techniques with statistics and probability and apply in engineering disciplines.

Pre-requisite: Mathematics I, Mathematics II, and Mathematics III

1 **Introductory Ideas:** Introduction to Operation Research, Optimization Techniques, Basic of Statistics, Introduction to Descriptive and Inferential Statistics. [05]

2 **Linear Programming**: Problem Formulation, Simplex Methods, Primal and Dual Problem, Dual Simplex, Sensitivity Analysis, Dynamic Programming, Integer Programming, Multi Criteria Decision Making. [10]

3 **Transportation and Assignment Models:** Introduction, Mathematical Formulation, Definitions, Physical Significance, Optimal Solution of Transportation (North West Corner Rule, Matrix Minima Method, Vogel's Approximation Method with MODI and Steeping Stone Methods); The Hungarian Method for Solution of the Assignment Problems, Variations in Transportation and Assignment Problems, The Travelling Salesman Problem.. [09]

4. **Decision and Queuing Theory:** Decision under various conditions, Game Theory, Minimax and Maximin Strategies, Birth and Death Process, Pure Birth and Pure Death Process, Classification of queuing models: $[(M/M/1):(FCFS/\infty/\infty)]$, $[(M/M/1):(SIRO/\infty/\infty)]$, $[(M/M/1):(FCFS/N/\infty)]$, $[(M/M/C):(FCFS/\infty/\infty)]$; Applications of Queuing Models. [09]

5. **CPM and PERT:** Project Management Techniques, Introduction to CPM and PERT Techniques, Rules of Network Construction, Network Analysis, Time Analysis, Time-Cost Optimization Algorithm. [07]

Outcome: After completion of the course, students would be able to apply the knowledge of optimization techniques with statistics and probability in inter-disciplinary engineering and solve curriculum problems.

Text Books:

1. Taha H. A, "Operations Research – An Introduction", Prentice Hall India, Latest Edition.
2. S.Palaniammal, Probability and Random Processes, PHI, 2013.

Reference Books:

1. P.K. Gupta and D.S. Hira, Operations Research, S. Chand, 2019.
2. Hillier F.S. and Lieberman G.J. Introduction to Operations Research, McGraw Hill, 2016.
3. Dass and Verma, Higher Engineering Mathematics, S.Chand, 2019.

ME 23.310 **Design of Machine Elements -II** **Total Lecture 40**
Credit: 3-0-0-3

Objective(s)

- *Develop an ability to apply knowledge of mathematics, science, and engineering*
- *To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.*
- *To develop an ability to identify, formulate, and solve engineering problems.*
- *To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Prerequisite(s) ME23.101, ME 23.201, ME 23.206

1. **Design of Gears:** Different types of gears – spur, helical, bevel and worm gears, Beam strength, wear strength, dynamics loads on gears, estimation of module based on beam strength and wear strength, Thermal consideration design of worm gears. **[14]**
2. **Friction Clutches and Brakes:** Different types of clutches, torque transmitting capacity for multidisc clutches, cone clutches, centrifugal clutches, Friction materials for clutches lining, energy equation and thermal considerations. Different types of brakes, Energy equations, Design of block brake, Design of band brake, Design of disc brake, Thermal consideration. **[9]**
3. **Rolling Contact Bearings:** Types of rolling contact bearings, Selection of bearing type, Static load carrying capacity, Equivalent bearing load, Load life relationship, selection of bearing life, Selection of bearing from manufacture's catalogue, Selection of taper roller bearings, Design of cyclic loads and speeds lubrication of bearing contact bearings, Mounting of bearings. **[6]**
4. **Sliding Contact Bearing:** Basic mode of lubrication, Petroff's equation, Mckee's Investigation, Reynold's equation, Raimondi Boyd method, Bearing design-selection of parameters, Bearing materials and construction, selection of lubricant. **[6]**
5. **IC Engine parts:** Cylinder, piston, connecting rod and Engine crank shaft. **[5]**

Outcome(s)

- *Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.*
- *Demonstrate knowledge on machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.*
- *Be able to approach a design problem successfully, taking decisions when there is not a unique answer.*

Text Books:

1. Bhandari, V. B. "Design of machine elements". Tata McGraw-Hill Education, 2010
2. Gupta, J. K., and R. S. Khurmi. "A textbook of machine design." SI Edition 2005

Reference Books:

1. Norton, Robert L. "Machine design: an integrated approach", Prentice-Hall Inc: NJ, USA,

2. Shigley, Joseph E., and Charles R. Mischke. "Machine Engineering Design.", McGraw-Hill Book Company.

ME 23.312 **CAD/CAM** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s) ME 19.101, ME 19.206, CS 19.101

Objective(s)

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

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

2. **Geometric Transformations, Curves and Surfaces**: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrices. Application of geometric transformations. Polygon, meshed and ruled surfaces: Bezier curves; B-spline curves. **[10]**

3. **Geometric Modeling**: Wireframe model: solid modeling: representation, volumetric properties, surface modeling, concepts of hidden-line removal and shading: Kinematics analysis and simulation. Application of CAD techniques to finite Element Mesh Generation. Computer Aided Manufacturing (CAM) **[8]**

4. **Introduction of CAM**: Basic concepts of manufacturing system and CAD/CAM. NC/CMNC Machine Tools; NC machine tools- basic components, coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment, flexible tooling, tool length compensation, tool path graphics; NC motion control system; Manual part programming, fixed/floating zero. Block format and codes: Computer assisted part programming. DNC and Adaptive Control: Direct numerical control: Adaptive control in machining system; Combined DNC/CNC system. **[10]**

5. **Computer Aided Process Planning and Automation**: Introduction and benefits of CAPP. Types of CAPP systems, machinability data selection systems in CAPP. Introduction to Automation **[8]**

Outcome(s)

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

Text Books:

1. Groover, Mikell P. "Automation, production systems, and computer-integrated manufacturing". Prentice Hall Press, Latest Edition.
2. Zeid Ibrahim, "CAD/CAM : Theory & Practice", Tata Mc Graw Hill Publication, Latest Edition

Reference Books:

3. Rao, Posinasetti Nageswara. "CAD/CAM: principles and applications". Tata McGraw-Hill Education, Latest Edition.
4. Radhakrishnan, Pezhingattil, S. Subramanyan, and V. Raju. "Cad/cam/cim". New Age International, Latest Edition.
5. Leondes, Cornelius T. "Computer aided and integrated manufacturing systems: a 5-volume set". Vol. 5. World scientific,.

ME 23.320 **Design of Machine Element Practice II** **Total Hours: 26**
Credit: 0-0-2-1

Objective(s):

- *Develop an ability to apply knowledge of mathematics, science, and engineering*
- *To develop an ability to design a system, component, or process to meet desired needs within realistic constraints.*
- *To develop an ability to identify, formulate, and solve engineering problems.*
- *To develop an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

Prerequisite(s): ME19.101, ME 19.201, ME 19.206

List of Experiments:

1. To design and draw according to data given Spur Gears. [**2]**
2. To design and draw according to data given Helical Gears **[2]**
3. To design and draw according to data given Bevel Gears. **[2]**
4. To design and draw according to data given Worm Gears. **[4]**
5. To design and draw according to data given Friction Clutch **[4]**
6. To design and draw according to data given different types of brakes. **[4]**
7. Selection and drawing of Rolling Contact Bearings **[4]**
8. Design and drawing of Piston and Connecting rod. **[4]**

Outcome(s):

- *Be able to analyze the stress and strain on mechanical components; and understand, identify and quantify failure modes for mechanical parts.*
- *Demonstrate knowledge on machine elements used in machine design; design machine elements to withstand the loads and deformations for a given application, while considering additional specifications.*
- *Be able to approach a design problem successfully, taking decisions when there is not a unique answer.*

ME 23.322 Advanced Production Technology Lab Total Hrs: 26

Credit: 0-0-2-1

Prerequisite(s): ME 23.112, ME 23.208

Objective(s): *To study tool dynamometer to provide with the practical knowledge requisite in the core industries. To demonstrate the theoretical concepts taught in Metrology and Quality Control. To understand and use various measuring tools and calibration of various measuring devices*

List of Experiments

1. By using lathe tool dynamometer measure the cutting forces in all directions and calculate the following: a) Shear plane angle b) Coefficient of friction c) Power consumption.
2. By using the drill dynamometer, measure the torque and thrust in Drilling operation.
3. Cutting forces measurement during milling using milling dynamometer.
4. Measurement of angle/taper using a sine bar.
5. Measurement of chordal thickness of Gear tooth by Gear tooth Vernier caliper.
6. Use of three-wire method to determine the effective diameter of external threads.
7. Measurement of flatness and roundness of a given machine/ground/lapped flat and round surface respectively using dial gauge.
8. Measurement of screw thread elements by tool Makers microscope and Inspection of various elements of screw thread by optical projector.
9. To measure surface roughness of a given test piece with the help of surface profilometer or surface roughness tester.

Outcome(s): *Upon completion of this course, the students can able to demonstrate and manufacture different types of components using the basic machine tools and also able to measures forces. the students can able to use measuring tools such as Sine Bar, Sine Center, Bevel Protractor, Tool Maker Microscope, Gear Tooth Micrometer, Optical Flats etc*

ME 23.328 **Project II** **Credit: 2**

Prerequisite (s): -

Objective (s):

- *To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.*
- *To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.*
- *To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.*
- *To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication* skills.

Each student / group has to work on research topics with hardware design and fabrication or advanced design and analysis projects. The projects must be in different specialization topics (Heat Power/Fluid Mechanics/Machine Design/ Applied Mechanics/ Production) from a list of topics offered by the department.

Students have to submit a project report to the respective supervisors and give a presentation of the work done in front of a specialization specific evaluation board. For each project, distribution of marks will be: 50 marks to be evaluated by the supervisor and 50 marks to be evaluated by the specialization specific evaluation board.

The project provides students with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project should demonstrate the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project should affirm students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

Outcome(s):

- *Knowledge of discipline or content area*
- *Ability to think critically*
- *Ability to communicate effectively*
- *Ability to use contemporary technology*
- *Commitment to ethical and social responsibilities*
- *Commitment to learning as life-long endeavour*

ME 23.401 **Vibration Engineering** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):

- *Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.*
- *Perform detailed analysis of the response of one and two degree of freedom systems in both free and forced vibration regimes.*
- *Explain the interaction of mechanical vibrations with humans.*
- *Perform vibration design of simple mechanical systems that can be approximated by one, two, or infinite degree of freedom systems.*

Prerequisite(s): ME 19.301, MA 19.201

1. **Introduction:** Basic Concept, Classification of vibrations and vibrating systems, Oscillating motion like harmonic motion, periodic motion and vibration terminology. **[10]**
   Free vibration of single degree-of-freedom system: Vibration model, Equation of motion, natural frequency, viscously damped free vibration, Logarithmic decrement, Coulomb damping.
   Harmonically forced vibration of single degree-of-freedom system: Forced harmonic vibration, vibration isolation, rotating unbalance, whirling of rotating shaft, support motion, Structural damping.
2. **Two Degree Freedom systems:** Introduction, Principal modes, Double pendulum, Torsional system with damping, coupled system, undamped dynamic vibration absorbers **[6]**
3. **Multi-degree-of-freedom system:** Free vibration of undamped systems, Torsional systems, Co-ordinate coupling and principal Co-ordinates, forced vibration of damp free and damped systems **[8]**
4. **Numerical technique to find Natural frequencies:** Rayleigh's method, Horzer's method, Matrix Iteration method, energy method. **[8]**
5. **Vibration analysis of continuous system:** Transverse vibration of strings, longitudinal vibration of rods, Torsional vibration of shafts, transverse vibration of beams. **[8]**

Outcome(s):

- *Ability to analyze the mathematical model of a linear vibratory system to determine its response.*
- *Ability to solve for the motion and the natural frequency for free and forced vibration of a single degree of freedom damped or undamped system.*
- *Ability to obtain linear mathematical models of real life engineering systems*
- *Ability to solve vibration problems that contain multiple degrees of freedom.*

Text Books:

1. Bhave S., "Mechanical Vibrations: Theory and Practice", Pearson India Ltd., 1st Edition 2010.
2. S. S. Rao, "Mechanical Vibrations", Pearson-Prentice Hall, 5th Edition 2011.

Reference Books:

1. Gowda, "Mechanical Vibrations", Tata McGraw-Hill Education, 1st Edition 2012
2. G. K. Groover, "Mechanical Vibrations", Nem Chand, 2nd Edition 1972

Elective 2

ME 23.403 **Maintenance Engineering** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisites:

Objective(s): *To make the students to explain the different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements.*

1. **Maintenance Planning:** Basic Principles of maintenance planning - Objectives and principles of planned maintenance activity Importance and benefits of sound Maintenance systems - Reliability and machine availability MTBF, MTTR and MWT - Factors of availability - Maintenance organization - Maintenance economics. **[8]**

2. **Preventive Maintenance:** Maintenance categories - Comparative merits of each category - Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication - TPM. **[8]**

3. **Condition Monitoring:** Condition Monitoring - Cost comparison with and without CM - On-load testing and off-load testing Methods and instruments for CM - Temperature sensitive tapes - Pistol thermometers - wear-debris analysis. **[8]**

4. **Repair Methods for Machine Elements:** Repair methods for beds, slideways, spindles, gears, lead screws and bearings - Failure analysis Failures and their development - Logical fault location methods - Sequential fault location. **[8]**

5. **Repair Methods for Material Handling Equipment:** Repair methods for Material handling equipment - Equipment records -Job order systems-Use of computers in maintenance. **[8]**

Outcome: *Student will be able to Understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.*

Text Books:

1. Srivastava S.K., Industrial Maintenance Management, S. Chand and Co. Latest Edition,
2. Bhattacharya S.N., Installation, Servicing and Maintenance, S. Chand and Co. Latest Edition,

Reference Books:

1. Higgins L.R., Maintenance Engineering Hand book, McGraw Hill, 5th Edition,
2. Garg M R., Industrial Maintenance, Latest Edition S Chand Publication

Elective 2

ME 23.405 **Turbomachinery** **Total Lectures: 40**

Credit: 3-0-0-3

Objective(s):

- *Teach students how to apply various understandings from other courses;*
- *Provide students with opportunities to apply basic flow equations;*
- *How to compare and chose machines for various operations.*

Prerequisite(s): ME 19.303

Introduction: Basic law and equations, dimensional parameters and their physical significance and specific speed. **[12]**
Energy Transfer in Turbomachine: General analysis of a turbomachine, energy transfer between fluid and rotor, degree of reaction.

Centrifugal Fans and Blowers: Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise. **[8]**

Centrifugal Compressor: Construction details, impeller flow losses, slip factor, diffuser analysis, and losses, performance curves. **[6]**

Axial Flow Compressor: Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, simple stage design problems and performance characteristics. **[8]**

Axial and radial flow turbines: Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics. **[6]**

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

- *Classify and explain the function of dimensionless number;*
- *Design Prototype from Model;*
- *Select Fluid Machines for Appropriate Operations;*
- *Applications of Thermodynamics Laws.*

Text Books:

1. Yahya S.H., Turbines, "Compressor and Fans", Tata McGraw-Hill, 4th Edition, 2011.
2. Venkanna B. K., "Fundamentals of Turbomachines", PHI Learning Pvt. Ltd., 1st Edition 2009

Reference Books:

1. Dixon S.I., "Fluid Mechanics and Thermodynamics of Turbomachinery", Butterworth-Heinemann, 6th Edition., 2010.
2. Shepherd, D.G, "Principles of Turbomachinery", Macmillan, 1995.

Elective 3

ME 23.407 **Work System Design** **Total Lectures: 40**
Credit: 3-0-0-3

Prerequisites: MA 19.204, ME 19.306

Objective: *The course should enable the students :*

- *To learn various Industrial Engineering techniques*
- *To impart knowledge on Forecasting, Project management, Inventory, Scheduling & capacity planning with appropriate tools and techniques needed for understanding the operational situation.*

1. **Introduction to Industrial Engineering and Plant Location:** Relevance & importance of industrial engineering in industry. Productivity Management*:* Productivity measurement and improvement. Factors affecting plant location, Selection of plant site, Quantitative techniques of plant location decision **[5]**

2. **Plant Layout & Material Handling***:* Plant layout, Types of layout Principles of layout design, Methods for evaluation of a layout, Quantitative techniques of developing layouts, Manual assembly lines, line balancing problems way to improve line balancing. Group Technology, parts family, parts classification and coding, production flow analysis. Introduction to material handling. **[8]**

3. **Work study & Ergonomics:** Method study, micro - motion study and principles of motion economy. Work measurement: time study, work sampling, standard data, PMTS. Introduction to ergonomics and its scope in relation to work. **[10]**

4. **Forecasting & Capacity Planning:** Use and types of forecasting, Methods of forecasting, Definition of capacity, capacity planning, capacity requirement planning, Capacity available and required. **[7]**

5. **Materials Planning & Scheduling:** Inventories-types and classification; ABC analysis, economic lot size, EOQ model, leads time and reorder point, inventory control systems. Aggregate planning: definition, aggregate planning methods, Introduction to MRP and MRP-II. Loading, scheduling and sequencing, single processor scheduling, flow shop scheduling, job shop scheduling, scheduling criteria; Gantt chart. **[10]**

Outcome: *The students should be able to:*

- *Understand Concept of Industrial engineering and its role in industry.*
- *Be good team member and project leaders to carry out projects in companies.*

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

Reference
1. Work Study, ILO, Geneva, Latest Edition.

Books: 2. Adam & Ebert, "Productions & Operations Management", PHI, Latest Edition.

Elective 3

ME 23.409 **Machine Tool Design** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s) ME 19.308

Objective(s)

- *To develop competency in understanding of machine tools and its working principles.*
- *To make the student conversant with design of machine tool structures and special features of machine tool design.*
- *To develop the understanding of mechanical vibration, Static and dynamic testing of machine tools, Modal analysis, Vibration isolation.*

1. **Machine Tool Drive:** working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, General requirements of machine tool design, Layout of machine tools. **[8]**
2. **Regulation of Speed and Feed Rates**: Aim of speed feed regulation, stepped regulation of speed, design of speed box, Design of feed box, Special cases of gear box design, Set stopped regulation of speed and feed rates. **[8]**
3. **Design of Machine Tool Structure:** Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Static and dynamic stiffness, Design of beds and columns,\ Design of housing models, Techniques in design of machine tool structure. **[8]**
4. **Design of Guide-ways and power Screws:** Function and type of guide-ways, design of slide-ways, protecting devices for slide-ways, Design of power screws. **[8]**
5. **Design of Spindles and Spindle Supports**: Materials for spindles, Design of spindles, Antifriction bearings, sliding bearings. **[8]**

Outcome(s)

- *Design various single and multipoint cutting tools*
- *Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application*
- *Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish*
- *Analyze economics of machining operations*

Text Books:

1. Mehta N. K. "Machine Tool Design & Numerical Control". Tata McGraw Hill Education Pte. Limited; 2012.
2. D. K Pal and S. K. Basu, "Design of Machine Tool", Oxford & IBH Publishing Pvt. Ltd.4th Edition

Reference Books:

1. G. Boothroyd, and W.A. Knight, "Fundamentals of machining and machine tools", Taylor & Francis, 3rd Edition
2. Donaldson, "Tool Design", Tata McGraw Hill Education Pte. Limited;.

Elective 3

ME 23.411 **Gas Turbine and Jet Propulsion** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):
- *Provide awareness and emphasis on the importance of f low physics that mechanical engineers are likely to encounter in the range of science and industry careers they follow.*
- *Understand compressible fluid flow.*
- *Learn the computational models of fluid flow*
- *Create an awareness of turbulent flow and its significance in industry*

Prerequisite(s): ME 19.303

1. **Compressible Flow Fundamentals:** Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility. **[8]**
2. **Flow Through Variable Area Ducts:** Isentropic flow through variable area ducts, T-s and h-s diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles. **[8]**
3. **Low Through Constant Area Ducts**: Flow in constant area ducts with friction (Fanno flow) - Fanno curves and Fanno flow equation, variation of flow properties, variation of Mach number with duct length. Isothermal flow with friction in constant area ducts.
   Flow in constant area ducts with heat transfer (Rayleigh flow), Rayleigh line and Rayleigh flow equation, variation of flow properties, maximum heat transfer. **[8]**
4. **Normal Shock:** Governing equations, variation of flow parameters like static pressure, static temperature, density, stagnation pressure and entropy across the normal shock, Prandtl - Meyer equation, impossibility of shock in subsonic flows, flow in convergent and divergent nozzle with shock, normal shock in Fanno and Rayleigh flows, flow with oblique shock (elementary treatment only). **[8]**
5. **Jet Propulsion:** Aircraft propulsion, types of jet engines, energy flow through jet engines, study of turbojet engine components-diffuser, compressor, combustion chamber, turbine and exhaust systems, performance of turbojet engines, thrust, thrust power, propulsive and overall efficiencies, thrust augmentation in turbojet engine, ram jet and pulse jet engines, Rocket propulsion, rocket engines thrust equation, effective jet velocity specific impulse, rocket engine performance, solid and liquid propellants, comparison of different propulsive systems. **[8]**

Outcome(s):
- *Solve simple one dimensional flow problems by making appropriate assumptions and by applying sensible boundary conditions.*
- *Solve simple problems in one dimensional isentropic and non-isentropic flow.*
- *Qualitatively appreciate the complexity of turbulence and the need for computational models for turbulent flow*
- *Assess flow contexts, be aware of the types of behavior that may occur, and know where to seek further information to predict behavior.*

Text Books:
1. Rathakrishnan.E, "Gas Dynamics", Prentice Hall of India, New Delhi, 2009
2. Zucker RD, Biblarz O. Fundamentals of gas dynamics. John Wiley & Sons; 2002.

Reference
1. Y.A.Cengel & J.M.Cimbala, Fluid Mechanics: Fundamentals & Applications,

Books:

1st Ed (2006) McGraw-Hill.

2. Patrich.H. Oosthvizen, William E.Carscallen, Compressible fluid flow, McGraw-

ME 23.402 **Manufacturing Management** **Total Lecture 40**
Credit: 3-0-0-3

Prerequisite(s) ME 19.306, ME 19.413

Objective(s) *To introduce the concepts of flexible manufacturing system, CIM, lean manufacturing, supply chain management, six sigma and sustainable manufacturing.*

1. **Flexible Manufacturing System & CIM:** Introduction, components of FMS machines, part movement system, work stations, system controller, planning and control hierarchy, system design, system set up, and flexible assembly system. Introduction to computer integrated manufacturing. **[8]**

2. **Lean and JIT:** Evolution of Mass production, Traditional vs. Mass production, Evolution of Toyota (Lean) Production System, JIT, pull and push systems of production; Kanban system. Introduction to ERP. **[10]**

3. **Supply Chain Management (SCM)**: Introduction, concept of logistics management, concept of supply management and SCM core competency, value chain elements of supply chain efficiency, flow in supply chains, key issues in supply chain management, decision phases in supply chain, supply chain integration process, supply chain competitive strategy and supply chain strategies, uncertainties in supply chain supply chain drivers. **[10]**

4. **Six Sigma Methodology:** Need for Six Sigma, Six Sigma Team, DMAIC Methodology: Define, Measure, Analyze, Improve and Control, Lean Six Sigma **[6]**

5. **Sustainability through Green Manufacturing Systems:** Concept of sustainability, Green manufacturing technique, Synchronous Manufacturing. **[6]**

Outcome(s) *The students will be able to design manufacturing systems which will be environmental friendly.*

Text Books:
1. Mikell P. Groover, "Automation, Production Systems, and Computer – Integrated Manufacturing", 3rd Ed., PHI Learning Pvt. Ltd., New Delhi, 2009.
2. Design and Analysis of Lean Production Systems, Ronald G. Askin & Jeffrey B. Goldberg, John Wiley & Sons, 2003

Reference Books:
1. Sunil Chopra & Peter Meindl, "Supply Chain Management, Strategy, Planning, and Operation ", 2nd Edition, PHI, 2004
2. John Nicholas. Competitive Manufacturing Management - Continuos Improvement, Lean Production, and Customer-Focused Qualities, McGraw-Hill International Editions.

Elective 4

ME 23.404 **Finite Elements Method** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):
- *To equip the students with the Finite Element Analysis fundamentals.*
- *To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.*
- *Develop finite elements formulations of engineering problems from the variety of application areas including stress, heat transfer and vibration analysis.*

Prerequisite(s): MA 19.201, ME 19.201, ME 19.204, ME 19.305

1. **Introduction:** Introduction to finite difference method and finite elements method, Advantages and limitations, Mathematical formulation of FEM, Different approaches in Finite Element Method - Direct Stiffness approach, simple examples, Variational approach, Elements of variational calculus - Principle of minimum potential energy, Rayleigh Ritz method, Weighted Residual methods, Point Collocation method, Galarkin method - Steps involved in FEM. **[10]**
2. **Types of Elements Used:** Interpolation Polynomials, Linear elements Shape function, Analysis of axial rod problem and simply supported beam. Quadratic element, nodal approximation, development of shape functions, element matrices and vectors, example problems, extension to plane truss, development of element equations, assembly, element connectivity, global equations, solution methods, beam element, nodal approximation, shape functions, element matrices and vectors, assembly, solution, example problems. **[6]**
3. **FEM Formulation of Solid Mechanics:** 2-D problem of shaft; Truss element analysis of pinned truss, Plane stress/strain problems, Axi-symmetric problems, thin plate problems; Vibration of shafts & beams. **[8]**
4. **FEM Formulation of Heat Transfer:** Introduction, Steady state heat condition, longitudinal deformation of a rod, unsteady state problem in one and two dimension. **[8]**
5. **FEM Formulation of Fluid Mechanics:** Basic equation of fluid mechanics, inviscid and incompressible fluids, viscous and non-Newtonian flows **[8]**

Outcome(s):
- *Identify mathematical model for solution of common engineering problems.*
- *Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts.*
- *Solve structural, thermal, fluid flow problems*
- *Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.*

Text Books:
1. S.S Rao, The Finite Element Method in Engineering, 2nd Ed., Pergamon Press, Oxford, Latest Edition.
2. O. C. Zienkiewicz and R. L. Taylor, The Finite Element Method, Volume 1-3 Butterworth-Heinemann, Latest Edition.

Reference Books:
1. T.R. Chandrupatla, A.D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India, Latest Edition.
2. K. J. Bathe, Finite Element Procedures, Prentice-Hall, Latest Edition.

ME 23.406 **Tribology in Design** **Total Lectures: 40**
Credit: 3-0-0-3

Objective(s):
- *Differentiate between the types of lubricants and its respective application area.*
- *Understand and explain different laws of friction and topology of surfaces.*
- *Appreciate the various modes of wear and the wear-mechanism maps.*

Prerequisites(s): ME 19.204, ME 19.206, ME 19.308

1. Tribology, Historical background, practical importance and subsequent use in the field **[8]**
Lubricants: Types and specific field of applications. Requisite properties of lubricants Viscosity, its measurement, effect of temperature and pressure on viscosity, standard grades of lubricants, and selection of lubricants. Lubricant Rheology, Lubrication Types, Basic equation of lubrication

2. **Friction:** Origin, Friction Theories, measurement methods, friction of metals and non-metals. **[8]**
Wear: Classification and Mechanisms of Wear, Delamination theory, Debris analysis, testing methods and standards, wear mechanism maps and approach to wear reduction. Related Case Studies

3. **Surface Roughness:** Standardization, measurement with contacting and non-contacting instruments, Statistical analysis of surface, characteristics of the surface, tribological behaviour of asperities contact. Behaviour of Tribological components: Plain & Antifriction Bearings: selection, effect of frictional torque, factors affecting performance, failure modes, bearing lubrication. **Gears:** friction & stresses, wear, lubrication & failure. Failure Case Studies **[8]**

4. **Hydrodynamic Bearings:** Mechanism of pressure development, classification, Idealized Journal Bearing, oil film thickness, pressure distribution, loads carrying capacity. Failure Case Studies. **[8]**
Elastohydrodynamic Lubrication: Theoretical considerations, line and point contacts, film thickness equations, different regimes in EHL contact.

5. **Antifriction Bearings:** Ball and roller bearings, geometry of ball bearings, radial load distribution, stresses and deformations, lubrication of ball bearings. Failure Case Studies. **[8]**
Monitoring of Equipment's Condition: Condition monitoring techniques, lubricant, corrosion, temperature & surface roughness monitoring. Failure Case Studies. Nano/Micro Tribology, Green Tribology.

Outcome(s):
- *Understand behaviour of bearing in different lubrication regimes and able to develop mathematical model.*
- *Select the type of bearing for any given required engineering use and determine the load carrying capacity and other related parameters.*
- *Decide on the condition monitoring techniques based on performance of tribological component*s

Text Books:

1. Sahoo P. “Engineering tribology”. PHI Learning Pvt. Ltd.; 2005.
2. Basu, S. K., S. N. Sengupta, and B. B. Ahuja. “Fundamentals of Tribiology”. PHI Learning Pvt. Ltd., 2005.

Reference Books:

1. Majumdar B.C. “Introduction to tribology of bearings”. S. Chand Publishing; 2008.
2. Stachowiak, G. W., A. W. Batchelor, and T. A. Stolarski. "Engineering tribology: Elsevier, 1993
3. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.

Elective 5

ME 23.408 **Product Design and Development** **Total Lecture 40**
Credit:3-0-0-3

Prerequisite(s) ME 19.413

Objective(s) *This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front end processes.*

1. **Introduction:** Concept of Product, definition and scope, Introduction to product development, Product design and development process, Challenges of product development, Need based developments; Technology based developments, Physical reliability & economic feasibility of design concepts. **[8]**

2. **Needs Identification & Conceptual Design**: Interpret raw data in terms of customers need, organize needs in hierarchy and establish the relative importance of needs, Generation, selection & embodiment of concept, Product architecture. Industrial design: process, need. Robust Design: Taguchi Designs & DOE. Design Optimization **[8]**

3. **Design for Mfg & Assembly:** Methods of designing for Mfg & Assembly. Designs for Maintainability. Designs for Environment. Product costing. Legal factors and social issues. Engineering ethics and issues of society related to design of products **[8]**

4. **Value Engineering/Value Analysis:** Definition. , importance of value, value analysis job plan, creativity,. Case studies. Economic analysis: Qualitative & Quantitative. Material and process selection in value engineering. Concept of Product Life Cycle Management **[8]**

5. **Concurrent Engineering:** Rapid prototyping, Tools for product design–Drafting / Modeling software. CAM Interface. Patents & IP Acts. Overview, Disclosure preparation. **[8]**

Outcome(s) *The student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.*

Text Books:

1. Karl T Ulrich, Steven D Eppinger, Product Design & Development. 6th Edition, Tata McGrawhill New Delhi 3.
2. David G Ullman, The Mechanical Design Process. 4th Edition McGrawhill Inc

Reference Books:

1. Kevin Otto & Kristin Wood Product Design, Techniques In Reverse Engineering and new Product Development. 1/e 2004, Pearson Education New Delhi.
2. Chitle A K, Gupta R C., Product Design and Manufacturing, 6th Edition. PHI

Elective 5

ME 23.410 **Advanced Metal Casting & Welding** **Total Lectures: 40**
Credit:3-0-0-3

Prerequisites: ME 23.307

Objective(s):

- *To make the students understand the concepts of advance casting technique.*
- *To make the students understand the concepts of advance welding technique.*

1. **Advanced Casting :** Processes, parameters and applications of Investment Casting, Continuous Casting, Centrifugal casting, Carbon dioxide molding, Shell Moulding, Gravity die/ permanent mold casting, pressure die casting, Resin bonded casting , plaster mold casting, Vaccum Casting, Full Mould Casting, Slush Casting, Non metal Molding /Ceramic Molding. **[10]**

2. **Inspection and Testing of Casting:** Defects in Casting, its causes and remedies, Inspection and Destructive and nondestructive Testing of Casting including. **[4]**

3. **Advanced Welding Technique-I:** Electron Beam Welding- Background of the Process, Weld Environment, Welding in Different Degrees of Vacuum, Equipment and Safety, Joint Design, Applications, Laser Beam Welding, Process Parameters, Applications and Limitations. Plasma arc welding: Theory and Principles, Transferred arc and Non-Transferred arc Techniques, Equipment and Tooling, Joint Design Advantages, Disadvantages. **[10]**

4. **Advanced Welding Technique-II**: Ultrasonic Welding; Propagation of ultrasonic waves in matter, mode of joint formation, joint types and design of product for ultrasonic welding, details of equipment. Friction Welding- Basic Principles, Process Variants, Different Stages of Friction Welding, Mechanism of Bonding, Influence of Process Parameters, Weld Quality and Process Control, Joining of Dissimilar Materials, Advantages, Limitations and Applications. Diffusion Welding- theory and Principle of Process, Key Variables, Intermediate Materials, Deformation Welding, Equipment and Tooling. **[10]**

5. **Thermal and Metallurgical Consideration.** Thermal considerations for welding, temperature distribution, Analytical analysis, heating & cooling curves. Metallurgical consideration of weld, micro & macro structure. Solidification of weld and properties. **[6]**

Outcome(s): *Student will be able to*

- *Develop advanced casting techniques for various alloys*
- *Develop advanced welding techniques*
- *Develop welding application concepts*

Text Books:

1. Khanna O.P., "Foundry Technology", Latest Edition, Dhanpat Rai *Publication*
2. Khanna O.P., "Welding Technology", Latest Edition, Dhanpat Rai *Publication*

Reference Books:

1. Mikell. P. Grover, Fundamentals of Modern Manufacturing, Fourth Edition, John Wiley & Sons.
2. Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, 7th Edition, Pearson.

Elective 5

ME 23.412 **Renewable Energy** **Total Lectures: 40**
Credit: 3-0-0-3

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

Prerequisite(s): ME 19.203, ME 19.305

1. **Importance and applicability of renewable energy sources**: Energy Resources and Their Utilization, Environmental Aspects of Electric Energy Generation. **[8]**
   Technology and economics of solar thermal systems: Solar Radiation and Its Measurement, Solar Thermal Energy Collectors, Solar Thermal Energy Conversion Systems. Solar Photovoltaic System
2. **Technology and economics of wind power:** Types of turbines and their aerodynamics. Theories of wind turbines. WECS components and state of art Feasibility of large wind turbines. Wind Farms. **[10]**
   Technology and economics of small hydro: Types and theories of small, mini, and micro hydro turbines. Hydroelectric systems and advantages at small hydro levels. Conversion apparatus and feasibility.
3. **Technology and economics of geothermal, wave and tidal energy systems:** **[8]**
   Geothermal Energy, Wave and tidal turbines. Harnessing wave energy, applicability and feasibility, Electric Power Generation by Ocean Energy.
4. **Technology and economics of biogas and biopower:** Biofuel production and gasification. Biopower generation methods with technical details: steam, combined cycle, cogeneration. **[6]**
5. **Fuel Cells, Hydrogen and Hybrid systems:** Fuel Cells, Hydrogen Energy System, Hybrid Systems. **[8]**
   Environmental Impact: Environmental impacts of renewable energy sources and remedial measures. Global Climate Change.

Outcome(s): *Upon successful completion of this course, the student will be able to:*
- *Identify appropriate renewable technology for application.*
- *Implement concepts of clean development mechanism (CDM) and carbon credits.*
- *Utilize energy management and renewable energy systems in everyday life.*
- *Select eco-friendly, cost effective, energy efficient alternatives to unsustainable practices.*

Text Books:
1. Rai, G. D., "Non-Conventional Energy Sources", Khanna Publication, First Edition, 2010.
2. Tiwari, G. N. and Ghosal, M. K., Renewable energy resources: basic principles and applications. Alpha Science International, First Edition, 2005.

Reference Books:
1. Khan, B.H., "Non-Conventional Energy Resources", Tata McGraw-Hill, First Edition, 2006.
2. Kothari DP, Singal KC, Ranjan R. Renewable energy sources and emerging technologies. PHI Learning Pvt. Ltd.;2nd Edition 2011.

ME 23.423 **Capstone Project I** **Credit: 2**

Prerequisite (s): -

Objective (s):

- *To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.*
- *To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.*
- *To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.*
- *To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication* skills.

Each student / group has to work on research topics with hardware design and fabrication or advanced design and analysis projects. The projects must be in different specialization topics (Heat Power/Fluid Mechanics/Machine Design/ Applied Mechanics/ Production) from a list of topics offered by the department.

Students have to submit a project report to the respective supervisors and give a presentation of the work done in front of a specialization specific evaluation board. For each project, distribution of marks will be: 50 marks to be evaluated by the supervisor and 50 marks to be evaluated by the specialization specific evaluation board.

The project provides students with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project should demonstrate the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project should affirm students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

Outcome(s):

- *Knowledge of discipline or content area*
- *Ability to think critically*
- *Ability to communicate effectively*
- *Ability to use contemporary technology*
- *Commitment to ethical and social responsibilities*
- *Commitment to learning as life-long endeavour*

ME 23.422 **Capstone Project II** **Credit: 6**

Prerequisite (s): -

Objective (s):

- *To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.*
- *To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.*
- *To encourage students to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.*
- *To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication* skills.

Each student / group has to work on research topics with hardware design and fabrication or advanced design and analysis projects. The projects must be in different specialization topics (Heat Power/Fluid Mechanics/Machine Design/ Applied Mechanics/ Production) from a list of topics offered by the department.

Students have to submit a project report to the respective supervisors and give a presentation of the work done in front of a specialization specific evaluation board. For each project, distribution of marks will be: 50 marks to be evaluated by the supervisor and 50 marks to be evaluated by the specialization specific evaluation board.

The project provides students with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project should demonstrate the student's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project should affirm students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

Outcome(s):

- *Knowledge of discipline or content area*
- *Ability to think critically*
- *Ability to communicate effectively*
- *Ability to use contemporary technology*
- *Commitment to ethical and social responsibilities*
- *Commitment to learning as life-long endeavour*