DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instructions* and *Syllabi of

B.E V and VI SEMESTER

2017-2018

UNIVERSITY COLLEGE OF ENGINEERING (AUTONOMOUS)

OSMANIA UNIVERSITY

HYDERABAD-500 007, TELANGANA

UNIVERSITY COLLEGE OF ENGINEERING, OSMANIA UNIVERSITY

VISION OF THE INSTITUTE

The Vision of the Institute is to generate and disseminate knowledge through a harmonious blending of Science, Engineering and Technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

MISSION OF THE INSTITUTE

- To achieve excellence in Teaching and Research.
- To generate, disseminate and preserve knowledge.
- To enable empowerment through knowledge and information.
- Advancement of knowledge in Engineering, Science and Technology.
- Promote learning in free thinking and innovative environment.
- Cultivate skills, attitudes to promote knowledge creation.
- Rendering socially relevant technical services for the community.
- To impart new skills of technology development.
- To inculcate entrepreneurial talents and technology appreciation programmes.
- Technology transfer and incubation.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION OF THE DEPARTMENT

To generate and disseminate knowledge in Mechanical Engineering and nurture professional, technical and scientific temper for serving the needs of the industry, research organizations and society.

MISSION OF THE DEPARTMENT

- Create technically competent mechanical engineers to suit the changing needs of global industry and society.
- To cultivate skills, attitudes to promote knowledge creation and technology development.
- Interact with prominent educational institutions and R&D organizations for enhancing teaching, research and consultancy services.

DEPARTMENT OF MECHANICAL ENGINEERING

B.E (Mechanical Engineering)

PROGRAM EDUCATIONAL OBJECTIVES

PEO 1	To provide the requisite fundamentals of varied subjects related to Mechanical Engineering to conceive, plan, model, design, construct, maintain and improve systems to enhance human comfort.
PEO 2	To provide knowledge of experimental, computational, analytical, simulation tools and techniques require to address the challenges in Mechanical Engineering and other allied fields.
PEO 3	To provide knowledge to apply Mechanical Engineering Fundamentals to design and implement cost effective systems in manufacturing.
PEO 4	To provide effective communication skills, creative methods, ethics and continuous learning techniques to fulfill their professional requirements and societal needs.

PROGRAM ARTICULATION MATRIX

S.No.	PEO Statement	M1	M2	M3
PEO 1	To provide the requisite fundamentals of varied subjects related to Mechanical Engineering to conceive, plan, model, design, construct, maintain and improve systems to enhance human comfort.	3	3	3
PEO 2	To provide knowledge of experimental, computational, analytical, simulation tools and techniques require to address the challenges in Mechanical Engineering and other allied fields.	3	3	3
PEO 3	To provide knowledge to apply Mechanical Engineering Fundamentals to design and implement cost effective systems in manufacturing.	3	3	3
PEO 4	To provide effective communication skills, creative methods, ethics and continuous learning techniques to fulfill their professional requirements and societal needs.	2	2	2

PROGRAM OUTCOMES (POs):

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

POs	
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an mechanical engineering to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems related to mechanical engineering and allied fields reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Mechanical engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the Mechanical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the mechanical engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the mechanical engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.
Program Specific Outcomes	
PS01	Apply the principles of collaborative and multi disciplinary approach for solving problems
PS02	Able to interact with industry and R&D institutions leading to start-ups/ budding entrepreneurs.

SCHEME OF INSTRUCTION & EXAMINATION

B.E VSemester (Mechanical Engineering)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P	Contact Hrs/wk	CIE	SEE	
1.	PC501ME	Dynamics of Machines	3	1	-	4	30	70	3
2.	PC502ME	Design of Machine Elements	3	1	-	4	30	70	3
3.	PC503ME	Metal Cutting & Machine Tools	3	-	-	3	30	70	3
4.	PC504ME	Hydraulic Machinery and Systems	3	-	-	3	30	70	3
5.	PC505ME	Metrology & Instrumentation	3	-	-	3	30	70	3
6.	PC506ME	Heat Transfer	3	-	-	3	30	70	3
7	MC901SOC	Gender Sensitization	3	-	-	3	30	70	3 Units
8	PE	Professional Elective -I	3	-	-	3	30	70	3
Practicals									
9.	PW961ME	Engineering Applications with Social Perspective*	-	-	-	-	50	-	1
10.	PC551ME	Manufacturing Processes Lab	-	-	2	2	25	50	1
11.	PC552ME	Dynamics Lab	-	-	2	2	25	50	1
			24	2	4	30	340	660	24

PROFESSIONAL ELECTIVE-I	
PE501ME	Mechanical Vibrations
PE502ME	Powder Metallurgy
PE503ME	Robotic Engineering
PE504ME	Theory of Elasticity

SCHEME OF INSTRUCTION & EXAMINATION
B.E VISemester (Mechanical Engineering)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P	Contact Hrs/wk	CIE	SEE	
1.	PC601ME	Machine Design	3	1		4	30	70	3
2.	PC602ME	Production Drawing	2	-	2	4	30	70	3
3.	PC603ME	Refrigeration and Air Conditioning	3	-	-	3	30	70	3
4.	PC604ME	Production and Operations Management	3	-	-	3	30	70	3
5.	PC605ME	Control Systems Theory	3	-	-	3	30	70	3
6.	PE *	Professional Elective-II	3	-	-	3	30	70	3
7.	OE **	OPEN ELECTIVE-I	3	-	-	3	30	70	3
8.	MC***	Mandatory Course	3	-	-	3	30	70	3 Units
Practicals									
9	PW962ME	Summer Internship	-	-	-	-	-	-	-
10.	PC651ME	Metrology & Machine Tools Lab	-	-	2	2	25	50	1
11.	PC652ME	Hydraulic Machinery Lab	-	-	2	2	25	50	1
			23	01	06	30	290	660	23

Note: **Summer Internship along with credits will be reflected in VII semester memorandum of marks

*PROFESSIONAL ELECTIVE-II	
PE601ME	Energy Systems
PE603ME	Computational Fluids Flows
PE604ME	Nano materials and Technology
PE605ME	Renewable Energy Sources
PE606ME	Operations Research
Mandatory Course***	
MCSS	Science ,Technology, Innovation and Society
MCPA	Indian Polity and Administration
MCBM	Business Ethics and Corporate Governance

**OPEN ELECTIVE-I	
OE601BM	MEMS
OE601CE	Disaster Management
OE602CE	Geospatial Techniques
OE601CS	Operating Systems
OE602CS	OOPS using JAVA
OE601EC	Embedded Systems
OE602EC	Signal analysis and transform techniques
OE601EE	Reliability Engineering
OE601ME	Industrial Robotics
OE602ME	Material Handling
OE601LA	Intellectual Property Rights

Course Code: PC501ME

DYNAMICS OF MACHINES

Credits: 3

Instruction: (3L+1T) per week Duration of SEE: 3 hours

CIE: 30 Marks SEE: 70 Marks

Course Objectives:

- To find static and dynamic forces on planar mechanisms.
- To know the causes and effects of unbalanced forces in machine members.
- To determine natural frequencies of undamped , damped and forced vibrating systems of one, two and multi degree freedom systems.

Course Outcomes:

- Understand various methods of static and dynamic analysis of planar and spatial mechanisms
- Understand and apply the gyroscopic effects in ships, aero planes and road vehicles
- Analyse balancing problems in rotating and reciprocating masses in machinery
- Apply the concepts of free and forced vibrations of single degree and multi degree freedom
- systems in real time applications
- Analyse and design various types of governors like Watt, Porter, Proell, hartung and their applications .

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	1			1			1	1	1
CO2	3	2	2	3	2				1			1	1	1
CO3	3	3	2	2	2				1			1	2	2
CO4	3	3	3	2	2				1			1		
CO5	3	2	2	2	2				1			1		

Unit-I

Static and Dynamic analysis of planar mechanisms: Graphical and analytical methods, Free body diagrams, Method of superposition, Equivalent offset inertia force, Inertia force in reciprocating engines, Flywheels.

Unit-II

Force analysis of space mechanisms, inertia matrix, Lagrangian and Newton-Euler formulation.
Gyroscopic effect in shafts, aero planes, Naval ships, Two & Four wheel automobiles.

Unit-III

Forces on bearings due to rotating shaft carrying several eccentric rotors, balancing of shafts carrying several rotors, determination of balancing masses from the forces on the bearings shaking forces in a single cylinders engine, partial balancing of reciprocating engine. Balancing of a two cylinder locomotive engine, determination of unbalanced forces and couples.

Unit-IV

The role of a centrifugal governor in speed control, Porter and Hartnell type governors, speed vs lift curves, power and stability.

Undamped free vibration of a single degree of freedom linear system (axial and torsional), determination of natural frequencies, equivalent system of combination of springs, stepped shafts, gears and rotors. Free response of single degree of freedom damped linear systems, damped natural frequencies, relative damping.

Vibration of harmonically forced single degree of freedom systems. Resonance, vibration isolation with coupled damper.

Partial differential equation governing free vibration of a simply supported uniform beam.
Derivation of natural frequencies.

Unit-V

Natural frequencies of two degree freedom linear systems.Nodes in three rotor systems. Modes of vibration, Determining natural frequencies by Holzer's method for multi-rotor systems. Dunkerley's method , Raleigh's method.

Suggested Reading:

1. S.S. Rathan, *Theory of Machines*, Tata-Mc Graw Hill, 1995.
2. Thomas Bevan, Theory of machines, 3rd edition, Pearson Education, 2005
3. A. Ghosh and Mallick, *Theory of mechanisms and machines*, Affiliated to E-W Press, 1988.
4. John.J.Vicker, Gordon R. Pennock, Joseph E. Shigley, *Theory of Machines & Mechanisms*, Oxford University Press, 2003.
5. Robert L. Norton, *Design of Machinery*, Tata Mc Graw Hill, 2005.

Course Code: PC502ME

DESIGN OF MACHINE ELEMENTS

Credits: 3

Instruction: (3L+1T) per week Duration of SEE: 3 hours
CIE: 30 Marks SEE: 70 Marks

Course Objectives:

- To understand the basics of mechanics of materials and design of a machine for static and fatigue strength, rigidity and wear criterions, use of codes and standards.
- To know the principles of ergonomic design.
- To learn the principles to design shafts, keys, belt drives, joints and couplings.

Course Outcomes:

- Understand the importance of standards, codes and importance of ergonomics, considerations of materials & manufacturing
- Analyse stress & strain induced in a machine element & decide the behavior based on failure criterion
- Analyse and evaluate fatigue and impact loads applied on mechanical components and realize the importance of stress concentration effects
- Design and evaluate various joining techniques (permanent and non permanent) under different loading conditions
- Design and analyze effects of various loading conditions on machine elements like keys, cotters, couplings, shafts, drive systems like belts pulleys

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	1	1	1	1		1		1	1	
CO2	3	3	3	3	1	1				1		1	1	
CO3	3	3	3	3	1	1				1		1	1	
CO4	2	3	2	3	2	1	1			1		1	1	
CO5	2	3	2	3	2	1	1			1			1	

Unit-I

Introduction, Materials used in machine design and their specifications to Indian standards. Important mechanical properties of materials used in design. Codes and standards used in design. Reliability, Principles of good Ergonomic Design, Manufacturing considerations.Preferrednumbers.Value analysis.

Analysis of Stress and Strain : Definition of stress and strain, Types of loading, Direct normal stress, bending stress, Torisonal stress, crushing and bearing stresses, Biaxial stress and Triaxial stress.

Theories of elastic failure, Stress concentration factor, factor of safety, Design of components for static loads, Introduction to thermal stresses.

Unit-II

Design for Fatigue and Impact loads; Importance of fatigue in design, Fluctuating stresses, fatigue strength and endurance limit. Factors affecting fatigue strength. S-N Diagram, Soderberg and Modified Goodman's diagrams for fatigue design. Cumulative fatigue, Miner's rule, Design of components for fatigue. Design of components for impact loading.

Unit-III

Design of keys, shafts – solid hollow stepped shafts and splined shafts under torsion and bending loads.Design of belt drive systems, selection of belts and design of pulleys.

Unit-IV

Design of cotter and knuckle joints, riveted and welded joints under direct and eccentric loading.
Design of couplings – Muff and Split Couplings, Flange, Flexible and Marine type of couplings.

Unit-V

Design of bolts and nuts, locking devices, bolt of uniform strength, design of gasket joints, design of power screws and screw jack. Thick and thin cylinders.

Suggested Reading:

1. V.B. Bhandari, *Machine Design*, Tata Mc Graw Hill Publication, 1991.
2. J.E. Shigley, C.R. Mischne, *Mechanical Engineering Design*, Tata Mc Graw Hill Publications, 2003.
3. Robert C. Juvinall, *Fundamentals of Machine Component Design*, John Wiley & Sons, 2005
4. Robert L. Norton, *Machine Design: An Integrated Approach*,2/e Pearson Education, 2000
5. M.F. Spotts, *Design of Machine Elements*, Prentice Hall of India, 1964.

Course Code: PC503ME

METAL CUTTING AND MACHINE TOOLS

Credits: 3

Instruction: (3L) per week — Duration of SEE: 3 hours

CIE: 30 Marks — SEE: 70 Marks

Course Objectives:

- To learn the tool material, geometry and mechanics of metal cutting for turning, drilling milling.
- To know the heat distribution, tool wear, tool life, various machining processes like lathe, milling, drilling, grinding etc.
- To learn various types of fixtures, conventional and unconventional machining

Course Outcomes: At the end of the course, the student shall be able to:

- Understand the geometry of single and multi point cutting tools and develop the relations for chip reduction coefficient, shear angle, shear strain, forces, power, specific energy and temperatures associated with orthogonal cutting.
- Select cutting fluids, tool materials and coatings to control tool wear and temperature
- Evaluate the Economics of machining for maximum production and minimum cost.
- Select the appropriate machine tool and tool & work holding devices for machining of a product.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS O1	PS O2
CO1	3	3	3	3	2	1				1		1	1	
CO2	3	3	2	2	2	2				1		1	1	
CO3	3	3	1	2	2							1		
CO4	3	2	1	1						1		1	1	1
CO5	3	2	1	1		1				1		1	1	1

Unit-I

Basic chip formation process. Cutting tool materials: High carbon steel, HSS, Stellite, Carbides, Coated carbides, Diamond. Tool geometry: Nomenclature of single point cutting tool by ASA and ORS. Geometry of drills, Milling cutters and broaches. Recommended Tool angles. Chip formation: Types of chips, BUE, Chip breakers. Machining: Orthogonal and oblique cutting, Mechanics of metal cutting, Merchant's analysis, Shear angle Solutions of Merchant and Lee & Shafer.

Unit-II

Theoretical estimation of forces in turning, drilling and milling. Thermal aspects of metal cutting: Sources of heat and heat distribution, various methods of measurement of temperature, Cutting fluids and applications. Tool wear, Tool life & Machinability: Types of wear, mechanism of tool wear, Tool life & Machinability. Effects of process parameters on Tool life.Taylor's tool life equation. Economics of machining: Tool life for maximum production, minimum cost. Machining with controlled contact.

Unit-III

Constructional features and specifications of machine tools: Various operations on Lathe, Types of Lathes and special attachments on a Centre Lathe. Drilling, Milling operations.Indexingmethods.Shaper, planer and slotter and their differences. Quick return mechanisms, Automatic feed devices. Jig Boring machines-Differences between horizontal and vertical jig boring machines.

Unit- IV

Grinding machines. Types of grinding, Abrasives and bonds used for grinding wheels. Specification and selection of wheels.Principles of Broaching, Lapping, Honing, Polishing, Buffing, Super finishing and burnishing.

Screws and gear manufacturing: Screw making by tapping, Chasers, Thread rolling, Thread milling, Thread grinding. Gear shaping, Gear hobbing, Gear shaving and grinding.

Unit-V

Jigs and Fixtures: Design principles for location and clamping. Tool holding and work holding devices.Quick clamping devices.Types of Jigs and fixtures.

Unconventional machining: Principles of working and applications of USM, AJM, EDM, ECM,LBM and EBM.

Suggested Reading:

1. David A. Stephenson, Johs S. Agapiou, *Metal Cutting Theory and Practice*, CRC Press, 3rd Edition, March 2016
2. B.L. Juneja ,Shekhon G.S. and Seth Nitin, *Fundamentals of metal cutting & Machine tools*, New Age Publishers, 2003.
3. P.C. Sharma, *A Textbook of Production Engineering*, S. Chand & Company Ltd., 2010, 5th Edition
4. Amitabha Ghosh and Ashok Kumar Mallik, *Manufacturing Science*, Affiliated East-West Press Pvt. Ltd. (2010), 2nd Edition.

Course Code: PC504ME

HYDRAULIC MACHINERY AND SYSTEMS

Credits: 3

Instruction: (3L) per week — Duration of SEE: 3 hours
CIE: 30 Marks — SEE: 70 Marks

Course Objectives:

- The purpose of this course is to learn the Fluid properties and fundamentals of Fluid statics and fluid flow
- To introduce the concepts of flow measurements and flow through pipes
- To introduce the concepts of momentum principles
- To impart the knowledge on pumps and turbines.

Course Outcomes:

- Apply conservation laws to fluid flow problems in engineering applications
- Design and analyze the performance of the reciprocating pumps
- Design, estimate the unit quantities and specific parameter of centrifugal pumps
- Design, working of various types of turbines and could draw the characteristic curves of turbines
- Estimate the performance of various hydraulic equipment and systems and design with Hydraulic power controls and fluids.

Unit-I

Introduction: Classification of Hydraulic machinery. Energy transfer in hydraulic turbines.Positive displacement and Rotodynamic pumps and description of their working principles.
Dynamic action of water: Impact of water jets on flat plates and curved surfaces – single and series, stationary and moving types. Forces on hinged plates and pipe bends. Impulse – momentum equation. Flow over radial and curved vanes.

Unit-II

Reciprocating pumps: Classification, working details, theory and terms used for single and double acting pumps. Effect of acceleration head and friction. Indicator diagrams. Effect of cavitation and limiting suction head on pump speed. Variation of pressure inside pump cylinder during suction and delivery strokes. Work done, power required and efficiency. Functions of air vessels. Work saved and rate of flow from air vessels. Losses and performance curves for reciprocating pumps.Industrial applications.

Unit-III

Centrifugal pumps: Working and constructional details of single stage centrifugal pump. Installation. Priming – significance and methods of priming. Basic classification of CF pumps. Types of impellers, casings and vane shapes used.Simple and multistage pumps and their applications.Series and parallel operation of CF pumps. Theory and terminology used CF pumps. Manometric head and its importance.Manometric efficiency and other efficiencies. Losses in CF pumps. Velocity diagrams. Effect of number of vanes and outlet angle of vane on head developed. Design of radial impellers and volute casing.Origin of cavitation.Limiting suction lift and NPSH.
Principles of similarity: Unit quantities, specific speed, performance prediction from model testing. Performance and characteristic curves. Methods of balancing of end thrust in CF pump installations.

Unit-IV

Hydraulic Turbines: Classification of impulse and reaction turbines and their differences in working. Impulse turbines: Salient features and working details of Pelton wheel installation. Velocity diagrams. Calculation of number of buckets, bucket sizes and power developed. Overall efficiency, speed regulation methods.

Reaction turbines: Constructional details and working of Francis and Kaplan turbines. Draft tube in reaction turbines. Theory, types and efficiency of draft tubes. Velocity diagrams. Blade angles and blade dimensions. Power developed and efficiencies, pressure head at inlet of the runner.

Principles of similarity applied to hydraulic turbines. Unit quantities, specific speed and its significance for turbine selection.Performance prediction from model tests. Performance and characteristic curves for Pelton wheel, Francis and Kaplan turbines. Characteristic diagram.Automatic speed regulation in power plants.Losses in turbine operation. Cavitation effects in reaction turbines and remedial measures. Functions and types of surge tanks.

Unit-V

Hydraulic equipment and system: Working and simple problems on hydraulic ram, hydraulic accumulator and intensifier and hydraulic press. Working details of fluid coupling torque converter. Description of general hydraulic valves in use.

Hydraulic power controls and fluidics: General description of servo-mechanism – Block diagram, types and applications, servo valves. Description of simple valve operated and pump controlled servo mechanisms. Introduction to fluidics. Terms used and Basic concepts of fluidic devices and attachment device. Description of working of amplifiers - Bistable, proportional, Turbulence and Vertex types.

Suggested Reading:

1. Jagdish Lal, *Hydraulic Machines*, Metropolitan Book Co., 1965.
2. Modi, P.N. & Seth, S.M., *A Text book of Fluid Mechanics and Hydraulic Machines*, Standard Book House, New Delhi, 2007.
3. N.S. Govind Rao, *Fluid Flow*, Tata Mc Graw Hill, 1983.
4. R.K. Bansal, *Fluid Mechanics and Hydraulic Machines*, Laxmi Publications (P) Ltd., 2004.
   Subirkar, *Introduction to Fluidics*, Published at Oxford & IBM Publishing Co., Bombay & New Delhi, 1984

Course Code: PC505ME

METROLOGY AND INSTRUMENTATION

Credits: 3

Instruction: (3L) per week — Duration of SEE: 3 hours

CIE: 30 Marks — SEE: 70 Marks

Course Objectives:

- To familiarize with Limits & fits, I.S.O. system and the instruments used to measure these limits.
- To have knowledge of various precision linear and angular measuring instruments.
- To learn the importance of form and how to measure form errors.
- To understand the working principles of various instruments used for the measurement of strain, forces, pressure, temperature and vibrations.

Course Outcomes:

- To understand manufacturing variables
- To be able to measure the physical phenomenon
- To understand and apply measure principles in industry
- To apply in practice industry
- To design innovate and modify measuring technology.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2	2	2	2	2	1	2	2	2
CO2	2	2	2	1	1	1	2	2	1	2	1	1	1	1
CO3	2	2	2	2	3	1	2	2	2	2	1	2	2	2
CO4	2	2	2	1	1	1	2	2	2	2	1	2	3	3
CO5	2	2	3	1	1	1	2	2	2	2	2	2	3	2

Unit-I

Limits and Fits, I.S.O. system. Types of interchangeability. Slip gauges and end bars. Height gauges, Abbe's rule, Types of micrometers. Tomlinson gauges, sine bar, autocollimator, calibration of precision polygons and circular scales. Dial indicator, Sigma mechanical comparator. Free flow and back pressure type Pneumatic comparators. Contact & non-contact tooling, Applications of single and multijet gauge heads; computation and match gauging.

Unit-II

Optical projector-measurement by comparison, movement and translation, chart gauge types and microgauge bridge lines. Tool maker's microscope, Floating carriage diameter measuring machine and coordinate measuring machine.Measurement of straightness & flatness using autocollimator.Roundness measurement with intrinsic datum (V-block, Bench centers) and extrinsic datum (TALYROND).

Unit-III

Taylor's principles for plain limit gauges. Usage and limitations of Ring and Snap gauges. Indicating type limit gauges. Position and receiver gauges, principles of thread gauging. Gauge materials and steps in gauge manufacture. General geometrical tests for machine tools. Surface roughness characteristics and its measurement. Elements of instrumentation system. Static characteristics, Systematic and random errors.

Dynamic response of first and second order instruments.

Unit-IV

Strain Measurement: Wire and foil type resistance strain gauges, Evaluation of principal strains with Rosette gauges. Desirable characteristics of gauge material, backing material and adhesive.Ballast and bridge circuits. Lead resistance compensation. Adjacent arm and self temperature compensating methods.Strain gauge calibration. Strain gauge circuits for measuring axial load, bending load and torque. Measurement of displacement with LVDT and Lasers interferometry.

Unit-V

Force Measurement: Proving ring, Strain gauge load cells, Piezo-electric load cell, Ballastic weighing, Pneumatic and hydraulic force meters. Pressure Measurement: Thermocouple vacuum gauge, High and Low pressure measuring devices. Pirani gauge, Bourdon gauge and Bulk modulus gauge, calibration methods.

Vibration measurement, accelerometers, vibration exciters, calibration of vibrometers.
Temperature measurement: Laws of thermo electricity, types of materials and junctions used in thermocouples, lead and extension wires, ambient temperature compensation, protection tubes, series and parallel circuits. RTD.Total radiation and Optical Pyrometers.

Suggested Reading:

1. R.K. Jain, *Engineering Metrology*, Khanna Publications, 1996.
2. I.C. Gupta, *A text book of engineering metrology*, Dhanpat Rai & Sons, 1984.
3. Bechwith, Marangoni, Lienhard, *Mechanical measurement*, LPE; Pearson Education Asia 2000.
4. D.S. Kumar, *Mechanical Measurements*, Metropolitan Book Co., New Delhi, 2001.
   RegaRajendra, Engineering Metrology.

Course Code: PC506ME **HEAT TRANSFER**
Credits: 3

Instruction: (3L) per week Duration of SEE: 3 hours
CIE: 30 Marks SEE: 70 Marks

Note: During examination, charts necessary for solving problems on unsteady conduction (Heisler charts), heat exchanger charts, tables giving properties of air and water will be supplied.

Course Objectives:

- To understand the basic concepts of heat transfer.
- To study the concepts of conduction, convection, radiation and heat exchangers applicable for commercial and industrial use.
- To study and solve problems on different modes of heat transfer which are related tothermal power plants, refrigeration and air conditioning.

Course Objectives:

- Understand the basic laws of heat transfer and analyse the problem of steady state heat conduction in simple geometries
- Able to understand the concept of fins which are used in various thermal engineering applications,
- Understand the unsteady state heat conduction in simple geometries
- Understand the fundamentals of convective heat transfer process and concepts of hydrodynamics and thermal boundary layers.
- Obtain the knowledge of radiation heat transfer problems and their solutions
- Able to understand different types of heat exchangers functionality and gain knowledge, to analyse and design heat exchangers. Obtain knowledge of boiling and condensation .

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	1						1		
CO2	2	2	1	2	3	1						1		
CO3	3	2	1	2	3	1						1		
CO4	3	2	1	2	3	1						1		
CO5	3	2	1	2	3	1						1		

Unit-I

Basic modes of heat transfer, basic laws of heat transfer, Fourier's law, Newton's law of cooling, Stefen – Boltzmann's law of thermal radiation. Conduction : general conduction equation on Cartesian, & Cylindrical coordinates.

One dimensional steady state conduction through slabs, hollow cylinders and spheres with and without heat generation.

Effect of variable thermal conductivity in heat transfer for one dimensional steady state conduction in plates.Steady state heat transfer through composite plates, cylinders and spheres.Critical radius of insulation.

Two dimensional steady state heat transfer in a plate with prescribed temperatures at the boundary.

Unit-II

FINS: Heat transfer analysis of a body with negligible internal temperature gradients.

Unsteady state conduction:

Lumped parameter analysis of a body with negligible internal temperature gradients. Transient heat transfer analysis of an infinite slab with specified temperature and connective boundary conditions. Use of Grover &Heisler charts for solving problems of infinite slabs, cylinders, spheres.

Unit-III

Convection: Buckingham theorem and use of dimensional analysis in free and forced convection, Physical significance of different dimensionless numbers.

Concept of hydrodynamic and thermal boundary layers.Reynlod's analogy for turbulent flow over flat surfaces.Mixing cup temperature in pipe flows.Calculation of heat transfer for flow over plates, cylinders and in pipes in free and forced convection using empirical formulae.

Unit-IV

Radiation: Absorptivity, reflectivity and transmitivity definitions. Concept of a blackbody and emissivity.Kirchoff's law.Lambert's cosine law, Plank and Wein's laws.Stefen-Boltzmann's law.Monochromatic and total emissive power.Hemispherical emissive power.Radiant exchange power.Radiant exchange between two grey surfaces. Shape factors. Radiant exchange between two infinite parallel plates and between concentric cylinders. Radiation shields.

Unit-V

Heat Exchangers: Classification and applications of heat exchangers in industry. Analysis and design of counter flow and parallel flow heat exchangers (shell and tube type) and condensers. Solving problems for multipass heat exchangers using non dimensional parameter plots.

Change of Phase

Boiling: Pool boiling regimes, nucleate pool boiling.

Condensation: Film condensation, dropwise condensation. Nusselt's analysis to determine condensate film thickness and heat transfer coefficient in film condensation.

Suggested Reading:

1. J.P. Holman, *Heat Transfer*, McGraw Hill Book Company, 1986.
2. S.C. Arora and S. Domkundwar, *A course in Heat and Mass Transfer*, Dhanpatrai& Sons, New Delhi, 2000.
3. D.S. Kumar, *Heat and Mass Transfer*, S.K. Kataria& Sons, New Delhi.
4. Frank. P. Incropera& David P. Dewitt, *Fundamentals of Heat & Mass Transfer*, John willey& Sons, 1990.

Course Code: PC901SOC

GENDER SENSITISATION

3 Units

Instruction: (3L) per week — Duration of SEE: 3 hours

CIE: 30 Marks — SEE: 70 Marks

Course Objectives:

- To develop students' sensibility with regard to issues of gender in contemporary India.
- To provide a critical perspective on the socialization of men and women.
- To introduce students to information about some key biological aspects of genders.
- To help students reflect critically on gender violence.
- To expose students to more egalitarian interactions between men and women.

Course Outcomes:

- Students will have developed a better understanding of important issues related to gender in
- contemporary India.
- Students will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from
- research, facts, everyday life, literature and film.
- Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.
- Students and professionals will be better equipped to work and live together as equals.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					1	2		2	1	2		1		
CO2					1	2		2	1	1		1		
CO3						2		2	1	2		1		
CO4						1		1	1	1		1		
CO5						1		1	1	1		1		

UNIT I

UNDERSTANDING GENDER: Why Should We Study It? Socialization: Making Women, Making Men: Introduction-Preparing for Womanhood-Growing up male-First lessons in caste-Different Masculinities; **Just Relationships: Being Together as Equals:** Mary Kom and Onler- Love and acid just do not mix-Love Letters-Mothers and Fathers-Further reading: Rosa Parks-The brave heart.

UNIT II

GENDER AND BIOLOGY: Missing Women: Sex Selection and Its Consequences - Declining sex ratio-.Demographic Consequences; **Gender Spectrum: Beyond the Binary -** Two or many? - Struggles with discrimination; **Our Bodies, Our Health.**

UNIT III

GENDER AND LABOUR: Housework: the Invisible Labour :"My mother doesn't work"- "Share the Load"; **Women's Work: Its Politics and Economics:** Fact and fiction-Unrecognized and unaccounted work- Wages and conditions of work.

UNIT IV

ISSUES OF VIOLENCE: Sexual Harassment: Say No! : Sexual harassment- not eve-teasing- Coping with everyday harassment- "Chupulu"; **Domestic Violence: Speaking Out :** Is home a safe place? When women unite-Rebuilding lives- New forums for justice; **Thinking about Sexual Violence:** Blaming the victim-"I fought for my life." - The caste face of violence.

UNIT V

GENDER STUDIES: Knowledge- Through the Lens of Gender - Point of view- Gender and the structure of knowledge- Unacknowledged women artists of Telangana; **Whose History? Questions for Historians and Others:** Reclaiming a past- Writing other histories- Missing pages from modern Telangana history.

Suggested Reading:

1. A.Suneetha, Uma Bhrugubanda, DuggiralaVasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, GoguShyamala, Deepa Sreenivas and Susie Tharu, "*Towards a World of Equals: A Bilingual Textbook on Gender"* Telugu Akademi, Hyderabad, 1st Edition, 2015.
2. www. halfthesky .cgg.gov.in

Course Code: PE551ME **MANUFACTURING PROCESS LAB.**

Credits: 1

Instruction: (2P) per week Duration of SEE: 3 hours

CIE: 25 Marks SEE: 50 Marks

Course Objectives:

- To understand the manufacturing processes, preparation of sand mould, casting process
- To learn about electrode composition and different welding processes like arc, gas, spot, TIG, MIG welding.
- To know the forming process.

Course Outcomes:

- Fabricate weldments using gas , arc and spot welding.
- Perform formability studies on sheet metals.
- Preparation of mould cavities for sand casting
- Test the properties of moulding sands.

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	2		1	1				2	3		1
CO2		3	2	2	1	1				2	3		1
CO3		3	2		1	1				2	3		1
CO4		3	2	2	1	3				2	3		1
CO5													

Foundry:

1. Study of foundry setup, equipment and the displayed charts with particular attention to moulding machines, sand muller, shell moulding machine & centrifugal casting machine.
2. Mixing and preparation of molding sand samples, Testing of greensand properties.
3. Preparation of molding sand aggregate and simple moulds of greensand complete with sprues, gates and risers.
4. Exercise of melting and casting involving prepared moulds, aluminium metal and crucible furnace. Cleaning of castings, study of the features of the final casting, its features and any visible defects.

Welding:

1. Study of the welding equipment and tools related to Arc, gas and resistance welding & displayed charts.
2. Practice of Arc, Resistance Spot, Resistance Butt and Gas welding. Identification of different types of gas flames.
3. Experimental study of
   (a) Electrode characteristics of SMAW.
   (b) Arc length and welding speed on bead characteristics.
   (c) Welding current on bead penetration.
4. Determination of weld characteristics using DC and AC power sources.
5. TIG and MIG welding process - study and exercises.

Forming:

1. Study of the forming equipment: Different types of mechanical presses and hammers, Metal spinning Lathe.
2. Conventional extrusion of metals.
3. Study of sheet metalworking dies and sheet metal working with existing dies.
4. Testing of metals: Fatigue tests. Testing of sheet metals for formability by using Erichson cupping test.
5. Study of HERF processes. Sheet metal forming with water hammer forming equipment.

Course Code: PE552ME

DYNAMICS LAB.

Credits: 1

Instruction: (2P) per week — Duration of SEE: 3 hours

CIE: 25 Marks — SEE: 50 Marks

Course Objectives:

- To understand the effects and importance of kinematic and dynamic analysis of mechanisms
- To understand effects and analysis of Single degree freedom vibration systems
- To study the gyroscope, governors and cams
- To carry out the static and dynamic analysis of four bar mechanisms and drives

Course Outcomes:

- To find out natural frequencies of various beams with different constraints
- Evaluate static and dynamic balancing of masses
- To find the gyroscopic effect on vehicles
- To find out kinematic and dynamic behavior of mechanisms
- To simulate kinematic and dynamic analysis of systems using software

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	2	2	1		1	2	2	1	1	1	
CO2	1	1	1	1	2			1	2	2	1	1	1	
CO3	1	1		1	1			1	2	2	1	1		
CO4	1	1	1	2	2	1		1	2	2	1	1	1	
CO5			2	2	3	1		1	2	2	1	1	2	1

Experiments to be conducted:

Study experiment on:

1. Free vibration of Cantilever Beam
2. Free vibration of Simply Supported Beam
3. Free/ Forced vibrations of a SDOF systemto find Moment of Inertia of a connecting rod
4. Modal analysis of a composite beam
5. Modal analysis of a disc
6. Balancing of Rotors
7. Centrifugal governors
8. Mechanical gyroscope
9. Static & Dynamic Balancing m/c
10. Study experiment on cam analysis

MSC ADAMS SOFTWARE

Simulation of kinematic and dynamic analysis of:

11. Grashoff 4 bar mechanism
12. Non Grashoff 4 bar mechanism
13. Slider crank mechanism
14. Double slider mechanisms
15. Gear (spur, helical, bevel) systems

16. Pulley, rope and chain systems
17. Cam drive systems.

Course Code: PE501ME

MECHANICAL VIBRATIONS

Credits: 3

Instruction: (3L) per week Duration of SEE: 3 hours

CIE: 30 Marks SEE: 70 Marks

Course Objectives:

- To gain the knowledge of mathematical modeling of a physical system and applying the principles of Newton's Second Law and conservation of energy to derive the equations of motion.
- To familiarize with linear systems with degrees of freedom.
- To study the response of a vibrating system with periodic excitation and understand the principle of vibration isolation.

Course Outcomes:

- Develop a mathematical model for a physical system and derive the governing differential equations.
- Determine the natural frequencies of single and two degrees of freedom systems.
- Determine the effect of damping in real time systems.
- Determine and analyze the response of machine members or structures in forced vibration with different excitation frequencies.
- Solve the eigen value problems to identify mode shapes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1							1	1	1
CO2	3	3	2	2	1							1	2	1
CO3	3	2	2	2	1							1	2	1
CO4	2	3	2	3	1							1	2	1
CO5	3	3	2	2	1							1	2	1

UNIT-I

Fundamentals of Vibrations Analysis- Introduction; Elements of vibration; vibration analysis procedure; spring elements-equivalent stiffness; Mass or inertia elements; Damping elements-equivalent damping-Types of damping, Definitions and Terminology, Simple harmonic motion.

Free Vibration Analysis-Single Degree of Freedom Systems Undamped Vibrations: Different methods for equation of motion-Newton's Second Law, D'Alembert's Principle of Virtual displacement, Principle of Conservation of Energy, Rayleigh's method.

Damped Vibrations: Differential equation of motion, critical damping coefficient and damping ratio; Damped natural frequency; Logarithmic decrement; Energy dissipated in viscous damping.

UNIT-II

Forced Vibration Analysis (Single Degree of Freedom System):Response of damped and undamped systems to harmonic excitation; frequency response curve; magnification factor; Harmonic excitation of the base, vibration isolation, transmissibility, force transmission to foundation; response of a damped system under rotating unbalance. Vibration measuring instruments-working principle of Seismic mass, Vibrometer, Accelerometer.

UNIT-III

Damped and Undamped Vibrations: Free and forced vibration analysis of two degree of freedom system-different methods for the formulation of equations of motion, natural frequencies, Principal modes-physical interpretation and orthogonality.

UNIT-IV

Torsional Vibrations: Torsional vibration of one, two and three rotor system, Equivalent shafting, Torsional vibration of a geared system, Coordinate coupling-static and dynamic coupling, whirling of rotating shafts.

UNIT-V

Numerical methods: Characteristic equation, Eigen values, identification of node and mode shapes. Eigen value method, Influence coefficients.

Suggested Readings:

1. G.S. Grover &Nigam ,MechanicalVibrations,Nem Chand & Bros, 6th edn,1998
2. S.S. Rao ,Mechanical vibration, 4th edn, Pearson, 2009
3. Thomson , William T, Theory of Vibration with Application,4th edn, Pearson Education,2007
4. V.P. Singh , Mechanical vibration, Dhanpath Rai &Co.,3rd edn,2006
5. Graham Kelley,S., Mechanical vibration – Schaums Outline Series, TMH
6. F.S. Tse, Morse &Hinkle ,Mechanical vibration, Allyn and Bacon, 1978

Course Code: PE502ME

POWDER METALLURGY

Credits: 3

Instruction: (3L) per week — Duration of SEE: 3 hours

CIE: 30 Marks — SEE: 70 Marks

Course Objectives:

- To understand the importance and advantages of Powder Metallurgy.
- To learn the steps of powder metallurgy-powder properties, mixing, compaction, sintering, post sintering operations, testing.

Course Outcomes:

- Able to understand the basic principles of powder metallurgy
- Able to characterize the various powders and their properties
- Apply the knowledge of powder products in various industries
- Analyze the pressing and sintering tools for powder making
- Testing and applications of cutting tools manufactured by PM method

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	2	1	2	-	-	1	1	-	2	-	-
CO2	3	1	1	2	2	1	-	-	-	-	-	-	-	-
CO3	2	1	2	1	-	1	-	-	-	-	-	1	-	-
CO4	1	3	1	2	2	1	-	-	-	-	-	-	-	-
CO5	1	-	1	1	3	-	-	-	-	-	-	-	-	-

Unit-I

Introduction, importance and advantages of Powder Metallurgy.

POWDER MANUFACTURE: Comminution, solid state reduction, electrolysis, thermal decomposition, and Atomization (water atomization, oil atomization, gas atomization, centrifugal atomization).

Unit-II

POWDER PROPERTIES, CHARACTERIZATION, AND MIXING: Chemical composition, particle shape, powder density, particle size, size distribution compressibility, green strength. Blending and mixing.

COMPACTION: Compact size, tool materials, design of sintered part, Olivetti process hot pressing, injection moulding, cold iso-static pressing, and hot iso-static pressing.

Unit-III

SINTERING: Theory of sintering. Sintering practice – furnace desing, furnace atmospheres, vacuum sintering, control of shrinkage, liquid phase sintering, activated sintering, and loose powder sintering.

Unit-IV

POST-SINTERING OPERATIONS: Re-press and re-enter, hot re-press, hot forge in a closed die, sizing, coining, HIP, steam treatment, infiltration, and impregnation. Heat treatment, hardening, and tempering, surface hardening, electro-plating, and other coatings. Deburring, machining and joining. Sinter forging.

Unit-V

Testing of sintered parts. Applications: Porous bearings and filters. Magnetic Materials, super alloys, High speed steels, Stainless steels, ODS materials, Production of Near-net shapes, Rapidly solidified powders, and spray forming. Manufacturing of Cutting tools, forming dies using powder metallurgy.

Suggested Reading:

1. E.P. DeGarmo, J.T. Black, R.A. Kohser, Materials and processes in manufacturing – 8th Ed., Prentice Hall, 1997.
2. Roy A. Lindberg, Processes and materials of manufacture – 4th Ed., Prentice Hall of India Pvt. Ltd., New Delhi, 1995.
3. H.H. Hausner – Hand book of powder metallurgy.

Course Code: PE503ME

ROBOTIC ENGINEERING

Credits: 3

Instruction: (3L) per week Duration of SEE: 3 hours

CIE: 30 Marks SEE: 70 Marks

Course Objectives:

- To provide student the fundamental knowledge of the various sub-disciplines in serial robots such as kinematics, dynamics, control & manipulation, and computer based acquisition etc.
- To provide adequate background in both analysis and design of serial robots

Course Outcomes:

- Identify and classify various robot configurations with their workspaces
- Possesses skill in developing spatial transformations and find forward kinematic solutions
- Perform inverse kinematics and determine Jacobean for various robot configurations
- Analyse the robot dynamics and develop control systems for various robot configurations
- Analyse and apply vision to various robot configurations

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	2	1							1	2	1
CO2	3	3	2	2	1							1	2	1
CO3	2	3	3	2	2							1	2	1
CO4	3	3	2	2	2							1	2	1
CO5		2	3	2	2							1	2	1

UNIT-I

Introduction to Robotics Basic structure of Robots.Degree of freedom of Robots. Work envelope. Classification of Robots based on drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry.Specification of requirement of motion and force for different application. Repeatability, Precision and Accuracy as applied to Robots.

UNIT-II

Rotation matrix.Homogeneous transformation matrix.Denavit and Hartenbergrepresentation.Euler angles and RPY representation.Representation of absolute position and orientation in terms of joint parameters, Kinematic equation for manipulators.Inverse kinematics of Robot arm for position and orientation.Redundancy in Robots.

UNIT-III

Jacobian for direct and inverse kinematics.Trajectory planning for Robots.Trajectory control based on incremental inverse kinematics of kinematic equations, Static force analysis, stiffness.

UNIT-IV

Newton - Euler formulation of dynamic equation.Lagrangianformulation.Inertia tensor. Control schemes, individual joint control and disadvantages. Control through computed torques.

UNTT-V

Position and velocity measurement.Optical encoders. Different types of End effectors for industrial Robots. Range and Proximity sensing.Tactilesensors.Force and Torque sensors. Drives used in industrial Robots. Introduction to techniques used in Robot vision. Image acquisition and processing.Introduction to Robot programming.

Suggested Reading:

1. Fu. K.S., GonZalez R.C., Lee C.S.G. "Robotics, Control-sensing vision and Intelligence", McGraw Hill, Int. Ed., 1987.
2. Asada and Sllotine , 'robot analysis and intelligence' BS Publications , India.
3. Spong and Vidyasagar, "Robot Dynamics & Control", John Wiley and Sons, Ed.,1990.
4. Groover M P, "Industrial Robotics", McGraw Hill Publications, 1999.
5. Mittal and Nagrath, "Industrial Robotics", Tata McGraw Hill Publications, 2004.
   Saha&Subirkumarsaha, 'robotics', tmh, india.

Course Code: PE504ME

THEORY OF ELASTICITY

Credits: 3

Instruction: (3L) per week hours CIE: 30 Marks Marks

Duration of SEE: 3 SEE: 70

Course Objectives:

- To familiarize stress and strain.
- To understand problems on bending, torsion, thin wall, thick wall and columns

Course Outcomes:

- Formulate the stress strain relations in elastic body
- Develop the governing equation and apply boundary conditions for 2D elastic problems
- Apply the general theorems to the 3D elastic continuum problems
- Analyse the stress Bending of straight beams and curved beams. Torsion of shafts, Membrane analogy. Bending of plates.
- Analyse Rotating disks of uniform and variable thickness. General treatment of column stability problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	0	2	0				0	1	1	1	1
CO2	2	2	2	0	2	0				0	1	1	1	1
CO3	2	2	1	1	1	0				0	1	1	1	1
CO4	2	2	2	1	2	1				1	1	1	1	1
CO5	2	2	2	1	2	1				1	1	1	1	1

Unit-I

Analysis of Stress: Stress tensor, Equilibrium equations in Cartesian coordinates, Two dimensional stress at a point and principal stresses. Three dimensional stress at a point and principal stresses. Stresses on an oblique plane in terms of principal stresses.

Unit-II

Analysis of Strain: Strains in terms of displacements in Cartesian coordinates, Equations of compatibility, Generalised Hook's Law and Lame's constants, Strain energy, Dilational and distortional energy, St. Venant's principle.

Unit-III

Two dimensional problems: Plane stress, Plane strain problems: Stress function, Bi-harmonic equation, Equilibrium equations, Strain displacement relations and compatibility equations in polar coordinates, Stress concentration.

Unit-IV

Bending of straight beams and curved beams. Torsion of shafts, Membrane analogy.Bending of plates.

Unit-V

Axi-symmetric problems, Thick walled cylinders subjected to internal and external pressures, Stresses in composite tubes, Rotating disks of uniform and variable thickness. General treatment of column stability problems.

Suggested Reading:

1. L.S. Srinath, *Advanced Mechanics of Solids*, Tat Mc Graw Hill Publ. Co., 1970.
2. S. Timeshenko& J.N. Goodier, *Theory of Elasticity*, Mc Graw Hill, 1970.
3. A.C. Uguaral, *Advanced Strength and Theory of Elasticity*, Elsevier Publication, 1965.
4. S. Singh, *Theory of Elasticity*, Khanna Publishers, 1979.

SCHEME OF INSTRUCTION & EXAMINATION
B.E VI Semester (Mechanical Engineering)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P/ Dwg	Contact Hrs/wk	CIE	SEE	
1.	PC601ME	Machine Design	3	1		4	30	70	3
2.	PC602ME	Production Drawing	2	-	2	4	30	70	3
3.	PC603ME	Refrigeration and Air Conditioning	3	-	-	3	30	70	3
4.	PC604ME	Production and Operations Management	3	-	-	3	30	70	3
5.	PC605ME	Control Systems Theory	3	-	-	3	30	70	3
6.	PE *	Professional Elective-II	3	-	-	3	30	70	3
7.	OE **	Open Elective-I	3	-	-	3	30	70	3
8.	MC***	Mandatory Course	3	-	-	3	30	70	3 Units
PRACTICALS									
9	PW961ME	Summer Internship	-	-	-	-	-	-	-
10.	PC651ME	Metrology & Machine Tools Lab	-	-	2	2	25	50	1
11.	PC652ME	Hydraulic Machinery Lab	-	-	2	2	25	50	1
			23	1	6	30	290	660	23

Note: **Summer Internship along with credits will be reflected in VII semester memorandum of marks

**PROFESSIONAL ELECTIVE-II	
PE601ME	Energy Systems
PE603ME	Computational Fluid Flows
PE604ME	Nano materials and Technology
PE605ME	Renewable Energy Sources
PE606ME	Operations Research
MANDATORY COURSE*	
MCSS	Science ,Technology, Innovation and Society
MCPA	Indian Polity and Administration
MCBM	Business Ethics and Corporate Governance

**OPEN ELECTIVE-I	
OE601BM	Micro Electro Mechanical System (MEMS)
OE602BM	Engineering Applications in Medicine
OE601CE	Disaster Management
OE602CE	Geo-Spatial Techniques
OE601CS	Operating Systems
OE602CS	OOPS using JAVA
OE601EC	Embedded Systems
OE602EC	Digital System Design using Verilog HDL
OE601EE	Reliability Engineering
OE601ME	Industrial Robotics
OE602ME	Material Handling
OE601LA	Intellectual Property Rights

MACHINE DESIGN

Credits:3

Instructions: (3L+1T) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn design criteria of machine components, selection of materials and manufacturing process.
- To learn application of principles to design helical coiled and leaf springs, gears, curved beams, sliding contact and rolling element bearings, chain drives, IC engine components and fly wheels.

Course Outcomes:

The Students will be able to

- Analyse helical and leaf springs for various applications under static and dynamic loading
- Classify and Design various gear configurations like spur, helical, bevel and worm for real time applications under static and dynamic loading conditions
- Categorize and design sliding and rolling bearing for real time applications
- Design various IC engine components for specified input conditions
- Design chain drives and curved beams based on the applications

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2	1				1			1	2	1
CO2	3	2	3	2	1				1			1	2	1
CO3	2	2	3	2	1				1			1	2	1
CO4	3	2	3	2	1				1			1	2	1
CO5	2	2	3	2	1				1			1	2	1

Unit-I

Mechanical springs: Introduction. Different types of springs. Materials used for springs.
Helical Springs: Whal factor, calculation of stress, Deflection and energy stored in spring. Design for static and fluctuating loads.
Leaf Springs: Stress and Deflection. Nipping of Leaf springs. Design for static and fluctuating loads.

Unit-II

Gears: Introduction of gear drives, different types of gears, Materials used for gears. Standards for gears and specifications.
Spur Gear Design: Lewis equation, Beam strength of gear tooth and static design. Wear load and design for Wear. Dynamic loads on gear tooth. Design of Helical, Bevel and Worm gears, concepts of Design for manufacturability.

Unit-III

Bearings: Introduction. Materials used for Bearings. Classification of bearings and mounting of bearings.
Design of sliding contact bearings: Properties and types of Lubricants, Design of Hydrostatic and Hydrodynamic sliding contact bearings.
Design of Rolling Contact Bearings: Different types of rolling element bearings and their constructional details, static load carrying capacity. Dynamic load carrying capacity. Load-life relationship, selection of bearing life. Design for cyclic loads and speeds. Design of Ball and Roller bearings.

Unit-IV

I.C. Engine parts: Introduction. Materials used. Design of piston, connecting rod and crank for I.C. Engines.
Fly wheels: Introduction. Design of solid disk type and rimmed fly wheels.

Unit-V

Design of curved beams: Introduction stresses in curved beams, expression for radius of curvature of neutral axis for rectangular, circular, trapezoidal and T-sections. Design of crane Hook, C-clamp. Design of chain drives: Power rating of roller chains. Strength of roller chains.

Suggested Reading:

1. Bhandari V.B. *Machine Design*, Tata Mc Graw Hill Publications, 1994.
2. J.E. Shigley , C.R. Misckhe, *Mechanical Engineering Design*, Tata Mc Graw Hill Publication, 2003.
3. P. Kannaiah, *Machine Design*, Science-Tech Publications, 2003.
4. M.F. Spotts, *Design of Machine Elements*, Prentice Hall, 1964.
5. Robert L. Norton, *Machine Design: An Integrated Approach*,2/e PearsonEducation, 2000

PC602ME

PRODUCTION DRAWING

Credits:3

Instructions: (2L+2P) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To learn design criteria of machine components, selection of materials and manufacturing process.
- To learn application of principles to design helical coiled and leaf springs, gears, curved beams, sliding contact and rolling element bearings, chain drives, IC engine components and fly wheels.

Course Outcomes:

The Students will be able to

- To understand fundamentals of production drawing
- Science of drawing in production drawing
- To apply in industry in real practice
- To develop as career
- To develop innovation techniques

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	1	2	2	2	2	2	2	2	2
CO2	2	2	3	2	2	2	2	2	1	2	2	2	1	2
CO3	2	3	1	2	1	2	2	2	2	2	1	2	2	1
CO4	2	2	2	2	1	2	2	2	2	3	2	1	2	3
CO5	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Unit1:

Fromat of drawing sheet, title block, columns for materials, processes, part list etc. conventional representation of materials and parts (Screwed joint, Welded joints, Springs, Gears, Elements of electrical, Hydraulic and pneumatic circuits, machine tool elements) Abbreviated indication of standard parts in assembly drawings.

Unit-II

Limits and fits, Basic definitions of terms: I.T. Grades of Tolerances and their estimation, fundamental deviations for Hole based and Shaft based systems. Alpha numeric designation of limits/fits. Types of Fits. Interchangeability and selective assembly. Study of Examples involving selection of fits and calculation of limits. Form and positional tolerances.

Unit-III

Indication of production requirements: Conventional practices of indicating tolerances of size, fit, geometrical form and position tolerances. Surface finish, surface treatments. Specification and indication method of above features on the drawings. Calculation of limits. Suggestion of suitable fits for mating parts.

Unit-IV

Production drawing practice: Part drawings from assembly drawings with conventional representations described in units I to III above.

PC602ME

Unit-V

Process sheets. Process sheet preparation incorporating Tool Work orientation diagrams. Tolerances and finishes obtainable from different manufacturing processes. Study of I.S. 2709 on limits and fits.

N.B. Tolerance charts to be provided in the examination Hall for calculation of limits.

Suggested Reading:

1. P. Narsimha Reddy, T.A. Janardhan Reddy, C.S. Rao, *Production Drawing Practice*, High Tech Publishers, 2001.
2. R.K. Jain, *Engineering Metrology*, Khanna Publishers, 8th Ed. 1985.
3. K.L. Narayana, P. Kannayya and K. Venkat Reddy, *Production Drawing*, New Age International (p) Ltd. Revised edition, 1997.

PC603ME

REFRIGERATION AND AIR CONDITIONING

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the basic concepts of refrigeration and air conditioning systems.
- To study the methods of refrigeration for commercial and industrial applications.
- To study the lower temperature applications: cryogenics by using cascade systems.
- Solving the problems related to cooling and heating system (HVAC).

Course Outcomes:

- Understand the basic concepts of refrigeration and air conditioning systems.
- Understand vapour compression and vapour absorption system and analyze the performance improvement
- Study the working principles of steam jet refrigeration and thermoelectric refrigeration system
- Analyze the psychromtric processes for air conditioning system.
- Study the different methods for production of low temperature and applications of cryogenics.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	2	2	-	-	-	2	2	-	-
CO2	3	3	2	1	-	-	-	-	-	-	2	3	-	-
CO3	2	3	3	-	-	-	2	-	-	-	2	2	-	-
CO4	3	3	2	2	1	2	2	-	-	-	1	2	-	-
CO5	3	3	2	-	2	-	-	-	-	-	2	2	-	-

Unit-I

Definition of Refrigeration & Air Conditioning. Necessity of refrigeration. Applications of refrigeration and air conditioning. Units of refrigeration. Refrigerants classification and desirable properties of refrigerants. Air refrigeration: Carnot refrigeration cycle and its limitation. Air refrigeration cycle operating on Brayton cycle and analysis. Aircraft refrigeration: Necessity.
Advantages of using air cycles for aircraft refrigeration. Refrigeration systems for low and high speed aircrafts.

Unit-II

Vapour compression system: Simple vapour compression cycle: COP, representation of cycle on T- S, P-H and H-S diagrams. Actual vapour compression cycle. Effect of superheating and sub cooling
– problems. Vapour absorption refrigeration systems: Ammonia –water, Lithium Bromide – water systems. Improvements using analyzer and rectifier. Desirable properties of combinations. Electrolux refrigerator – Its working.

Unit-III

Steam jet refrigeration systems: Analysis using T-S and H-S diagrams. Quantity of motive steam required. Use of barometric and evaporative condensers. Limitations and advantages of steam jet systems.
Thermoelectric refrigeration systems: Seebeck effect, Peltier effect and Thompson effect. Analysis of the thermoelectric refrigeration systems using Peltier effect. Expression for COP. Criterion for selecting thermoelectric effects. Vortex tube refrigeration – principle and working.

PC603ME

Unit-IV

Psychrometric properties of air: Psychrometric chart and psychrometric processes and combination of processes. By pass factor. SHR and Room conditioning using SHR with and without recirculation.Design and classification of Air conditioning systems, RSHF, GSHF, ERSF. Human comfort and tolerances. ASHRAE comfort charts. Effective temperature.

Unit-V

Cryogenics: Limitations of single stage vapour compression systems applied to low temperature applications. Multistage compression and cascade systems for production of low temperature. Joule Thompson effect and coefficient. Inversion curve. Liquification of air using Linde and cloude systems. Liquification of hydrogen and helium. Application of cryogenics in metallurgy, cryobiology and cryosurgery.

Suggested Reading:

1. C.P. Arora & S. Domkundwar, *A course in Refrigeration and air conditioning*, Dhanapatrai & Sons, 1996.
2. V.K. Jain, *Refrigeration and Air conditioning*, S. Chand & Company, 1996.
3. Jordon & Priester, *Principles of Refrigeration and Air Conditioning*, Prentice Hall, India, 1965.
4. Marshall siting, *Cryogenics*, D. Van Nostrand Company, Inc., 1963.

PC604ME

PRODUCTION AND OPERATION MANAGEMENT

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the concept of scientific management, classify various types of manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources
- To understand the importance of quality, inventory control and concepts like MRP I and MRP II
- To know the emerging management concepts like TQC, Kanban, Lean and Agile Manufacturing.

Course Outcomes:

- To comprehend the role of operations management in the overall business strategy of the firm.
- To describe the concepts and methods of forecasting both long-term and short-term by using different techniques along with cost analysis.
- To select the appropriate tool for marketing concepts & Strategies, with financial and time management
- To evaluate the operations management problems using the appropriate tools.
- To understand the role of information system in implementing modern management concepts

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	0	1	0	1	3	1	1	0	0	2	2	2	1	2
CO2	0	2	1	1	2	0	2	0	1	2	2	2	1	0
CO3	1	1	0	0	1	0	0	1	0	1	1	1	1	2
CO4	1	1	2	1	1	0	0	0	1	0	0	1	1	2
CO5	0	2	2	0	2	0	0	0	0	2	2	2	1	2

UNIT-I

Scientific Management by Taylor and Henri Fayol. Functions of Management, Types of Business firms and organizational structures, Designing Products, Services and Processes: New product design and development. Product life cycle: phasing multiple products. Types of Manufacturing processes: Product, job shop, batch, assembly line and continuous process technology: Flexible manufacturing systems.

UNIT-II

Locating production and services facilities, effects of location and costs and revenues, factor rating simple median model (linear programming). Layout planning: process layout; product layout- Assembly lines; line balancing manufacturing cellular layout. Scheduling system and aggregate planning for production and services; loading assignment algorithm; priority sequencing and other criteria. Work study, Work measurement techniques; predetermined time study; Work sampling

UNIT-III

Quality planning and control; basic concepts, definitions and history of quality control. Quality function, Quality policy and objectives. Economics of quality and measures of the cost of quality. Quality consideration in design, Use of statistical process control charts for variables and attributes. Acceptance sampling; single double and multiple sampling, operating characteristic Curve- calculation of producers risk and consumer's risk.

UNIT-IV

Inventory Control: Definition of Inventory and Inventory Control, Types of Inventory, Objectives & Benefits of Inventory Control, Terminology, Cost Trade-off, Inventory Models: Deterministic and Stochastic inventorymodels: variable demand: lead time, specific service level, perishable products and service.

Selective Control of Inventory: ABC, VED and SDE Analysis. Inventory control procedures; Fixed Order Quantity System (Q-System) versus Fixed Period Quantity systems (P-System); Material requirement planning(MRP); MRP as a scheduling and ordering system; MRP system components; MRP computational procedure, MRP –limitations and Advantages. Detailed Capacity Planning: Capacity planning decision, measuring capacity: estimating future capacity needs, Manufacturing Resource Planning (MRP-II).

UNIT V

Emerging Management Concepts: Japanese management overview, value added manufacturing, Japanese manufacturing techniques; total quality control - Deming contribution to TQC, quality circles; fishbone diagram, Taguchi method of quality control, push or pull system, Kanban system, Juran's Triology, Quality Loss Function and Calculations. Introduction to Lean and Agile Manufacturing Concepts.

Suggested Readings:

1. Everett, E. Adam. Jr and Ronald. J. Ebert - "Production and operations management – concepts, models and behaviour" - Prentice – Hall (India) Pvt. Ltd., New Delhi, 5th ed. 1998, New Delhi.
2. Lee J. Krajewski, Larry. P. Ritzman, "Operations Management: Strategy and Analysis" - Addison Wesley Longman (Singapore) Pvt Ltd., India Branch, 5th ed., 2000 year.
3. Richard B. 8hase, Nicholas, J. Aquilano and F. Robert Jacobs. "Production and operations management - manufacturing and services"- Irvin McGraw - Hill; New Delhi, 5th ed. 1998.
4. J.M.Juran & Frank M.Gryna, "Quality Planning and Analysis", Tata McGraw Hills

PC605ME

CONTROL SYSTEMS THEORY

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To introduce students to the fundamental of feedback control system theory and use of analytical design methods in designing, analyzing various physical systems and to apply the gained knowledge in developing solutions for real world systems.
- To develop the ability of formulating mathematical models and designing feedback control systems.
- To provide students with necessary tools to analyze linear feedback control systems.
- To introduce the students to the concepts of digital control and modern control.

Course Outcomes:

- Differentiate open and closed loop systems and develop mathematical models of various systems like mechanical, electrical, electro- mechanical systems.
- Evaluate the effects of transient and steady state responses and apply these models to real time systems.
- Application of time response and frequency response methods to determine the stability of the system.
- Apply the concepts of discrete time control systems.
- Analyse and design multi input, multi output systems by state space analysis.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1				1			1	2	2
CO2	3	2	3	2	1				1			1	2	1
CO3	3	2	3	2	1							1	1	1
CO4	2	2	2	2	1							1	1	1
CO5	3	2	3	2	1							1	1	1

Unit-I

Introduction: Classification of control systems. Examples of control systems with applications in Mechanical Engineering. Basic laws: Mechanical, Electrical, Fluid, Thermal. Relationships of components and analogies. Performance characteristics of control system components. Hydraulic and pneumatic control systems. Methods of analysis using standard input functions. Laplace transformation, use of transfer functions.
Derivation of system equations: The simultaneous equation method. Block diagram method and Laplace transform approach.
Error sensing devices: Potentiometer, synchros, and AC-DC servomotors, Encoders, Decoders.

Unit-II

Time Response: Response characteristics of systems Types of input. Transient response of first and second order system for step input. Time domain specification. Types of system, static error coefficients, error series, Routh-Hurwitz criterion of stability.
Root Locus Techniques: Typical systems analyzed by Root Locus Techniques. Effect of location of roots on the system response.

Unit-III

Frequency response analysis: The frequency response of a second order system, effect of numerator factors, zero factors in a transfer function. Bode plots, Gain-Phase plot, Nyquist criterion for stability, Gain Margin and Phase Margin, compensation techniques.

Unit-IV

Discrete Control Analysis: The Z-transformation, digital control, advantages and disadvantages, Digital control system architecture. The discrete transfer function. Z-domain stability. Stability tests. Jury's stability criteria.

Unit-V

State space representation: Concept of state. State variable, state models of linear time invariant systems, derivation of state model from transfer functions and differential equations. State transition matrix, solution of state equations by time domain method.

Suggested Reading:

1 Ogata, 'modern control engineering', prentice hall, 5th edition, India, 2010
2 Norman S Nise, control system engineering', Wiley publications, 6th edition, 2010
3 Francis Raven H. "Automatic Control Engineering", Tata McGraw Hill, 5* Edition, 1995.
4 Peter Dransfield, "Engineering Systems and Automatic Control", Prentice Hall of India,, 1974
5 Gene F. Franklin, J. David Powell, Abbas Emamin Naini, "Feedback control of Dynamic Systems", Pearson Education Pvt. Ltd., 4* Edition, 2004.
6 Benjamin kuo, 'automatic control systems ', 9th edition, wiley, india, 2010

PW961ME

SUMMER INTERNSHIP

Credits:2

Instructions: 8 weeks *CIE: 50 Marks*

Course Objectives:

- To give an experience to the students in solving real life practical problems with all its constraints.
- To give an opportunity to integrate different aspects of learning with reference to real life problems.
- To enhance the confidence of the students while communicating with industry engineers and give an opportunity for useful interaction with them and familiarize with work culture and ethics of the industry.

Course Outcomes: Student will be

- Able to design/develop a small and simple product in hardware or software.
- Able to complete the task or realize a prespecified target, with limited scope, rather than taking up a complex task and leave it.
- Able to learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to prespecified criteria.
- Able to implement the selected solution and document the same.
- Able to write a technical report and present it to appropriate audience

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1		1	2			1	2	2	1	1	2	1
CO2	2	1		1	2			1	2	2	1	1	2	1
CO3	2	1		1	2			1	2	2	1	1	2	1
CO4	2	1		1	2			1	2	2	1	1	2	1
CO5	2	1		1	2			1	2	2	1	1	2	1

Summer Internship is introduced as part of the curricula for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Industry / R & D Organization / National Laboratory for a period of 8 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide. After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the department. Award of sessional marks are based on the performance of the student at the work place and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will coordinate the overall activity of Summer Internship.

***Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and credits will be awarded after evaluation in VII semester.**

PC651ME

METROLOGY AND MACHINE TOOLS LABORATORY

Credits:1

Instructions: (2P) hrs per week *Duration of SEE: 3hours*

CIE: 25 Marks *SEE: 50 Marks*

Objectives:

- To have knowledge of various precision measuring instruments.
- To familiarise machining and metal cutting operations.

Course Outcomes:

- Perform different operations such as step turning, knurling , taper and thread cutting on a lathe
- Perform different operations on shaper
- Perform indexing to machine spur gears on milling machine
- Evaluate internal and external taper angles, straightness and flatness of a given surface

SNO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3	2			3				2	3		1
CO2		3	2	2		3				2	3		1
CO3		3	2			3				2	3		1
CO4		3	2	2	1					2	3		1

List of Experiments:

Metrology:

1. a) Measurement with inside, outside and depth micrometers, Vernier calipers and Height gauges.
b) Measurement of roundness errors with Bench Centres, V-block and dial gauge.

2. a) Measurement of Linear and Angular dimensions with Tool Maker's Microscope: Flat specimens. Plain cylindrical specimens with centers and threaded components.
b) Measurement of angles with Sinebar, Bevel protractor and Precision level.

3. Measurement with Dial Indicator / Electrical Comparator / Mechanical Comparator /Dial Bore Gauge / Snap Gauge.

4. Calibration of Outside micrometer / Dial gauge.

5. Calibration and Force measurement with Strain gauge type load cell / Proving Ring /Spring type sensor.

6.Speed measurement with contact & non-contact type sensors / Temperature measurement with Thermocouple.

Machining Operations:

1. Thread Cutting on Lathe: single start and multi start threads.
2. Typical exercises on Shaper, Drilling machine, Milling machine and cylindrical grinding machine.
3. Gear milling.
4. Production of threads with taps and threading dies and milling cutters.
5. Study of reaming, boring and burnishing operations.
6. Experiments on CNC Lathe, CNC Milling and CNC EDM.

Metal Cutting:

7. Estimation of shear angle by measuring thickness and length of chips.
8. Measurement of Cutting forces with Lathe tool dynamometer and determination of friction angle and stresses on shear plane and rake plane.
9. a) Test for tool life.
b) Measurement of Chip-tool interface temperature by thermocouple.

PC652ME

HYDRAULIC MACHINERY LAB

Credits:1

Instructions: (2P) hrs per week — *Duration of SEE: 3hours*

CIE: 25 Marks — *SEE: 50 Marks*

Objectives:

- The purpose of the lab course is to support the understanding of the application of theoretical concepts of hydraulics machinery.
- To conduct performance tests on pumps, turbines and other hydraulic machines.

Course Outcomes:

- Test the performance of hydraulic turbines.
- Develop procedure for standardization of experiments
- Calibrate flow discharge measuring devices used in pipes, tanks, turbines
- Test the performance of centrifugal and reciprocating pumps.
- Estimate the performance analysis in turbines

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	1						1		
CO2	2	2	1	2	3	1						1		
CO3	3	2	1	2	3	1						1		
CO4	3	2	1	2	3	1						1		
CO5	3	2	1	2	3	1						1		

Laboratory Exercises:

1. Study of positive displacement and Rotodynamic pumps with the help of models.
2. Study of the working of turbines.
3. Performance and characteristic curves of a centrifugal pump.
4. Performance and characteristic curves of Peltron wheel and Turgo wheel.
5. Performance and characteristic curves of Francis turbine.
6. Performance of reciprocating pump.
7. Performance and characteristic curves of Kaplan turbine.
8. Performance of Axial Flow pump.
9. Study of hydraulic and pneumatic control circuits and assembly of simple control circuits.
10. Performance study of Jet pump.

PE601ME

ENERGY SYSTEMS
(Professional Elective-II)
Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the concepts and applications of non-conventional energy sources.
- To learn the principles of power generation - solar, wind, biomass, waste heatrecovery, IGCC

Course Outcomes:

- Understand the principles of energy extraction
- Differentiate between conventional and non conventional energy systems
- Classify and compare various non conventional energy systems like biomass, wind, solar and oceanic energy
- Analyse and Evaluate various non conventional energy systems
- Design suitable non conventional energy systems for specific applications

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

Unit-I

Solar energy: Solar radiation – measurement, collection and storage, design of flat plate and parabolic concentrating collectors. Solar power plants. Photo voltaic power systems. Application of SPV and Solar Thermal Systems.

Unit-II

Wind Energy: Estimation of wind energy potential. Horizontal and vertical axis wind turbine rotors. Aerodynamic design considerations for wind rotor blades. Wind electric generators operation and control. Aero generators for battery charging.

Unit-III

Bio mass energy: Source of biomass. Energy from solid wastes. Biomass for energy production. Methane production. Bio mass energy conversion technologies. Use of Biogasifier. Bio mass power generation using agricultural residues. Introduction to Hybrid energy systems.

Unit-IV

Principles of waste heat recovery and co-generation. Analysis of heat recovery systems. Regenerators and recuperations for waste heat recovery, Advantages of fluidized bed boilers. Atmospheric fluidized bed combustion (AFBC), Pressurized fluidized bed combustion (PFBC) and Circulation fluidized bed combustion (CFBC).

Unit-V

Co-generation power systems, condensate and back pressure steam turbines. Design of waste heat recovery boilers. Combined cycle power plants based on waste heat recovery. Integrated gasification combined cycle (IGCC) power plants. Optimisation of power plant cycle efficiency. Clean coal technologies.

Suggested Reading:

1. D. Yogi Goswami Frant Krcish, *Principles of Solar Engineering* Taylor and Francis, USA, 1999.
2. Tony Burton, David Sharpe, *Nickel Jenking Wind Energy Hand Book*, John Wiley and Sons, Newyork, USA,

2001.
3. Ajit Varma, Basant Behera, *Green Energy, Biomass Processing Technology*, Capital Publishing Company, New Delhi, 2003.
4. V. Ganapathy, *Industrial Boilers Heat Recovery Steam Generators*, ABCO Industries, USA, 2002.

PE603ME

COMPUTATIONAL FLUID FLOWS
(Professional Elective-II)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the equations of fluid flow.
- To learn Finite difference method with heat transfer equations and grid generation.
- To learn Finite volume method and staggered grid.

Course Outcomes:

- The Students are expected to explain the governing equations of different types of fluid flow systems
- The Students are expected to explain averaging of turbulent flow properties and classify second order partial differential equations
- The Students are expected to be able to formulate finite difference equations based on accuracy, type of differencing and should be able to analyse their stability.
- The Students are expected to discretise the problem domain to apply FDM and solve equations using numerical methods.
- The Students are expected to apply Finite volume method for basic equations of heat transfer and fluid flow problems.

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2
CO1	3	3	2	1	1	1	1	-	-	2	3	2	2	2
CO2	*3*	2	2	1	3	-	-	-	-	1	1	1	1	1
CO3	*3*	3	3	3	3	-	-	-	-	1	1	1	1	-
CO4	*3*	3	3	2	3	-	-	-	-	-	-	1	1	1
CO5	*3*	3	3	3	3	1	-	-	1	1	1	1	1	1

Unit-I

Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations- Navier Stokes equations, Reynolds and Favre averaged N-S equations. Heat transfer conduction equations for steady and unsteady flows. Steady convection-diffusion equation.

Unit-II

Introduction to turbulence, Mixing length model, K-e turbulence Model.
Classification of PDEs-Elliptic, parabolic and hyperbolic equations. Initial and boundary value problems.

Unit-III

Concepts of Finite difference methods- forward, backward and central difference. Finite difference solutions- Parabolic partial differential equations. Euler, Crank Nicholson,Implicit methods. Higher order difference methods. Errors, consistency. stability analysis- von Neumann analysis. Convergence criteria.

Unit-IV

Elliptic partial differential equations – Jacobi, Gauss Seidel and ADI methods. Viscous incompressible flow, Stream function- Vorticity method. Introduction to Grid Generation- Types of grid- O,H,C.

Unit- V

Introduction to finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows, Staggered grid, SIMPLE Algorithm.

Suggested Reading:

1. Muralidhar K, Sundararjan T, *Computational Fluid Flow and Heat transfer*, Narosa Publishing House, 2003.
2. Chung, T J, *Computational Fluid Dynamics*, Cambridge University Press, 2002.
3. Patankar, S V, *Numerical Heat transfer and Fluid flow*, Hemisphere Publishing Company, New York, 1980.
4. John D Anderson, *Computational Fluid Dynamics*, Mc Graw Hill, Inc., 1995.
5. Pradip Niyogi, Chakrabartty S K, Laha M K, *Introduction to Computational Fluid Dynamics*, Pearson Education,2005

PE604ME

NANO MATERIALS AND TECHNOLOGY
(Professional Elective-II)

Credits:3

Instructions: (3L) hrs per week — *Duration of SEE: 3hours*
CIE: 30 Marks — *SEE: 70 Marks*

***Course Objectives*:**

- To familiarize Nano materials and technology.
- To understand Nano structures, fabrication and special Nano materials.

Course Outcomes:

Unit-I

Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nano Technology, Bottom-up and Top-down approaches, challenges in Nano Technology.

Unit-II

Materials of Nano Technology:
Introduction-Si-based materials, Ge-based materials, Smart materials, metals, Ferroelectric materials, Polymer materials, GaAs & InP (III-V) group materials, Nano tribology and Materials, Principles and analytical techniques of XRD, SEM, TEM and STM/AFM.

Unit-III

Nano Structures:
Zero dimensional Nano structure (Nano Particles)- Synthesis procedure, characterization techniques, properties and applications of Nano Particles
One dimensional Nano structures (Nano Wires, Nano Tubes)- Various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes.

Unit-IV

Nano Fabrication:
Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping) MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques).

Unit-V

Special Nano Materials
Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal- ceramics and polymer-Ceramics), Characterization procedures, applications. Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications.

Suggested Reading:

1. A.K.Bandyopadyay, *Nano Materials*, New Age Publications, 2007.
2. T. Pradeep, *Nano: The Essentials: Understanding Nanoscience and Nanotechnolgy*, Tata McGraw-Hill, 2008.
3. Carl. C. Koch, *Nano Materials Synthesis, Properties and Applications*, Jaico Publishing House, 2008.
4. Willia Illsey Atkinson, *NanoTechnology*, Jaico Publishing House, 2009.

PE605ME

RENEWABLE ENERGY SOURCES
(Professional Elective-II)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Outcomes:

- Able to understand the resources of renewable energy
- Utilization of solar energy and thermal
- Understanding kinetics of wind energy and utilization of wind energy
- Understand the applications of biomass energy
- Gain the knowledge of OTEC, wave, tidal and geothermal energy sources.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					2	2		2	2				
CO2	3		2	2	1	2	2	1	2	2	2	2		
CO3	3	2	2	2	1	2	2	1	2	2	2	2		
CO4	3	2		2		2	2	1	2	2	1	2		
CO5	3					2	2	1	2	2	1	2		

Unit-I

Statistics on conventional energy sources and supply in developing countries, Definition - concepts of NCES. Limitation of RES. Criteria for assessing the potential of NCES. Classification of NCES - Solar, Wind, Geothermal, Biomas, Ocean Energy Sources, Comparison of these energy sources.

Unit-II

Solar Energy-Definition-Energy available from Sun. Solar radiation data. Solar energy conversion into heat-Flat plate and concentrating collectors. Principle of Natural and Forced convection. Solar engines-Stirling, Brayton engines, Photovoltaics-p-n junctions. Solar cells. PV systems-Stand-alone, Grid connected solar power satellite. Calculation of energy through photovoltaic power generation.

Unit-III

Wind energy-Energy available from wind, General formula-Lift and Drag-Basis of wind energy conversion-Effect of density, frequency variances, angle of attack, wind speed. Windmill rotors- Horizontal axis and Vertical axis rotors. Determination of torque coefficient. Induction type generators-Working principle.

Unit-IV

Nature of Geothermal sources, Definition and classification of resources. Utilization for electricity generation and direct heating. Well Head power generating units. Basic features - Atmospheric exhaust and condensing, exhaust types of conventional steam turbines. Pyrolysis of Biomass to produce solid, liquid and gaseous fuels. Biomass gasification. Constructional details of gasifier, usage of biogas of chulhas. Various types of chulhas for rural energy needs.

Unit-V

Wave, Tidal and OTEC energy - Difference between tidal and wave power generation. Principles of tidal and wave power generation. OTEC power plants. Operational of small open- cycle experimental facility. Design of 5 Mw OTEC pro-commercial plant. Economics of OTEC. Environmental Impacts of OTEC. Status of multiple product OTEC systems.

Suggested Reading:

1. Ashok V. Desai, "Non-Conventional Energy", Wiley Eastern Ltd., 1990.
2. Mittal K.M.,"Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd., 1997.
3. Ramesh R., Kumar K.U., "Renewable Energy Technologies", Narosa Publishing House, New Delhi, 1997.

PE606ME

OPERATIONS RESEARCH
(Professional Elective-II)
Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

***Course Objectives*:**

- To familiarize with basics of OR, including mathematical modeling, feasible solutions, optimization and iterative computayions.
- To understand algorithms to solve different types of transportation models.
- To construct network models and solve using CPM & PERT techniques.
- To model queuing problems, understand probability distributions.

Course Outcomes:

- Formulate engineering and managerial situations as LPP, transportation and Assignment problems.
- Solve LPP, Transportation and Assignment problems
- Formulate multi-stage applications into a dynamic programming framework.
- Solve Integer programming problems.
- Draw and solve the project network models

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	3					1		2			2
CO2	3	2	1	3					1		2			2
CO3	3	2	2	3					1		2			2
CO4	3	2	1	3					1		2			2
CO5	3	2	2	3					1		3			2

Unit-I

Introduction to Operations Research, simulation and art of modeling. Construction of Linear Programming (LP) model, graphical method of solving LP problem Standard LP form and determination of basic solutions. Unrestricted variables and solutions. Simplex method, Big-M method. Two phase method, Degeneracy, Unbounded solution, Infeasible solution.

Unit-II

Duality: Definition, Relationship between optimal primal and dual solutions. Economic interpretation, Dual simplex method, Post optimal or sensitivity analysis, Integer programming.

Unit-III

Transportation model, Transportation algorithm. Assignment model, Hungarian method Transhipment model. Traveling salesman problem, Dynamic Programming. Knapsack problem. Problem of dimensionality.

Unit-IV

Network models: Minimum spanning tree algorithm. Shortest route problem, Maximal flow model. Minimum cost capacitated flow problem (to be removed), CPM, PERT. Game Theory:
Introduction, Game with pure and mixed strategies. Goal programming: Introduction, Simplex method for solving goal problem.

Unit-V

Sequencing Models : Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines, processing 2 jobs through m machines. Probabilistic dynamic programming, Queuing models, Poisson queues, single server and multiple server model, machine servicing models.

Suggested Reading:

1. Hamdy, A. Taha, *Operations Research – An Introduction*, Seventh Edition, Prentice Hall of India Pvt. Ltd., 2002.
2. Ronald L. Rardin, *Optimization in Operations Research*, First Indian Reprint 2002, Pearson Education Asia.
3. R. Paneerselvam, *Operations Research*, Prentice Hall of India Private Ltd., 2002.
4. Singiresu S. Rao, *Engineering Optimization Theory of Practice*, 3rd edition, New Age International (P) Ltd. Publishers.
5. S.C. Sharma, *Operations Research*, Discovery Publishing House, 2006

OE601BE

MICRO ELECTROMECHANICAL SYSTEM (MEMS)
(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To introduce various sensors and actuators. • To introduce different materials used for MEMS.
- To educate on the applications of MEMS to various disciplines.

Course Outcomes: Student will acquire the

- Understand the basics of micro electrical mechanical systems
- Usage of mechanical and electrical effects in developing sensors for real time systems
- Usage of mechanical and electrical effects in developing actuators for real time systems
- Evaluate the operation of micro devices, micro systems and their Applications.
- Design the micro devices, micro systems using the MEMS fabrication process

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	1							1	1	
CO2	2	2	2	1	1							1	1	
CO3	2	2	2	1	1							1	1	
CO4	2	2	2	1	1							1	1	
CO5	2	2	2	2	1							1	1	

Unit I:

INTRODUCTION Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication - Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis –Flexural beam bending- Torsional deflection.

Unit II:

SENSORS AND ACTUATORS-I Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators –Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys.

Unit III:

SENSORS AND ACTUATORS-II Piezoresistive sensors – Piezoresistive sensor materials - Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.

Unit IV:

MICROMACHINING Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching –Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch -Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

Unit V:

POLYMER AND OPTICAL MEMS Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene –Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS –Lenses and Mirrors – Actuators for Active Optical MEMS.

Suggested Readings:

1. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
2. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
3. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.
4. Mohamed Gad-el-Hak, editor, "The MEMS Handbook", CRC press Baco Raton, 2001.

OE602BE

ENGINEERING APPLICATIONS IN MEDICINE

(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*

CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- Provide a basic knowledge of human physiology to engineering graduate students.
- Understand the applications of various branches of engineering in Medicine.

Course Outcomes:

- Importance and evolution of medical health care
- Applications of solid and fluid mechanics in bio medical systems
- Evaluation of Brain machine interface based systems
- understand the characteristics and design challenges in signal processing of bio-mechanical systems
- Effect and reach of replacement materials for various bio mechanical systems

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1	1	1						1	
CO2	2	2	2	2	1	1						1	1	
CO3	2	2	2	3	2	1						1	2	1
CO4	2	3	2	2	1							1	1	
CO5	2	3	2	3	2	1						1	1	1

Unit I:

Evolution of Modern healthcare, Major organ systems- Cardiovascular, Respiratory, Nervous, Skeletal, Muscular. Homeostasis. Physiological signals and their diagnostic importance.

Unit II:

Solid mechanics-Analysis of muscle force and joint reaction force for the limb joints. Fluid mechanics-Factors governing and opposing blood flow, Wind-Kessel model, Application of HagenPoiseuille flow to blood flow.

Unit III:

Brain-Computer Interface: Brain signals for BCIs, Generic setup for a BCI, Feature extraction and Feature translation involved in BCIs. Typical applications-Word forming, Device control.

Unit IV:

Bioelectricity-Excitable cells, Resting potential, Action potential, Accommodation, Strength- Duration Curve, Propagation of impulses in myelinated and unmyelinated nerves. Medical Instrumentation system- Functions, Characteristics, Design Challenges. Signal Processing-QRS detection.

Unit V:

Materials and Tissue Replacements-Types of Biomaterials- Metals, Polymers, Ceramics and Composites and their applications in Soft and Hard tissue replacements. Implants- Manufacturing process, Design, fixation.

Suggested Reading:

1.John Enderle,Susan m. Blanchard and Joseph Bronzino, Introduction to Biomedical Engineering, Second Edition, Elsevier, 2005.

2. Joseph D.Bronzino, Biomedical Engineering Fundamentals,
3rd Edition, CRC press, 2006 3. Ozkaya, Nordin. M, Fundamentals of Biomechanics, Springer International Publishing, 4th Edition, 2017.

OE601CE

DISASTER MANAGEMENT
(Open Elective-I)
Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

Course Outcomes:

- The students will be exposed to disasters, their significance and types
- Understand the relationship between vulnerability, disasters, disaster prevention and risk reduction and understand impact on Natural and manmade disasters
- Preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity
- Evaluate available Disaster management systems and evolve at better systems.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1				1	2	3	1	1	1		1	1	
CO2	2	1	1	1		1	3	1	1	1		1		
CO3	2		1			1	3	1	1	1				
CO4	2					1	3	1	1	1		1		
CO5	2					1	3	1	1	1		1		

Unit I:

Introduction to Disasters: Concepts and definitions of Disaster, Hazard, Vulnerability, Resilience, Risks. Natural and Manmade disasters, impact of drought, review of past disasters and drought in India, its classification and characteristics. Classification of drought, causes, Impacts (including social, economic. political, environmental, health, psychosocial, etc.).

Unit II:

Disaster: Classifications, Causes, Impacts including social, economic, political, environmental, health, psychosocial etc. Differential Impacts - in terms of caste, class, gender, age, location, disability Global trends in disasters, urban disasters, pandemics, complex emergencies, climate change. Cyclones and Floods: Tropical cyclones & Local storms, Destruction by tropical cyclones and local storms, Cumulative atmospheric hazards/ disasters, Cold waves, Heat waves, Causes of floods, Rood hazards in India.

Unit III:

Approaches to Disaster Risk Reduction: Disaster cycle - its analysis, Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural sources, roles and responsibilities of community, Panchayati Raj Institutions/Urban Local Bodies (PRis/ULBs), states, Centre, and other stake-holders.

Unit IV:

Inter-relationship between Disasters and Development: Factors affecting Vulnerabilities, differential impacts, impact of development projects such as darns, embankments, changes in Land-use etc. Climate Change Adaptation, Relevance of indigenous knowledge, appropriate technology and local resources.

Unit V:

Disaster Risk Management in India: Hazard and Vulnerability profile of India Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, OM Act and Policy, other related policies, plans, programmes and legislation) Field Work and Case Studies: The field work is meant for students to understand vulnerabilities and to work on reducing disaster risks and to build a culture of safety. Projects must be conceived creatively based on the geographic location and hazard profile of the region where the college is located.

Suggested Reading :

1. Sharma V. K. (1999). Disaster Management, National Centre for Disaster Management, IIPE, Delhi.
2. Gupta Anil K, and Sreeja S. Nair. (2011). Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi.
3. Nick. (1991). Disaster Management: A Disaster Manager's Handbook. Asian Development Bank, Manila Philippines.
4. Kapur, et al. (2005). Disasters in India Studies of grim reality, Rawat Publishers, Jaipur.
5. Pelling Mark, (2003). The Vulnerability of Cities: Natural Disaster and Social Resilience Earthscan publishers, London.

OE602CE

GEO-SPATIAL TECHNIQUES
(Open Elective-I)
Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- Description about various spatial and non-spatial data types, and data base management techniques
- Development of the concepts and professional skills in utility of geospatial techniques
- Enhancement of knowledge of geospatial techniques to field problems

Course Outcomes:

- Understand the importance of geographical information systems
- Classify various spatial and non-spatial data types, and data base management techniques
- Evaluate various methods of data modelling
- Applications of GPS for in Environmental and natural resource management, soil and water resources, agriculture, geology and urban planning
- Understand and apply the remote sensing technology for modeling environment, watershed management and urban planning.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	1	1	2					1		
CO2	2	2	2	1	2	1	2					1		
CO3	2	2	2	1	2	1	2					1		
CO4	2	2	2	1	2	1	1					1		
CO5	2	2	2	1	2	1	1					1		

Unit I:

Introduction: Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems. Projections and Coordinate Systems: Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

Unit II:

Data Acquisition and Data Management: data types, spatial, non spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty. Data Processing: Geometric errors and corrections, types of systematic and non systematic errors, radiometric errors and corrections, internal and external errors. 49

Unit III:

Data Modeling: Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system. GIS Analysis and Functions: Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non spatial data

Unit IV:

Applications of GIS: Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

Unit V:

Introduction to Remote Sensing: General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

Suggested Reading :

1. Burrough, P. A., and McDonnell R. A. (1998), 'Principles of Geographical Information Systems', Oxford University Press, New York
2. Choudhury S., Chakrabarti, D., and Choudhury S. (2009), 'An Introduction to Geographic Information Technology', I.K. International Publishing House (P) Ltd, New Delhi
3. Kang-tsung Chang. (2006), 'Introduction to Geographical information Systems', Tata McGraw-Hill Publishing Company Ltd., Third Edition, New Delhi
4. Lilysand T.M., and Kiefer R.W. (2002), 'Remote Sensing and Image Interpretation', John Wiley and Sons, Fourth Edition, New York
5. Sabins F.F. Jr. (1978), 'Remote Sensing Principles and Interpretations', W.H. Freeman and Company, San Francisco
6. Tor Bernhardsen. (2002), 'Geographical Information System', Wiley India (P) Ltd., Third Edition, New Delhi
7. Hoffman-Wellenhof, B, et al. (1997), 'GPS Theory and Practice', Fourth Edition, Springer Wein, New York.

OE601CS

OPERATING SYSTEMS
(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week — *Duration of SEE: 3hours*

CIE: 30 Marks — *SEE: 70 Marks*

Course Objectives:

- To understand CPU, Memory, File and Device management
- To learn about concurrency control, protection and security
- To gain knowledge of Linux and Windows NT internals

Course Outcomes:

- Classify the components and functions of operating systems
- Analyze and evaluate various Scheduling algorithms
- Compare and contrast various memory management schemes
- Apply the principles of concurrency
- Perform administrative tasks on Linux Windows Systems

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1							1		
CO2	2	2	2	2	1							1		
CO3	2	2	2	2	1							1		
CO4	2	2	2	2								1		
CO5	2	2	2	2	2							1		

Unit I:

Introduction to Operating Systems: OS structure and strategies, Process concepts, Threads, Inter process communication. CPU scheduling algorithms, Process synchronization, Critical section problem, Semaphores, Monitors.

Unit II:

Memory management, Swapping, Contiguous allocation, Paging, Static and Dynamic partitions, Demand paging, Page replacement algorithms, Thrashing, Segmentation, Segmentation with paging. File system interface: File concepts, Access methods and protection. File system implementation: File system structure, Allocation methods, Directory implementation. 51

Unit III:

Deadlocks: Necessary conditions, Resource allocation graph, Methods for handling deadlocks, Prevention, Avoidance, Detection and Recovery. Protection: Goals, Domain of protection, Access matrix. Security: Authentication, Threat monitoring, Encryption.

Unit IV:

Device Management: Disk scheduling methods, Disk management, Device drivers and interfaces, CPU- Device interactions, I/O optimization.

Unit V:

Case Studies: The Linux System–Design principles, Kernel modules, Process management, Scheduling, Memory management, File systems, Input and Output, Inter process communication Windows NT – General Architecture, The NT kernel, The NT executive.

Suggested Reading:

1. Abraham Silberschatz, Peter B Galvin, Operating System Concepts, Addison Wesley, 2006
2. William Stallings, Operating Systems-Internals and Design Principles, 5th edition, PHI, 2005
3. Andrew S Tanenbaum, Modern Operating Systems, 4th edition, Pearson, 2016

OE602CS

OOPS USING JAVA
(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week | *Duration of SEE: 3hours*
CIE: 30 Marks | *SEE: 70 Marks*

Course Objectives:

- To introduce fundamental object oriented concepts of Java programming Language -such as classes, inheritance, packages and interfaces
- To introduce concepts of exception handling and multi-threading
- To use various classes and interfaces in java collection framework and utility classes
- To understand the concepts of GUI programming using AWT controls
- To introduce Java I/O streams and serialization

Course Outcomes:

Student will be able to

- Understand fundamental object oriented concepts of Java programming Language -such as classes, inheritance, packages and interfaces
- Compare and contrast various exception handling and multi-threading concepts
- develop java applications using OO concepts and packages
- write multi threaded programs with synchronization implement real world applications using java collection frame work and I/O classes
- write Event driven GUI programs using AWT/Swing

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	1							1		
CO2	2	2	2	2	1							1		
CO3	2	2	2	2	1							1		
CO4	2	2	2	2								1		
CO5	2	2	2	2	2							1		

Unit I:

Object Oriented System Development: understanding object oriented development, understanding object oriented concepts, benefits of object oriented development. Java Programming Fundamentals: Introduction, overview of Java, data types, variables and arrays, operators, control statements. 53

Unit II:

Java Programming OO concepts: classes, methods, inheritance, packages and interfaces.Exceptional Handling, Multithreaded Programming

Unit III:

I/O Basics, Reading Console Input and Output, Reading and Writing Files, Print Writer Class, String Handling Exploring Java.Lang, Collections Overview, Collection Interfaces, Collection Classes, Iterators, Random Access Interface, Maps, Comparators, Arrays, Legacy Classes and Interfaces, String Tokenizer

Unit IV:

Introducing AWT working With Graphics: AWT Classes, Working with Graphics .Event Handling: Two Event Handling Mechanisms, The Delegation Event Model, Event Classes, Source of Events, Event Listener Interfaces AWT Controls: Control Fundamentals, Labels, Using Buttons, Applying Check Boxes, CheckboxGroup, Choice Controls, Using Lists, Managing Scroll Bars, Using TextField, Using TextArea, Understanding Layout Managers, Menu bars and Menus, Dialog Boxes, FileDialog,Handling events by Extending AWT Components, Exploring the controls, Menus and Layout Managers.

Unit V:

Java I/O Classes and Interfaces, Files, Stream and Byte Classes, Character Streams, Serialization.

Suggested Readings:

1. Herbert Schildt, The Complete Reference JAVA, Tata McGraw Hill, 7thEdition, 2005 2. James M Slack, Programming and Problem Solving with JAVA, Thomson learning, 2002
3. C.Thomas Wu, An Introduction to Object-Oriented Programming with Java, Tata McGraw Hill, 5thEdition, 2005.

OE601EC

EMBEDDED SYSTEMS
(Open Elective-I)
Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To understand the fundamentals of embedded systems
- To study the block diagram and advanced hardware fundamentals
- To study the software architecture of embedded systems
- To learn the tool chain of embedded systems
- To understand the tools and debugging process of embedded systems.

Course Outcomes:

Student will be able to

- acquire an overview of what an embedded system implies
- understand the architecture of a microprocessor and microcontroller to enable to design embedded applications using them.
- apply theoretical learning to practical real time problems for automation.
- understand how to build and debug an embedded system application.
- analyze and design real world applications and interface peripheral devices to the microprocessor.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	2							1	1	
CO2	2	2	2	2	2							1	1	
CO3	2	2	2	2	2							1	1	
CO4	2	2	2	2	2							1	1	
CO5	2	2	2	2	2							1	1	

Unit I:

Fundamentals of embedded systems: Definition of Embedded system, Examples of Embedded Systems, Typical Hardware, Terminology, Gates, A few other basic considerations, Timing Diagrams, Memory 55

Unit II:

Advanced hardware fundamentals: Microprocessors, Buses, Direct Memory Access, Interrupts, Other Common Parts, Built-Ins on the Microprocessor, Conventions used in Schematics, Microprocessor Architecture, Interrupts Basics, Shared Data Problem, Interrupt Latency.

Unit III:

Software architecture of embedded systems: Round- Robin, Round-Robin with Interrupts, Function- Queue-Scheduling Architecture, Real- Time Operating System Architecture, Selecting an Architecture

Unit IV:

Embedded software development tools: Host and Target Machines, Cross compilers, Cross Assemblers and Tool Chains, Linkers /Locaters for Embedded Software, Getting Embedded Software into Target System: PROM programmers, ROM Emulators, In-Circuit Emulators.

Unit V:

Debugging techniques: Testing on your host machine, Instruction Set Simulators, The assert Macro, Using Laboratory Tools

Suggested Readings:

1. David. E. Simon, "An Embedded Software Primer", Low price edition, Pearson Education, New Delhi, 2006.
2. Frank Vahid and Tony Givargis "Embedded System Design: A Unified Hardware/Software. Approach". John Wiley & Sons, October 2001.
3. Rajkamal, "Embedded systems: Programming, architecture and Design", second edition, McGraw-Hill Education (India), March 2009.

OE602EC

DIGITAL SYSTEM DESIGN USING VERILOG HDL
(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week — *Duration of SEE: 3hours*

CIE: 30 Marks — *SEE: 70 Marks*

Course Objectives:

- To familiarize with various modeling styles: structural, dataflow and behavioral of Verilog HDL.
- To develop combinational and sequential circuits using various modeling styles of Verilog HDL.
- To design and develop Verilog HDL models of data path and control units of Central Processing Unit (CPU).
- To learn Synthesis and FPGA design flow.
- To design and develop real time applications: Booth's multiplier, Divider, hardwired control for basic CPU and FIR filter.

Course Outcomes: Student will be

- Classify various modeling styles: structural, dataflow and behavioral of Verilog
- HDL.
- Implement and distinguish different Verilog HDL modeling styles.
- Construct and analyze Verilog HDL models of combinational and sequential circuits.
- Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications.
- Outline FPGA design flow and timing analysis

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

Unit I:

Structural modeling: Overview of Digital Design with Verilog HDL, Basic concepts, modules and ports, gate-level modeling, hazards and design examples.

Unit II:

Dataflow and Switch level modeling: dataflow modeling, operands and operators. Switch Level Modeling: CMOS switches and bidirectional switches and design examples.

Unit III:

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules and design examples.

Unit IV:

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions. Verilog HDL synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples. With effect from the Academic year 2017-2018 24

Unit V:

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Readings:

1. Samir Palnitkar, "Verilog HDL A Guide to Digital Design and Synthesis," 2nd Edition, Pearson Education, 2006.
2. Ming-Bo Lin, Digital System Designs and Practices: Using Verilog HDL and FPGA," Wiley India Edition, 2008.
3. J. Bhasker, "A Verilog HDL Primer," 2nd Edition, BS Publications, 2001.

OE601EE

RELIABILITY ENGINEERING
(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week — *Duration of SEE: 3hours*

CIE: 30 Marks — *SEE: 70 Marks*

Course Objectives:

- To understand the concepts of different types of probability distributions. importance of reliability evaluation of networks.
- To make the students understand about Reliability, availability model of Power Systems and markov modeling of Power Plants. with identical and no identical units.

Course Outcomes:

- Understand the importance of various probability density functions
- Classify the various failures and and their causes
- Develop reliability block diagrams and evaluate failure rate
- Analyse various markov models for single and multi components
- Determine the frequency of failure and cumulative failure using makov and other models

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

Unit I:

Discrete and Continuous random variables, probability density function and cumulative distribution function. Mean and Variance. Binomial, Poisson, Exponential and Weibull distributions.

Unit II:

Failure and causes of failure. Failure rate and failure density. Reliability function and MTTF. Bath tub curve for different systems. Parametric methods for above distributions. Non - Parametric methods from field data.

Unit III:

Reliability block diagram. Series and parallel systems. Network reduction technique, Examples. Evaluation of failure rate, MTTF and reliability, Active and Standby Redundancy, r out of n configuration. Non-series - parallel systems. Path based and cut set methods. 59

Unit IV:

Availability, MTTR and MTBF, Markov models and State transition matrices. Reliability models for single component. two components, Load sharing and standby systems. Reliability and availability models of two unit parallel system with repair and standby systems with repair.

Unit V:

Repairable Systems. maintainability. Preventive maintenance, Evaluation of reliability and J1TTF. Overhauling and replacement. Optimum maintenance policy. Markov model of a power plant with identical units and non-identical units. Capacity outage probability table. Frequency of failures and Cumulative frequency.

Suggested Reading:

1. Charles E.Ebeling, Reliability and MAintainabelity Engineering,Mc Graw Hill Inetrnational Edition, 1997.
2. BAlaguruswamy, Reliability Engineering,Tata McGraw Hill Publishing company Ltd,1984.
3. R.N.Allan. Reliability Evaluation of Engineering Systems,Pitman Publishing,1996.
4. Endrenyi. Reliability Modelling in Electric Power Systems. JohnWiley & Sons,1978.

OE601ME

INDUSTRIAL ROBITICS
(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week — *Duration of SEE: 3hours*

CIE: 30 Marks — *SEE: 70 Marks*

Course Objectives:

- To provide student the fundamental knowledge of the various sub-disciplines in serial robots such as kinematics, dynamics, control & manipulation, and computer based acquisition etc.
- To provide adequate background in both analysis and design of serial robots.

Course Outcomes: Student will be able to

- Capable to relate mechanical structures of industrial robots and their operational workspace characteristics and have an understanding of the functionality and limitations of robot actuators and sensors
- Apply spatial transformation to obtain forward/Inverse kinematics equation of robot manipulators using analytical/numerical/simulation tools
- Apply robot vision techniques to get the required information from input images
- Design and develop a industrial robot for a given purpose economically
- Appreciate the current state and potential for robotics in new application areas

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1							1	2	
CO2	2	2	2	2	2							1	2	
CO3	2	2	2	2	2							1	2	
CO4	2	2	2	2	1							1	2	
CO5	2	2	2	2	1							1	2	

Unit I:

Introduction to Robotics Basic structure of Robots. Degree of freedom of Robots. Work envelope. Classification of Robots based on drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry. Specification of requirement of motion and force for different application. Repeatability, Precision and Accuracy as applied to Robots.

Unit II:

Rotation matrix. Homogeneous transformation matrix. Denavit and Hartenberg representation. Euler angles and RPY representation. Representation of absolute position and orientation in terms of joint parameters, Kinematic equation for manipulators. Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots.

Unit III:

Jacobian for direct and inverse kinematics. Trajectory planning for Robots. Trajectory control based on incremental inverse kinematics of kinematic equations, Static force analysis, stiffness.

Unit IV:

Newton - Euler formulation of dynamic equation. Lagrangian formulation. Inertia tensor. Control schemes, individual joint control and disadvantages. Control through computed torques.

Unit V:

Position and velocity measurement. Optical encoders. Different types of End effectors for industrial Robots. Range and Proximity sensing. Tactile sensors. Force and Torque sensors. Drives used in industrial Robots. Introduction to techniques used in Robot vision. Image acquisition and processing. Introduction to Robot programming.

Suggested Reading:

1. Fu. K.S., Gon Zalez R.C., Lee C.S.G. "Robotics, Control-sensing vision and Intelligence", McGraw Hill, Int. Ed., 1987.
2. Asada and Sllotine , 'robot analysis and intelligence' BS Publications , India.
3. Spong and Vidyasagar, "Robot Dynamics & Control", John Wiley and Sons, Ed.,1990.
4. Groover M P, "Industrial Robotics", McGraw Hill Publications, 1999.
5. Mittal and Nagrath, "Industrial Robotics", Tata McGraw Hill Publications, 2004.
6. Saha & Subir kumar saha, 'robotics', TMH, india.

OE602ME

MATERIAL HANDLING
(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To know about the working principle of various material handling equipments
- To understand the Material handling relates to the loading, unloading and movement of all types of materials
- To understand the estimation of storage space and maintenance of material handling equipments

Course Outcomes: Student will be able to

- Importance of individual components of a material handling system
- Classify various conveying systems that are available in industry
- Compare and contrast various bulk solid handling systems and their design features
- Evaluate various modern material handling systems and their integration
- Calculate number of MH systems required, storage space, cost and maintenance

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2								1		
CO2	2	2	2	2								1		
CO3	2	2	2	2								1		
CO4	2	2	2	2								1		
CO5	2	2	2	2								1		

Unit I:

Mechanical Handling Systems: Belt Conveyors and Desing, Bucket Elevators, Package conveyors, Chain and Flight Conveyors, Screw Conveyors, Vibratory Conveyors, Cranes and Hoists.

Unit II:

Pneumatic and Hydraulic Conveying Systems: Modes of Conveying and High pressure conveying systems, Low Velocity Conveying System. Components of Pneumatic Conveying Systems: General Requirements, Fans and Blowers, Boots-Type Blowers, Sliding-Vane Rotary Compressors, Screw Compressors, Reciprocating Compressors, Vacuum Pumps.

Unit III:

Bulk Solids Handling: Particle and Bulk Properties. Adhesion, Cohesion and Moisture Content. Gravity Flow of Bulk Solids: Static and Dynamic Pressure Distribution in Bulk Solids. Modes of Flow: Mass Flow, Funnel Flow and Expanded Flow from Hoppers, Bins and Silos.

Unit IV:

Modern Material Handling Systems: Constructional features of (i) AGV (ii) Automated storage and retrieval systems. Sensors used in AGVs and ASRS.

Bar code systems and RFID systems: Fundamentals and their integration with computer-based information systems.

Unit V:

Total MH Throughput: Calculation for no. of MH systems; storage space estimation based on no of aisles. Maintenance of MH equipment, spare parts management, cost of materials handling, cost per unit load computations.

Suggested Reading:

1. Dr. Mahesh Varma, "Construction Equipment and its Planning & Application", Metropolitan Book Co.(P) Ltd., New Delhi, India 1997.
2. James M. Apple, "Material Handling Systems Design", The Ronald Press Company, New York, USA, 1972.
3. Woodcock CR. and Mason J.S., "Bulk Solids Handling: An Introduction to Practice Technology", Leonard Hill USA, Chapman and Hall, New York.
4. M P Groover etal, "Industrial Robotics", Me Graw Hill, 1999.

INTELLECTUAL PROPERTY RIGHTS
(Open Elective-I)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- To create awareness on Engineering Ethics providing basic knowledge about ethics, moral issues & moral dilemmas and professional ideals.
- To understanding, define and differentiate different types of intellectual properties (IPs) and their roles in contributing to organizational competitiveness.
- To expose to the Legal management of IP and understanding of real life practice of Intellectual Property Management.

Course Outcomes: Student will be

- Is aware of Engineering Ethics providing basic knowledge about ethics, moral
- issues & moral dilemmas and professional ideals
- Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
- Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development
- Identify activities and constitute IP infringements and the remedies available to the IP owner
- Describe the precautious steps to be taken to prevent infringement of proprietary rights and duties in products and technology development.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						1		3		1	2	1		
CO2						1		3		1	2	1		
CO3						1		3		1	2	1		
CO4						1		3		1	2	1		
CO5						1		3		1	2	1		

Unit I:

Meaning, Nature, Classification and protection of Intellectual Property — The main forms of Intellectual Property — Copyright, Trademarks, Patents, Designs (Industrial and Layout) -- Geographical Indications - Plant Varieties Protection and Biotechnology – Traditional Knowledge – Indigenous Knowledge --etc

Unit II:

Introduction to the leading International instruments concerning Intellectual Property Rights
— The Berne Convention — Universal Copyright Convention — The Paris Union — Patent Co- operation Treaty -- The World Intellectual Property Organization (WIPO) and the UNEESCO, International Trade Agreements concerning IPR — WTO — TRIPS.

Unit III:

Select aspects of the Law of Copyright in India — The Copy Right Act, 1957 - Historical evolution — Meaning of copyright — Copyright in literary, dramatic and musical works, computer programmes and cinematograph films — Neighbouring rights — Rights of performers and broadcasters, etc. — Ownership and Assignment of copyright — Author's special rights — Notion of infringement — Criteria of infringement — Infringement of copyright in films, literary and dramatic works — Authorities under the Act — Remedies for infringement of copyright. 66

Unit IV:

Intellectual Property in Trademarks and the rationale of their protection - The Trade Marks Act, 1999 — Definition of Trademarks — Distinction between Trademark and Property Mark - Registration — Passing off — Infringement of Trademark — Criteria of Infringement — Remedies. The Designs Act, 2000 — Definition and characteristics of Design — Law in India — Protection and rights of design holders — Copyright in design — Registration — Remedies for infringement..

Unit V:

Patents — Concept of Patent — Historical overview of the Patents Law in India — Patentable Inventions — Kinds of Patents — Procedure for obtaining patent — The Patents Act, 1970 — Rights and obligations of a patentee — Term of patent protection — Use and exercise of rights
— Exclusive Marketing Rights — Right to Secrecy — The notion of 'abuse' of patent rights — Infringement of patent rights and remedies available.

Suggested Reading:

1. P. Narayanan: Patent Law, Eastern Law House, 1995.
2. RoyChowdhary,S.K.&Other:LawofTrademark,Copyrights,Patentsand Designs, Kamal Law House, 1999.
3. John Holyoak and Paul Torremans: Intellectual Property Law.
4. B.L. Wadhera: Intellectual Property Law, Universal Publishers, 2nd Ed. 2000.
5. W.R. Cornish: Intellectual Property Law, Universal Publishers, 3rd Ed. 2001.
6. Cornish, W. R. "Intellectual Property Law" Eastern Law House, Second Edition, 1997.
7. Jacob, R and Alexander, D. "A guide book to intellectual property, Patents, trademarks. Copy rights and designs. Sweet & Maxwell, 1993.

MCSS

SCIENCE, TECHNOLOGY, INNOVATION AND SOCIETY
(Mandatory Course)

Credits:3

Instructions: (3L) hrs per week *Duration of SEE: 3hours*
CIE: 30 Marks *SEE: 70 Marks*

Course Objectives:

- to understand science as a social activity, i.e. to consider how interactions between people, institutions, and material structures shape what we mean by "science" and "technology".
- to articulate important differences between science and technology and to explore the relationship between them through specific case studies.
- to pursue a critical view of scientific knowledge-formation and technological innovation.
- to discuss a myriad of social impacts of new technologies and consider the ethics of technical and scientific practice.

Course Outcomes:

- Students will develop a better understanding of important issues related to Science, Technology, Innovation and Society.
- Students will be sensitized to basic dimensions of the philosophical, sociological and technological aspects of scientific knowledge and innovation.
- Students will attain a finer grasp that of how to innovate and develop the science and technology.
- Students and Professionals will accomplish with rational and scientific thinking.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1					1	3	1	1		1				
CO2					1	3	1	1		1				
CO3					1	3	1	1		1				
CO4					1	3	1	1		1				
CO5					1	3	1	1		1				

Unit I:

Introduction and Approaches to STIS – Historical context of Science, Technology and Innovation - The Social Dimensions of Scientific Knowledge - The Philosophy of Science - Methods in Science: Inductivism and Falsification - Sociological Perspectives on Scientific Practice: Marx, Durkheim, Mannheim and Merton.

Unit II:

Scientific Community and Growth of Scientific Knowledge – Karl Pooper: Objective Knowledge, Induction and Satisfaction Thomas Kuhn's Paradigm of Science, Ben Divid's Institutional Perspective, Diane Krane's Communication and international Model – Post-Kohnian Sociology of Science: John Horgan's End of Science - and Notion of Techno-Science.

Unit III:

Science in Everyday Life: Technology and Gadgets - Social Media - Network Societies - Online Communities - Affects and effects of the Internet (Social Media) – e-Books and their future – Digital Photography, e-Commrece - The Scientist: Science and Debate.
Science and Other Disciplines - Science and Art - Science and Stories - Science and Films - Science and Culture – Propaganda - Science Investigating Mysteries.

Unit IV:

Science, Technology and Innovation and National Development - The Game of Monopoly: US Business and Science – JP Morgan, The Current War: Edison, Tesla, Morgan and Westinghouse, The Geneticist War: Vaviloff, Lysenko and Stalin, The War against the Four Pests: Mao Zedong - Nationalism and Science and Technology - Philippine Cases

Unit V:

Technoscience and Globalization – Life after Science and Technology: The New Reproductive Technologies, Robots, Minds and Society – Public understanding of Science, Political Economy of Science and Technology, STIS and Social Justice – Science Policy in India, Impact of STIS on Society and Social Change.

Suggested Readings:

1. Bridgstock, M. (1998). Science, Technology and Society: An Introduction, Cambridge University Press.
2. Sergio Sismondo (2009) (2 edition). An Introduction to Science and Technology Studies, Wiley-Blackwell Publications
3. Thomas S. Kuhn (1962). The Structure of Scientific Revolutions, University of Chicago Press
4. Wenda K. Bauchspies et al (2005), Science, Technology, and Society: A Sociological Approach, Wiley-Blackwell Publications.

MCPA

INDIAN POLITY AND ADMINSTRATION
(Mandatory Course)

Credits:3

Instructions: (3L) hrs per week — *Duration of SEE: 3hours*

CIE: 30 Marks — *SEE: 70 Marks*

Course Objectives:

- To identify the transformative role of Indian administrative systems;
- To make out the multi-dimensionality of problems and processes of Indian polity and Administration;
- To understand the form and substance of Indian Constitution and Administration;
- To appreciate the emerging issues in Indian polity in the context of changing role of state, market and civil society.

Course Outcomes:

After study of the course, the learner should be able to:

- Identify the transformative role of Indian administrative systems
- To understand form and substance of Indian Constitution and Administration
- Discern the connects and disconnects between structure, purpose and process and results in Indian Administration;
- Indian administration role as the main instrument of State to achieve its developmental goals
- Appreciate the varying historical, socio-economic, political and other conditioning factors that gave Indian Administration its distinct nature to the learner.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						1	2	2	1	1	1			
CO2						1	2	2	1	1	1			
CO3						1	2	2	1	1	1			
CO4						1	2	2	1	1	1			
CO5						1	2	2	1	1	1			

Unit I: Indian Constitution

a) Nature of the Constitution Salient features – Preamble
b) Fundamental Rights, Directive Principles - Fundamental Duties
c) Amendments of the Constitution: Procedure for Amendment– Emergency Provisions

Unit II: Centre – State Relations and Local Self Government

a) Distinctive features of Indian Federation
b) Legislative, Administrative and Financial relations between the Union and the States
c) Decentralization Experiments in India – 73rd and 74th Amendments

Unit III: State Government

a) Governor, Chief Minister and Council of Ministers
b) Secretariat and Directorates
c) Changing Nature of District Administration and the role of District Collector

Unit IV: Accountability & Control

a) Legislative, and Executive Control
b) Judicial control and Judicial Review
c) Right to Information Act

Unit V: Social and Welfare Administration in India

a) Reservations for SC, ST and Backward classes
b) National SC and ST Commission; Women's Commission
c) Minorities Commission and Human Rights Commission

Suggested References:

1. Avasthi and Avasthi(2002), Indian Administration, LaxmiNarain Aggarwal,Agra.
2. Basu, D.D.(2000),Introduction to the Constitution of India, Wadhwa and Company, New Delhi.
3. Fadia and Fadia, Indian Administration(2012),Sahitya Bhavan Publications, Agra.
4. Maheswari,S.R.(2001),IndianAdministration,OrientBlackswan,Hyderabad
5. Pylee, M.V(2009), An Introduction to the Constitution of India, Vikas, NewDelhi
6. Ramesh K. Aroraand Rajni Goyal(2002),Indian Public Administration, Vishwa Parkashan, New Delhi.
7. Subash C. Kashyap(1989), Indian Polity: Retrospectand Prospect, Allahabad University Alumni Association, National Public House

MCBM

BUSINESS ETHICS AND CORPORATE GOVERNANCE
(Mandatory Course)

Credits:3

Instructions: (3L) hrs per week — *Duration of SEE: 3hours*

CIE: 30 Marks — *SEE: 70 Marks*

Course Objectives:

- The objective of the course is to familiarize the students with theory and practice of managing ethics in business and create aapproach of values and ethics among them.
- The course helps the students learn the role of corporate governance and its impact on business organization

Course Outcomes: At the end of this course student is expected reach the following outcomes.

- Familiarize the integrated view of ethics and values.
- Contrast and compare the dimensions of ethics in decision making.
- Understand and evaluate the ethical issues relating to environment.
- Importance of good corporate governance
- Classify and analyse various theories of corporate governance in India.

SNO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2	1	2		1	1			
CO2						2	2	3		1	1			
CO3						2	2	3		1	1			
CO4						2	1	3		1	1			
CO5						2	1	2		1	1			

Unit I: An Overview of Business Ethics and Values

Meaning of Business Ethics, need for business ethics, Objectives of business ethics, the Unitarian view, the separatist view, the integration view. Values - introduction, meaning and concept, characteristics of value,value and its importance. Personal values, ethical and human values. Influence of values on organizations.

Unit II: Ethics in Organizations

Overview of ethical philosophies-Deontological, teleological, utilitarianism, virtue ethics theories. Meaning of ethicaldilemma – types of ethical dilemma, resolving ethical dilemma at workplace. Determinants of ethical decision making, ethical leadership and importance, whistle blowing, ethical dilemma in whistle blowing. Ethical implications of technology.

Unit III: Ethical Issues in Society

Ethical Issues relating to environment - Environmental degradation and pollution. Ethical Issue in Production - Addictive and hazardous products, genetically modified food, carbon emission. Corruption and ethics, Gender ethics and discrimination, corporate social responsibility.

Unit IV: Corporate Governance- Introduction

Concept of Corporate Governance, objectives, features of good corporate governance, advantages of good corporate Governance, Corporate Governance code.

Unit V: Corporate Governance – Principles and Theories

Principles of Corporate Governance, theories of Corporate Governance- Agency theory, shareholder theory, stakeholder theory, stewardship theory. Corporate Governance in India.

Suggested Reading:

1. Gavai. A.K, *Business Ethics*, 1e, 2008, Himalaya Publishing House, Mumbai.
2. Khanka, *Business Ethics and Corporate Governance (Principles and Practices)*, 1e,2014, S. Chand, New Delhi
3. Kumar Senthin; Rajan Senthin, *Business Ethics and Values*, 1e, 2006, Himalaya publishing House.
4. Laura P. Hartman, *Perspectives in Business Ethics*, 2e, 2003, Tata McGraw Hill, New Delhi.
5. Murthy C.V.S, *Business Ethics Text and Cases,* Himalaya Publishing House, Mumbai.
6. Prasad Keshoo, *Corporate Governance,* 2e, PHI
7. Rituparna Raj,*A study in Business Ethics*, Himalaya Publishing House, Mumbai
8. Balachandran, Chandrasekharan, *Corporate Governance, Ethics and Social responsibility*, 2e, 2011, PHI.