SEMESTER - I					
Code	**Course**	**L**	**T**	**P**	**C**
PH-1101/CH-1101	Physics /Chemistry	3	1	0	8
EE 1101	Basic Electrical Engineering	3	0	0	6
MA 1101	Mathematics - II	3	1	0	8
CE 1101	Engineering Graphics	1	0	3	5
HS 1101	Communication Skills	3	0	0	6
PH-1111/CH-1111	Physics /Chemistry Laboratory	0	0	2	2
ME 1111	***Workshop***	***0***	***0***	***3***	***3***
	Physical Training - III	0	0	2	0
	NCC/NSO/NSS	0	0	2	0
		13	**2**	**8**	**38**

ME 1111	WORKSHOP	L	T	P	C
	First Semester	0	0	3	3
	(All Branch)				
	Pre-requisite - Nil				

General safety precautions in workshop and introduction.

Carpentry Shop: Safety precaution, Kinds of wood and timber, Application of timber as per their classification, Carpentry hand tools and machines, Demonstration of wood working machine like, band saw, circular saw, thickness planner, wood working lathe, surface planners etc.

Exercise: Different types of carpentry joint.

Smithy Shop: Safety precaution, Different types of forging tools, Study of furnace, Operation in Smithy shop.

Exercise: A simple job on Smithy.

Welding Shop: Safety precaution in welding shop, Introduction to gas and arc welding, Soldering and brazing etc. Welding equipment and welding material.

Exercise: A simple job on gas/arc welding.

Fitting Shop: Safety precaution, Introduction to fitting shop tools, equipment, Operation and their uses, Marking and measuring practice.

Exercise: A simple job using fitting tools and equipments.

Machine Shop: Safety precautions, Demonstration and working principles of some of the general machines, like lathe, shaper, milling, drilling , grinding, slotting etc., General idea of cutting tools of the machines.

Exercise: A simple job on lathe/ shaper.

Texts/Reference:

1. S K Hajra Choudhury, S K Bose, A K Hajra Choudhury, Nirjhar Roy: Workshop Technology Vol I & II; Media Promoters & Publishers Pvt. Ltd.
2. B S Raghuwanshi: A Course in Workshop Technology Vol I & II: Dhanpat Rai & Co.
3. H S Bawa: Workshop Technology Vol I & II; TMH

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SEMESTER - II					
Code	**Course**	**L**	**T**	**P**	**C**
EC 1101	Basic Electronics	3	0	0	6
CS 1101	Introduction to Computing	3	0	0	6
MA 1102	Mathematics - II	3	1	0	8
ME 1101	***Engineering Mechanics***	***3***	***1***	***0***	***8***
PH-1101/CH-1101	Physics /Chemistry	3	1	0	8
CS 1111	Computing Laboratory	0	0	2	2
EE 1111	Electrical Sciences Lab	0	0	2	2
PH-1111/CH-1111	Physics /Chemistry Laboratory	0	0	2	2
	Physical Training - III	0	0	2	0
	NCC/NSO/NSS	0	0	2	0
		15	**3**	**6**	**42**

ME 1101	ENGINEERING MECHANICS	L	T	P	C
	Second Semester	3	1	0	8

(All Branch)

Pre-requisite- PH1101, MA1101

PART – I: STATICS

Statics of rigid bodies: Classification of force systems- principle of transmissibility of a force Composition and resolution- Resultant of a coplanar force systems and conditions of equilibrium, free body diagrams. Moment of a force, couple, properties of couple- Varignon's theorem

Beams: Types of loading, Support reactions of simply supported and overhanging beams under different types of loading.

Concurrent and parallel forces in space, conditions of equilibrium.

Friction Laws of friction-angle of friction- cone of friction- ladder friction- wedge friction.

Properties of surfaces: centroid of simple and composite areas- Theorems of Pappus – Guldin. Moment of inertia of areas, Parallel and perpendicular axes theorems- Radius of Gyration, moment of inertia of simple and composite areas.

Plane Truss: Statically determinate trusses; Analysis of a truss - method of joints, method of section.

Virtual Work: Degree of freedom, Virtual displacement and virtual work; Principle of virtual work.

PART–II: DYNAMICS

Kinematics of Particles: Differential equations of kinematics – rectilinear and curvilinear motions; Cartesian co-ordinate system; Normal and tangent co-ordinate system, projectile motion.

Kinetics of Particles: Equation of motion, D'Alemberts Principle, Work, energy and power, Principle of impulse and momentum. *Impact:* Direct and oblique impact.

Rotation of Rigid Bodies: Moment of inertia of material bodies, Kinematics and Kinetics of rotation-equation of motion, Principle of work and energy; Principle of impulse and momentum.

Plane motion of Rigid Bodies: Translation of a rigid body in a plane; Kinematics of plane motion; Instantaneous center of rotation; Kinetics of plane motion – equation of motion, principle of work and energy; Principle of impulse and momentum.

Texts/Reference:

1. K. L. Kumar: Engineering Mechanics: Tata McGraw Hill

2. J.L.Meriam & L.G.Kraige: Engineering Mechanics -Statics & Dynamics: John Wiley&Sons,Inc
3. F. P. Beer & E. R. Johnston: Vector Mechanics for Engineers- Statics & Dynamics: Tata McGraw Hill
4. R.C. Hibbeler: Engineering Mechanics - Statics & Dynamics: Pearson Education Asia
5. S. Timoshenko and D. H. Young: Engineering Mechanics: McGraw Hill
6. Nelson: Engineering Mechanics:TMH

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SEMESTER - III					
Code	**Course**	**L**	**T**	**P**	**C**
MA 1201	Mathematics - III	3	1	0	8
ME 1201	***Thermodynamics-I***	***3***	***1***	***0***	***8***
ME 1202	***Theory of Mechanisms and Machines***	***3***	***1***	***0***	***8***
ME 1203	***Manufacturing Process-I***	***3***	***0***	***0***	***6***
ME 1204	***Material Science***	***3***	***0***	***0***	***6***
ME 1205	***Machine Drawing***	***1***	***0***	***2***	***4***
	Physical Training - III	0	0	2	0
	NCC/NSO/NSS	0	0	2	0
		15	**3**	**2**	**40**

ME 1201	**THERMODYNAMICS-I**	L	T	P	C
	Third Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite-PH 1101, CH 1101, MA 1101, MA 1102

Concepts of Thermodynamics: Macroscopic and Microscopic concepts, System and its Classification. Thermodynamic State. Properties, Process and Cycles, Thermodynamic Equilibrium, Concept of Temperature, Temperature Scale, Energy Interactions (Work Transfer and its Different Modes, Heat Transfer).

First Law of Thermodynamics: First Law applied to Non Flow as well as Flow Processes, Concepts of internal Energy, Enthalpy, Specific Heats, PMMI, Energy Equations for Flow Systems, Application of Energy Equations to different Engineering Components.

Second Law of Thermodynamics: Need of the Second Law, Preliminary definitions, Different statements of the Second Law of Thermodynamics and their equivalence, Reversibility and Irreversibility, Causes of Irreversibility, Reversible Cycles, Carnot Theorem, Absolute Thermodynamic Temperature Scale, Third law of Thermodynamics.

Entropy: Clausius Theorem and Inequality, Entropy Principle, Entropy and Disorder, Evaluation of Entropy change during various processes, T-S and H-S diagrams, Concept of Third Law of Thermodynamics.

Properties of Substances: Gases-Equation of state of an Ideal Gas, Specific Heats, Internal Energy, Enthalpy and Entropy change of Ideal Gases.

Equation of state of Real Gases, Principle of corresponding state, Compressibility Factor.

Steam – Definition of Sensible Heat, Latent Heat, Saturation Temperature, Quality, Evaluation of Properties from Steam Table and Mollier Diagram.

Concept of Exergy Analysis: Concept of exergy, Irreversibility, exergy balance, exergy transfer accompanying heat, exergy transfer accompanying work, flow exergy, exergy balance for control volume. Exergetic efficiency, exergetic efficiencies of common components: turbines, pumps, nozzles etc.

Texts/Reference:

1. P.K. Nag: Engineering Thermodynamics, 5/e: Tata McGraw Hill
2. Cengel: Thermodynamics, 7/e: Tata McGraw Hill
3. Ganeshan: Engineering Thermodynamics: Tata McGraw Hill
4. M.J. Moran, Shappiro: A Text Book on Classical Thermodynamics: John Wiley & Sons Ltd.
5. Van Wylen: A Text Book on Classical Thermodynamics: John Wiley & Sons Ltd

6. Rogers and Mayhew: Engineering Thermodynamics: Pearson Education Publication

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ME 1202	**THEORY OF MECHANISMS AND MACHINES**	L	T	P	C
	Third Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite- ME 1101, ME 1111, CE 1101, MA 1101, MA 1102

Introduction to Kinematics and Mechanisms: Elements of kinematic chain, Mechanism, Their inversions, Mobility and range of movements, The four bar Mechanism, Miscellaneous mechanisms, Straight line generating mechanisms, Intermittent motion mechanism.

Synthesis of Mechanism: Number synthesis – Grubler`s criterion inconsistencies, Grashoff`s law of mobility of a four bar mechanism, Transmission angle – determination of minimum value.

Belt Drive: Introduction, Velocity ratio, Belt Length, Limiting ratio of Belt Tensions, Maximum effective tension and Power transmitted, Centrifugal Tensions and stresses in Belt, Maximum tension and its role in Power Transmission, Initial tension and its role in power transmission, Condition for maximum Power Transmission, Idler Pulleys, materials of Belt drive

Gear Drive: Introduction, Rolling Contact and Positive drive, Classification of Gears, Nomenclature for Straight Spur Gears, Fundamental law of tooted Gearing, Conjugate Teeth, Tooth Profiles, Contact Ratio, Interference and under cutting, Methods of reducing or eliminating Interference, Epicyclic Gear Trains

Governors: Types and application, Functions of a Governor, Characteristic of centrifugal governors, Quality of Governor: Definations of controlling forces, stability, sensitiveness, isochronisms, capacity and coefficient of insensitiveness, Spring controlled governors of Hartnel and Hartung types, Effect of friction, Effort and power, Effect of Friction: Insensitiveness.

Cam and followers: Principle, different types, cam profiles, follower motions.

Balancing: Static and dynamic force diagram, Inertia forces and their balancing for rotating and reciprocating machines, Identification of inertia forces for reciprocating masses in engine mechanisms, Partial primary balance of single cylinder engines and uncontrolled locomotives, Balancing of multi cylinder in line engines, V- twin engines, Radial engines – direct and reverse crank methods.

Texts/Reference:

1. S.S.Rattan: Theory of Machines: Tata McGraw Hill Publication
2. Bevan T: Theory of Machines: CBS publishing

3. H. H. Mabie & C. F. Reinholtz: Mechanisms and Dynamics of Machines: John Willey & Sons Publishing Co.
4. A. Ghosh & A.G. Ambekar: Theory Of Mechanisms and Machines: Jain Brothers, New Delhi
5. A. G. Ambekar: Mechanism and Machine Theory: PHI

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ME 1203	**MANUFACTURING PROCESS – I**	L	T	P	C
	Third Semester	3	0	0	6

(Mechanical Engineering Branch)

Pre-requisite- PH 1101, CH 1101, ME 1101, ME1111

Metal Forming: Elastic and plastic deformation. Concept of strain hardening. Hot and cold working processes -rolling, forging, extrusion, swaging, wire and tube drawing. Machines and equipment for the processes. Parameters and force calculations. Test methods for formability.

Sheet Metal Working: Applications of sheet formed products. Shearing mechanism. Processes like blanking, piercing, punching, trimming, etc. Forming processes like bending, cup drawing, coining, embossing, etc. Presses for sheet metal working; Part feeding systems; Elements of die; punch and die clearances; Progressive, compound and combination dies. High energy rate forming processes.

Powder Metallurgy: Introduction. Production of metal powders. Compaction and sintering processes. Secondary and finishing operations. Economics, advantages, and applications of powder metallurgy.

Metal Casting: Introduction: Brief History, Advantages and Limitations, Applications

Patterns: Pattern materials, allowances, types of pattern, color code scheme

Sand Casting: Green and dry sand casting process, types of sand, molding sand and its properties, molding sand composition.

Cores: Use, core material, types of cores, advantages and limitations, core prints, chaplets

Gating and Risering System: Element of gating systems, types of gates, Riser design considerations

Special Molding Processes: Carbon dioxide molding process, Investment casting process, Die casting process, shell molding process, Full molding process, Vacuum-Sealed casting process

Casting defects: Causes and remedies of defects such as blowholes, pinholes, blisters, hot tears, cold shut, metal penetration,

Melting Practices: cupola: charge calculations, construction; other furnaces: working of induction furnace, crucible furnace, and reverberate furnace

Welding: Introduction: Principle of welding, general applications such as construction of bridges, towers, automobiles & electronic circuits, etc.

Classification of welding processes: Classification based on application of filler material & without filler material, source of energy, fusion and pressure welding processes. Various joining processes such as welding, brazing and soldering.

Soldering and brazing: Difference between both the processes, consumables used, methods of brazing, fluxes used, their purpose and flux residue treatment. Arc welding power sources; Conventional welding transformers, rectifiers & current and voltage. The influence of these power sources on welding.

Manual metal arc(MMA) or shielded metal arc (SMA) welding: Equipment requirement, electrodes for welding of structural steels, coating constituents and their functions, types of coatings; ISI electrode classification for plain carbon steel (IS 815:1974 & IS 814:1991), current and voltage selection for electrodes.

Submerged arc welding (SAW): Process details, consumables such as fluxes and wires for welding mild steel, variations in submerged arc welding process like single wire, tandem wire, parallel wires, field of applications.

Gas metal arc welding (GMAW) or MIG/MAG welding: Process details, shielding gases, electrode wires, their sizes, and welding current ranges.

TIG welding: Process details, power sources requirements, electrode sizes and materials, current carrying capacities of different electrodes, shielding gases, application of process.

Resistance welding: General principle of heat generation in resistance welding, application of resistance welding processes. Process details and working principle of spot, seam, and. projection welding, electrode materials, shapes of electrodes, electrode cooling, selection of welding currents, voltages, II manufacture of resistance seam welded (RSW) tubes by seam welding.

Texts/Reference:

1. Rao P N,3/e: Manufacturing Technology, (Volume I): Tata Mcgraw Hill Education Private Limited
2. S K Hajra Choudhury, S K Bose, A K Hajra Choudhury, Nirjhar Roy: Workshop Technology Vol I; Media Promoters & Publishers Pvt. Ltd.
3. Schey: Introduction to Manufacturing Process, 3/e: TMH
4. Nagendra B. S Parashar, Mittal R. K: Elements Of Manufacturing Processes: PHI Learning (2009)
5. Phillip F. Ostwald, Jairo Munoz: Manufacturing Processes and Systems, 9th Ed: Wiley India Pvt Ltd.
6. Begman & Amstead: Manufacturing Process: Addison- Willey Publishers

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ME 1204	**MATERIAL SCIENCE**	L	T	P	C
	Third Semester	3	0	0	6

(Mechanical Engineering Branch)

Pre-requisite- PH 1101, CH 1101

Structure of solids: Crystallographic planes and directions, methods determining the crystal structures, atomic packing, crystal defects

Phase transformations and phase equilibrium: Stability of phases and equilibrium, phase transition, phase equilibrium diagrams, phase rule and equilibrium, cooling curves, solid solution equilibrium diagrams, iron-iron carbide equilibrium diagram

Rate processes and crystallization:

Kinetics of phase transformation, crystallization, nucleation, homogenous nucleation, heterogeneous nucleation, crystal growth, dendritic growth

Heat treatment of steels:

Annealing, normalizing and spheroidizing, quenching, hardenability, precipitation hardening, time temperature transformation diagram. Continuous cooling transformation diagram, effect of alloying elements

Mechanical properties

Stress and strain, normal stress strain curve, true stress strain curve, toughness and resilience, fatigue, creep

Texts/References

1. Avner: Introduction to physical metallurgy: Mc Graw hill
2. Smith: Material Science & Engineering, 4/e: McGraw-hill
3. Dieter: Mechanical Metallurgy, 3/e: McGraw-Hill
4. Nazang: Material science: Khanna publisher

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ME 1205	**MACHINE DRAWING**	L	T	P	C
	Third Semester	1	0	2	4

(Mechanical Engineering Branch)

Pre-requisite- CE 1101

ISI conventions in drawing Surface finish, Fits and tolerance (to be indicated on working drawings), Orthographic projection of different types of composite bodies. Bolts and nuts, Keys, Pins, Set

screws, Riveted joints, Welded joints, Pipe joints, Flanged coupling , Flat and V-belt pulleys, Threads(internal and external), Studs, Washers, Springs, Plain journal bearing, Ball and roller bearings.

Assembly and part drawings for parts such as: Stuffing box, Foot step bearing, Plummer block, Universal joints, Gear pump, Screw jack, Cross head of steam engine, Connecting rod, Piston assembly, Stuffing box, Eccentric sheave, Tail stock.

Texts/Reference:

1. N. D. Bhatt: Machine Drawing: Charotor Publishing House, Anand
2. Ajeet Singh: Machine Drawing, 2/e: Tata Mc Graw Hill Publishing
3. K.L. Narayana, P. Kannaiah & K. Venkata Reddy: Production Drawing: New Age International Publisher
4. R.K. Dhawan: A Text Book of Machine Drawing: S. Chand & Company Publishing House

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SEMESTER - IV					
Code	**Course**	**L**	**T**	**P**	**C**
ME 1206	***Thermodynamics-II***	***3***	***1***	***0***	***8***
ME 1207	***Fluid Mechanics-I***	***3***	***1***	***0***	***8***
ME 1208	***Instrumentation and Measurement***	***3***	***1***	***0***	***8***
ME 1209	***Mechanics of Solids***	***3***	***1***	***0***	***8***
HS 1201	Managerial Economics	3	0	0	6
ME 1211	***ME Lab-I***	***0***	***0***	***2***	***2***
	Physical Training - III	0	0	2	0
	NCC/NSO/NSS	0	0	2	0
		15	**4**	**2**	**40**

ME 1206	**THERMODYNAMICS-II**	L	T	P	C
	Fourth Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite-ME 1201, MA 1101, MA 1102, PH 1101, CH 1101

Thermodynamic property relations: Maxwell relation, specific heat relations, relations for changes in internal energy, enthalpy and entropy, Clapeyron equation, Joule-Thomson coefficient, generalized relations and charts for residual enthalpy and entropy

Gas Power Cycle: An overview of reciprocating IC engines, its classification, engine components, working principle of 2-stroke and 4-stroke engines, valve timing diagrams, engine performance parameters. An overview of gas turbine, its classification, air-standard cycle for gas turbine. Stirling and Ericsson cycles.

Vapour power cycle: Carnot cycle, Rankine cycle, actual vapour power cycle processes, reheat cycle, regenerative cycle, feed water heaters (open and closed), characteristics of an ideal working fluid in vapour power cycle, binary vapour cycles, thermodynamics of combined cycles.

Reciprocating air compressor: Single stage and multistage air compressors, work done per cycle, compressor capacity and power calculation, volumetric efficiency and isothermal efficiency, effect of clearance ratio on volumetric efficiency, intercooler and after cooler.

Combustion processes: Fuels and combustion, theoretical and actual combustion processes, enthalpy of formation and enthalpy of combustion, first law analysis of reacting systems, adiabatic flame temperature, entropy change of reacting systems, second law analysis of reacting systems.

Refrigeration and Psychrometry: Gas cycle refrigeration, vapour compression refrigeration, vapour absorption refrigeration, types of refrigerants and properties of ideal refrigerants, psychrometric properties and processes, psychrometric chart.

Texts/Reference:

1. P.K. Nag: Engineering Thermodynamics, 5/e: Tata McGraw Hill
2. Cengel: Thermodynamics, 7/e: Tata McGraw Hill
3. Ganeshan: Engineering Thermodynamics: Tata McGraw Hill
4. Rogers and Mayhew: Engineering Thermodynamics: Pearson education
5. M J Moran: A Text Book on Classical Thermodynamics: John Wiley &sons.

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ME 1207	**FLUID MECHANICS - I**	L	T	P	C
	Fourth Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite- ME 1201, ME 1101, MA 1101, MA 1102, PH 1101

Introduction: Introductory concepts and definitions, properties and classification of fluids, Pascal's law of fluid pressure, measurement of pressure, forces on submerged plane and curved surfaces, buoyancy, metacenter.

Kinematics of Fluids: Introduction, scalar and vector fields, flow field and description of fluid motions, existence of flow.

Conservation Equations: System, conservation of mass, conservation of momentum and conservation of energy.

Applications of Equations of Motion and Mechanical Energy: Introduction, Bernoulli's equation in irrotational flow, measurement of flow rate through pipe, flow through orifices.

Principles of Physical Similarity and Dimensional Analysis: Introduction, concept and type of physical similarity, applications of dynamic similarity, dimensional analysis.

Laminar and Turbulent Flows: Introductions, definitions of laminar and turbulent flows, laminar flow through a circular pipe, laminar flow between parallel plates, laminar flow through an annulus, hydrodynamic lubrication.

Numerical solution of fluid mechanics problems: Numerical solution of simple problems of fluid mechanics, a brief introduction to Computational Fluid Dynamics.

Texts/Reference:

1. S.K. Som and G. Biswas: Introduction to Fluid Mechanics and Fluid Machines: Tata McGraw Hill.
2. Sukumar Pati: Textbook of Fluid Mechanics & Hydraulic Machines, 1/e: McGarw-Hill
3. Cengel: Fluid Mechanics, 2/e: McGarw-Hill
4. Streeter: Fluid Mechanics , 9/e: McGarw-Hill
5. White: Fluid Mechanics, 7/e: McGarw-Hill
6. K.L. Kumar, Eurasia: Engineering Fluid Mechanics: Publishing House (P) Ltd
7. A.K. Jain: Fluid Mechanics: Khanna Publishers

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ME 1208	**INSTRUMENTATION AND MEASUREMENT**	L	T	P	C
	Fourth Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite- ME 1101, MA 1101, MA 1102, ME 1201, ME1111

Generalized measurement system, Measurement terminology: Calibration,, Accuracy, Precision, Sensitivity, Threshold, Hysteresis, Dead space, errors in measurements, Dynamic characteristic of simplified measuring system, Characteristic of first order and second order systems.

Transducer elements: Analog transducers, Digital transducers, Intermediate elements – Amplifier, Compensator, Differentiating and Integrating elements, Filters, Data transmission elements.

Indicating and recording elements: Digital voltmeters, Cathode Ray Oscilloscope (CRO`S), Galvanometric recorders, Data acquisition systems.

Strain measurement: Types of electrical resistance strain gauges, Theory of operation, Gauge material, Gauge factor, Mounting techniques, Moisture proofing, Calibration circuits, Strain measurement in static and rotating shafts, Proper orientation of gauges, Commercial strain measuring system.

Measurement of Force, Torque and Pressure.

Force Measurement: Hydraulic and pneumatic load cells, elastic force devices.

Pressure Measurement–moderate pressure measurement, high pressure measurement, low pressure (Vacuum) measurement, elastic pressure measurement devices.

Torque Measurement: Transmission dynamometer, Absorption dynamometer**.**

Viscosity Measurements: Redwood viscometer.

Temperature Measurement: Temperature measurement using change in physical properties, electrical type temperature sensors, radiation thermometry.

Flow measurement: Head type area flow meter, solid flow meter, electrical type (Hot wire Anemometer) and accelerometers.

Miscellaneous Instruments in Industrial and Environmental application: Environmental air pollution measurement, gas chromatography.

Introduction to mechatronics and robotics.

Texts/Reference:

1. E. O. Doeblin and D. N. Manik: Measurement systems: Tata Mcgraw Hill Publishing Company Ltd.
2. B.C.Nakra , K.K.Chaudhary: Instrument Measurement and Analysis: Tata Mcgraw Hill Publishers
3. Holman: Experimental Methods for Engineers (Special Indian Edition),7/e: Mcgraw Hill Publishers

4. James W. Dailly, William F. Rilley, Kenneth G: Instrumentation for Engineering Measurements: McConnell, Willey Student Edition
5. John H. Craig: Introduction to Robotics: Pearson
6. Thomas G. Beckwith, D. Marangonic, John H. Liehard V: Mechanical Measurement: Pearson Education
7. Richard S. Figliol, Donald E. Beasley: Theory and Design for Mechanical Measurements: Willey Student Edition

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ME 1209	**MECHANICS OF SOLIDS**	L	T	P	C
	Fourth Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite- PH 1101, ME 1101, ME 1204, MA 1101, MA 1102

Properties of materials: definition

Simple stresses and Strains: Concept of stress and strain, constitutive relation, deformation of axially loaded bars, members with varying cross section, composite bars, thermal stress. Saint-Venant's Principle and stress concentration, lateral strain, Poisson's ratio, volumetric strain, elastic constants and their relationship. Strain energy due to axial loads- gradually and impact loads, Thin walled pressure vessels.

Concept of stress and strain tensor, generalized Hooke's law

Transformation of stresses and strains: Stresses on inclined plane, Mohr's circle, principal plane, principal stresses, transformation of stress and strains in a plane, principal strains, Mohr's Circle of stress and strains.

Stresses in beams: SF and BM diagrams for cantilever, simple supported and overhanging beams, Relationship between rate of loading, SF and BM.

Theory of bending, assumptions, neutral axis and moment of resistance, bending stresses in symmetrical sections, section modulus, composite beams.

Shear stress distribution: rectangular, circular, I- section and and T- section

Torsional stresses in shafts: Analysis of torsional stresses, power transmitted

Combined Stresses: Combined bending and direct Stresses, resultant stresses for column of different sections subjected to eccentric load, limit of eccentricity for no tension, combined bending and torsion

Deflection of beams: Relationship among curvature, slope and deflections, slope and deflection for Cantilever and S. S beams, Machaulay's method.

Theories of failures: Significance, failure theories for ductile and brittle materials, Tresca Criterion, Von-Mises Yield criterion, Mohr's Theory. Failure due to creep and fatigue.

Texts/Reference:

1. Strength of Material by Rattan, McGraw-Hill Education
2. Mechanics of Materials by Beer & Johnson, Tata McGraw-Hill, New Delhi
3. Strength of Materials Part- 1 & 2 by Timoshenko
4. Engineering Mechanics of solids by E P Popov, PHI
5. Mechanics of Materials by Pytel & Singer, Harper Collins Publishers India Pvt. Ltd., New Delhi

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ME 1211	**ME Lab-I**	L	T	P	C
	Fourth Semester	0	0	2	2

(Mechanical Engineering Branch)

Pre-requisite-ME 1201, ME 1202, ME 1203, ME 1204

All areas of Thermal Engg / Design / Manufacturing / Production Engg

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SEMESTER - V					
Code	**Course**	**L**	**T**	**P**	**C**
ME 1301	***Dynamics and Control of machinery***	***3***	***1***	***0***	***8***
ME 1302	***Fluid Mechanics-II***	***3***	***1***	***0***	***8***
ME 1303	***Manufacturing process-II***	***3***	***0***	***0***	***6***
ME 1304	***Machine Design-I***	***3***	***0***	***0***	***6***
HS 1301	Business Management	3	0	0	6
ME 1311	***ME Lab-II***	***0***	***0***	***3***	***3***
ME 1312	***ME Lab-III***	***0***	***0***	***3***	***3***
		15	**2**	**6**	**40**

ME 1301	**DYNAMIC AND CONTROL OF MACHINERY**	L	T	P	C
	Fifth Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite- ME 1101, ME 1202, ME 1209

Static and dynamic force analysis: Introduction, Forces, moments and Couples, Static Equilibrium, Graphical Force Analysis, Analytical Approach to Force Analysis, Dynamic equilibrium of Systems of particles, Dynamic Equilibrium of System of rigid bodies, Flywheel, Gyroscope and gyroscopic effects, Cam Dynamics, Analysis of cam and follower.

Bearings: Hydrodynamic and boundary lubrication, Analysis of journal and thrust bearings.

Vibration: One degree of freedom system, Free and forced vibrations, Transverse and torsional vibration, Critical speed, Vibration isolation and measurements, Two degree of freedom systems, Vibration absorber, Multi degree of freedom system.

Control: Open and closed loop control, Block diagrams, Laplace transform, Mathematical model of physical system, Basic control action- pneumatic controller and hydraulic controller, Transient response of first order and second order system, Routh`s stability criteria, Frequency response analysis, Improving system performance, Introduction to non- linear control.

Texts/Reference:

1. Norton: Kinematics and Dynamics of Machinery (SIE): Mc Graw-Hill, 1/e,
2. Rattan: Theory of Machines: Mc Graw-Hill, 3/e
3. Gowda: Mechanical Vibrations: Mc Graw-Hill, 1/e
4. J. S. Rao & R.V. Dukkipati: Mechanism & Machine Theory: New Age International Publication
5. K. Ogata: Modern Control Engineering: Prentice Hall International
6. B. C. Kuo: Automatic Control System: Prentice Hall International
7. A.Ghosh & A.K. Mallick: Theory of Mechanisms & Machines: Affiliated East West Press Pvt Ltd
8. Kenneth J. Waldron and Gary L. Kinzel: Kinematics, Dynamics and Design of Machinery: Wiley India

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ME 1302	**FLUID MECHANICS-II**	L	T	P	C
	Fifth Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite- ME 1207, ME 1201, ME 1206

Flow of Ideal Fluids: Introduction, elementary flows in a two-dimensional plane, superposition of elementary flows, aerofoil theory

Viscous Incompressible Flows: Introduction, general viscosity law, Navier-Stokes equation, exact solution of Navier-Stokes equation.

Laminar Boundary Layer: Introduction, boundary layer equations, momentum-integral equation of boundary layer, separation of boundary layer.

Turbulent Flow: Introduction, classifications of turbulent flow, laminar-turbulent transition, mean motion and fluctuation, turbulent boundary layer.

Compressible Flow: Introduction, thermodynamic relations of perfect gases, speed of sound, pressure field due to a moving source. Basic equations for one-dimensional flow, stagnation and sonic properties, normal shock waves, Fanno line flows, Rayleigh line flow. Oblique shock.

Principles of Fluid Machines: Introduction, classification of fluid machines, hydraulic turbines and pumps.

Numerical solution of fluid mechanics problems: Numerical solution of fluid mechanics problems and its applications in Computational Fluid Dynamics.

Texts/Reference:

1. S.K. Som and G. Biswas: Introduction to Fluid Mechanics and Fluid Machines: Tata McGraw Hill.
2. Sukumar Pati: Textbook of Fluid Mechanics & Hydraulic Machines: McGraw-Hill, 1/e
3. Cengel: Fluid Mechanics: McGarw-Hill, 2/e
4. Streeter: Fluid Mechanics: McGarw-Hill, 9/e
5. White: Fluid Mechanics: McGarw-Hill, 7/e
6. Subramanian: Hydraulic Machines: McGraw-hill, 1/e
7. K.L. Kumar: Engineering Fluid Mechanics: Eurasia Publishing House (P) Ltd
8. A.K. Jain: Fluid Mechanics: Khanna Publishers

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ME 1303	**MANUFACTURING PROCESS-II**	L	T	P	C
	Fifth Semester	3	0	0	6

(Mechanical Engineering Branch)

Pre-requisite- ME 1111, ME 1203, ME1202, ME1208

Introduction: Introduction to machine tools, motions of machine tools, generation of surfaces, types of machine tools, basic elements of machine tools.

Mechanics of Machining (Metal Cutting): Geometry of single point cutting tools, Conversion of tool angles from one system to another, Mechanism of chip formation, Orthogonal and oblique cutting, Use of chip breaker in machining, Machining forces and Merchant's Circle Diagram (MCD), Taylor's Tool Life Equations

Lathe: Principle, classification, specifications, operations performed on a lathe. Calculation for machining time, Machining parameters & performance.

Capstan and Turret Lathes: Introduction, comparison among capstan, turret and engine lathe, turret indexing mechanism, feeding mechanism, cutting tools and tool holders, turret tooling layout.

Shaper: Principle, classification, specifications, shaper mechanisms – crank and slotted lever quick return mechanism, feed mechanism, operations performed on shaper – machining horizontal, vertical, angular surfaces, cutting slots, grooves, key ways, machining irregular surfaces, splines and gears. Cutting speed, feed, depth of cut and calculation for machining time for shaping operations.

Planer: Principle, classification, specifications, comparison between shaper and planer.

Milling machine: Principle, classification, specifications, peripheral milling, up and down milling, face milling, end milling, different operations performed on milling machines, dividing heads, methods of indexing – direct, simple, compound and differential indexing, milling of spur gear, milling cutters.

Drilling machine: Principle, classification, specifications, operations performed on drilling machines, twist drill nomenclature.

Grinding machines: Principle, classification, specifications, different grinding processes, grinding wheel – components (wheel material), grit, grade and structure, standard marking system of grinding wheels. Glazing and loading in wheels, dressing, truing, balancing, and mounting of grinding wheels.

Texts/Reference:

1. P N Rao: Manufacturing Technology Vol 2- Metal Cutting and Machine Tools: Tata Mc Graw Hill
2. Schey: Introduction to Manufacturing Process: McGraw-Hill
3. S K Hajra Choudhury: Workshop Technology Vol II Machine Tools: Media Promoters & Publishers Pvt. Ltd.

4. G Boothroyd & W A Knight: Fundamentals of Machining and Machine Tools: CRC Press Taylor & Francis Group
5. H Gerling: All About Machine Tools: New Age Int. (P) Ltd.
6. R K Jain: Production Technology: Khanna Publishers
7. A. Ghosh & A. K. Mallik: Manufacturing Science: Affiliated East-West Press Pvt. Ltd.
8. B S Raghuwanshi: A Course in Workshop Technology Vol II (Machine Tools): Dhanpat Rai & Co.

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ME 1304	**MACHINE DESIGN – I**	L	T	P	C
	Fifth Semester	3	0	0	6

(Mechanical Engineering Branch)

Pre-requisite- ME 1101, ME 1202, ME 1209

Introduction: General considerations and procedure of Machine Design, Mechanical properties, Design stress, factor of safety, Stress-strain diagram for ductile and brittle materials, Theories of failure, Stress concentration factor, Design for variable loads: endurance limit, Goodman and Soderberg criteria.

Riveted Joints: Types, Modes of failure, Strength and efficiency of riveted joints, Pitch of rivets, Design stresses, Structural joints of butt and lap type, Boiler joints, Rivets subjected to eccentric loading.

Welded Joints: Types of welds, Strength of welds, Eccentric load in plane of weld, Welded pressure vessel and some practical applications.

Keys and Pins: Types of keys, Stresses in keys, Design of square, rectangular and taper keys.

Shafts: Shafts subjected to twisting moment, bending moment, combined twisting and bending moment, fluctuating loads, axial load in addition to combined torsion and bending loads

Coupling: Rigid and flange coupling, Design of flange coupling

Cotter and Knuckle Joints: Design of Socket and spigot cotter joints, Sleeve and cotter joints, Gib and cotter joint for strap end of a connecting rod, Gib and cotter joint for square rods, knuckle joint.

Lever: Application of lever in engineering practice, Design of a lever, Foot lever, Cranked lever, Lever for lever safety valve, Bell crank lever.

Texts/Reference:

1. Bhandari: Design of Machine Elements: McGraw-Hill Publishers, 2/e
2. Shigley: Mechanical Engineering Design: McGraw Hill Publishers, 9/e

3. Bhandari: Introduction to Machine Design: B, McGraw Hill Publishers, 3/eV
4. R. S. Khurmi & J. K. Gupta: Machine Design: S. Chand & Co
5. Sharma & Agarwal: Machine Design: S. K. Kataria & Sons
6. Kannaiah, P: Machine Design: SCITECH Publications
7. Mahadevan K, Reddy: Design Data Handbook: KB, CBS, New Delhi
8. Spotts: Design of Machine Members: Prentice Hall Publishers

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ME 1311	**ME Lab-II**	L	T	P	C
	Fifth Semester	0	0	3	3

(Mechanical Engineering Branch)

Pre-requisite- ME 1211, All theory subjects in previous semesters

All areas of Thermal Engg / Design / Manufacturing / Production Engg

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ME 1312	**ME Lab-III**	L	T	P	C
	Fifth Semester	0	0	3	3

(Mechanical Engineering Branch)

Pre-requisite- ME1211, All theory subjects in previous semesters

All areas of Thermal Engg / Design / Manufacturing / Production Engg

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SEMESTER - VI					
Code	**Course**	**L**	**T**	**P**	**C**
ME 1305	***Automobile Engineering***	***3***	***1***	***0***	***8***
ME 1306	***Turbo machinery***	***3***	***1***	***0***	***8***
ME 1307	***Advanced Manufacturing Process***	***3***	***0***	***0***	***6***
ME 1308	***Machine Design-II***	***3***	***0***	***0***	***6***
ME 1309	***Heat Transfer***	***3***	***0***	***0***	***6***
ME 1313	***Workshop Practice***	***0***	***0***	***3***	***3***
ME 1314	***ME Lab-IV***	***0***	***0***	***3***	***3***
		15	**2**	**6**	**40**

ME 1305	**AUTOMOBILE ENGINEERING**	L	T	P	C
	Sixth Semester	3	1	0	8
	(Mechanical Engineering Branch)				

Pre-requisite-ME 1201, ME 1202, ME 1206, ME 1301, ME1304

Introduction: Automotive Vehicles, Development, Layout and types of automotive vehicles- cars, buses, tractors, air cushion vehicles and off the road vehicles, Various resistance to the motion of a vehicle, Power required for propulsion, Acceleration and hill climbing.

Automotive engine: classification, S.I. and C.I. engines, combustion chamber types, engine balancing, multi-cylinder arrangements.

Automobile engine parts: Cylinder block, cylinder head, crank case, oil pan, cylinder liners, piston, piston rings, connecting rods, crank shaft, valves, valve actuating mechanism, valves layout, materials used, valve and port timing diagrams.

Fuel supply system: Simple carburetor, constant choke, constant vacuum carburetor, types of carburetor, mixture strength requirements, fuel pumps for petrol engines, petrol injections, diesel fuel pump and fuel injector for diesel engines.

Ignition system: Battery ignition system, comparison between battery ignition and magnetic ignition system, ignition advance methods, electronic ignition.

Cooling system: Necessity, coolant types, methods of cooling.

Lubrication system: Objectives, system of engine lubrication, crank case ventilation.

Chassis construction: The frame and its functions, layout of the components of transmission system in four wheel rear drive vehicles.

Clutches: Purpose, requirements, relative merits and demerits of different types of clutches.

Transmission System: Purpose, sliding mesh gear box, constant mesh gear box, power flow diagrams, torque converter, automatic transmission - an overview.

Universal coupling, propeller shaft, final drive - types, functions. Differential - purpose, construction.

Suspension System: Semi-floating, full floating and three quarter floating construction,

Steering System: Steering mechanisms, steering linkages, steering gears - for rigid front axle and independent front wheel suspension.

Brakes: types of brakes, numerical problems relating to brake torque, minimum stopping distance with front wheel braking, rear wheel braking, wheel braking and heat dissipation.

Electrical equipment: Generator, voltage regulator and cut-out, starter, lighting circuit.

Application of CNG in automotive engines.

CFD analysis of flow over surfaces of Automobiles

Texts/Reference:

1. Automotive Mechanics, 2/e, by Srnivasan, McGrawhill
2. Automotive Mechanics (Special Indian Edition), 10/e, by Crouse, McGrawhill
3. Automobile Engineering Vols - I & II, by Kirpal Singh, Standard Publishers Distributers
4. Automotive Mechanics by Heitner Joseph, East West Press
5. Automobile Engineering by William H. Crouse & Donald L Anglin

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ME 1306	**TURBO MACHINERY**	L	T	P	C
	Sixth Semester	3	1	0	8

(Mechanical Engineering Branch)

Pre-requisite- ME 1201, ME 1206, ME 1207, ME1302

Introduction: Definition of a turbo-machine, Fundamental theory of turbo-machines, and classification of turbo machinery

Hydraulic Turbines: Introduction, Classifications of hydraulic turbines, Concepts of heads of turbines, Concept and definitions of efficiencies of turbines. Impulse Turbines: Main components of Pelton turbines, Design of components of Pelton turbines, Force, Power and efficiency of Pelton turbine. Reaction Turbines Main components of modern Francis turbine, Design of components of Francis turbine, Torque, Power and efficiency of Francis turbine, Component and design of Propeller and Kaplan turbines. Draft tube, Function and efficiency of draft tube, Types of draft tube, Governing of turbines, Governing of hydraulic turbines, Specific speed, Performance characteristic curves of turbines, Selection and performance of turbines, Cavitations of turbines.

Centrifugal Pumps: Introduction, Main components of Centrifugal pumps, Definitions of head and efficiency of a centrifugal pump, Working principle, Priming of centrifugal pump, Multistage centrifugal pumps Specific speed, Performance characteristic curves of turbines, Selection and performance of a centrifugal pump, Cavitation in pump, operational difficulties in centrifugal pumps. Axial Flow Pumps:

Steam Turbines: Introduction, Working principle of steam turbine, Classification of steam turbine, simple impulse turbine, compounding of steam turbine, pressure compounded impulse turbine, velocity compounded impulse turbine, pressure-velocity compounded impulse turbine. Flow through impulse turbine blades, Velocity triangle, work done, power and efficiencies, Blade sections.

Flow through impulse reaction turbine blades, Velocity triangles, work done, efficiencies, Degree of reaction, Person's Turbine, Blade sections, Governing of steam turbines.

Losses of steam turbines, State point locus, reheat factor, turbine efficiency parameters.

Centrifugal Compressor: Introduction, Basic Components, Principle of Working, Velocity Triangle, Enthalpy-Entropy Diagram, Slip, Power Input Factor, Compressor Efficiency, Flow Coefficient, Pressure Coefficient, Degree of Reaction, Pre-whirl, Effect of Impeller Blade Shape on Performance, Vaned and Vaneless Diffuser, Surging and Choking in Compressor.

Axial Flow Compressor: Introduction, Basic Components and Principle of working, Stage Velocity Triangle, Enthalpy-Entropy diagram, Work done factor, Degree of reaction, Polytropic efficiency, Flow Coefficient, Pressure Coefficient, Compressor Stalling.

Fan and Blower: Centrifugal fan, Fan Impeller, performance and point of operation, axial flow fan, blade profiles, performance and blowers.

Texts/Reference:

1. Ganesan: Gas Turbine: McGraw-Hill Education, 3/e
2. S.M. Yahya, Satyaprakashana: Turbines, Compressors and Fans: Publishers, New Delhi, 4/e
3. R. Yadav: Steam & Gas Turbine and Power Plant Engineering: Central Pub. House
4. R. K. Bansal: A Test Book of Fluid Mechanics and Hydraulic Machines: Laxmi Pub.
5. Earl Logan: Turbomachinery: Jr. Marcel Dekker Inc.
6. S. L. Dixon: Fluid Mechanics and Thermodynamics of Turbomachinery: Butterworth-Heinmann

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ME 1307	**ADVANCED MANUFACTURING PROCESS**	L	T	P	C
	Sixth Semester	3	0	0	6

(Mechanical Engineering Branch)

Pre-requisite- ME 1203, ME 1303

Introduction to Advanced Manufacturing Processes and their importance.

Advanced Machining Processes: Introduction of advanced machining processes, process principle, applications, advantages and limitations of processes such as Abrasive Jet Machining (AJM), Water Jet Machining (WJM), Abrasive Water Jet Machining (AWJM), Ultrasonic Machining (USM), Electrochemical Machining (ECM), Electro Discharge Machining (EDM), Electron Beam Machining (EBM), Laser Beam Machining (LBM) processes.

Advanced Casting Processes: Metal mould casting, continuous casting, squeeze casting, vacuum mould casting, evaporative pattern casting, ceramic shell casting their process principles and applications.

Advanced Welding Processes: Electron Beam Welding (EBW), Laser Beam Welding (LBW), Ultrasonic Welding (USW), their process principles and applications.

Advanced Metal Forming Processes: High energy rate forming (HERF) process, Electromagnetic forming, explosive forming, Electro hydraulic forming, Stretch forming, Contour roll forming, their process principles and applications.

Rapid prototyping (RP): Importance of RP, introduction of solid-based, liquid-based, powder-based RP processes.

Introduction to emerging trends in manufacturing: Micro-manufacturing, Micro-Electro-Mechanical-Systems (MEMS), basic concepts of Nanotechnology.

Texts/Reference:

1. Schey: Introduction to Manufacturing Processes: McGraw-Hill Publisher, 3/e
2. Courtney: Mechanical Behavior of Materials: McGarw-Hill Publisher, 2/e
3. E. P. DeGarmo, J. T Black, R. A. Kohser: Materials and Processes in Manufacturing (8th Edition): Prentice Hall of India, New Delhi (ISBN 0-02-978760).
4. A. Ghosh, and A. K. Mallik: Manufacturing Science: Affiliated East-West Press Pvt. Ltd. New Delhi.
5. G.F. Benedict, Marcel Dekker: Nontraditional Manufacturing Processes, Inc. New York (ISBN 0-8247-7352-7).
6. N. P. Mahalik: Micromanufacturing and Nanotechology: Springer

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ME 1308	**MACHINE DESIGN - II**	L	T	P	C
	Sixth Semester	3	0	0	6

(Mechanical Engineering Branch)

Pre-requisite- ME 1202, ME 1209, ME 1304

Threaded Fasteners and Power Screws: Stresses in bolts, Effect of initial tension, Bolts under dynamic and impact loading, Eccentric loading, Power screws, Form of threads, Force analysis, Screw and nut design, Differential and compound screws. Stresses in power screws.

Belt Drive: Introduction, Mechanics of belt drive, Belt Materials, Selection of a pulley, Design of Flat belts, Design of V-belts.

Springs: Application and classification of springs, Stress in coil springs of round, square and rectangular wires, Deflection of coil springs, Design of compression and tension springs, Coil spring subjected to impact and fluctuating loads, Material for coil springs, Critical frequency, Energy stored

in springs.

Clutches: Positive and Frictional clutches, Plate friction or disc clutches, Cone clutches.

Brake: Block brakes, Band brakes, Disc brakes (internal expanding and external contacting shoe

Gears: Spur gears – Nomenclature, interference in involute gears, beam strength of spur tooth, Lewis equation and Lewis form factor, velocity factor, Barth`s formula, working stresses in gear teeth, dynamic loads on gear teeth, design of spur gear for wear (Buckingham equation).

Helical gears – Nomenclature, Virtual number of teeth, Tooth Properties, Force Analysis. Beam strength, Dynamic loading, Wear strength.

Bearing: Type of bearings, Selection of bearing, Theory of lubrication, Heat balance of bearing, Mechanical aspects of bearing design. Load and life of bearings, Equivalent bearing load, Load- life relations.

Texts/Reference:

1. Bhandari: Design of Machine Elements: McGraw-Hill Publishers, 2/e
2. Shigley: Mechanical Engineering Design: McGraw Hill Publishers, 9/e
3. Bhandari,V. B: Introduction to Machine Design: McGraw Hill Publishers, 3/e,
4. R. S. Khurmi & J. K.Gupta: Machine Design: S. Chand & Co
5. Sharma & Agarwal: Machine Design: S.K. Kataria & Sons
6. Kannaiah: P Machine Design: SCITECH Publications
7. Mahadevan K, Reddy KB: Design Data Handbook: CBS, New Delhi
8. Spotts: Design of Machine Members: Prentice Hall Publishers

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ME 1309	**HEAT TRANSFER**	L	T	P	C
	Sixth Semester	3	0	0	6

(Mechanical Engineering Branch)

Pre-requisite- ME 1201, ME 1206, ME 1207, ME 1302

Conduction Heat Transfer: One- dimensional heat conduction equation for slab, cylinder, sphere and composite medium (with and without heat generation), Concept of critical thickness of insulation. Numerical methods for solution of heat conduction problems.

Heat Transfer For Extended Surfaces: Analysis of steady- state heat transfer for fins of uniform cross-section, Fin performance.

Radiation Heat Transfer: Nature of thermal radiation, Radiative properties, Kirchoff`s law, Black body radiation intensity and total emissive power, Displacement law, Radiation heat transfer between black/grey surfaces, network method of solving radiation problems, Concept of view factor.

Convection: Application of dimensional analysis to free and forced convection, Concept of velocity and thermal boundary layer, Equations of motion and energy, Empirical equations of convective heat transfer, Reynold`s analogy, Heat transfer in boiling and condensation.

Heat Exchangers: Basic types of heat exchanger, LMTD and $\in$- NTU method of heat exchanger analysis.

Computational studies in heat transfer processes in Conduction, Convection and Radiation. Experimental techniques related to heat transfer analysis. Heat transfer analysis from commercial software.

Texts/Reference:

1. Holman: Heat Transfer:, McGraw-Hill Publications, 10/e
2. Cengel: Heat & Mass Transfer: McGraw-Hill Publishers, 4/e
3. Kays: Convective Heat & Mass Transfer: McGarw-Hill Publishers
4. P.K.Nag: Heat Mass Transfer: McGarw-Hill Publishers, 3/e
5. Kreith: Principles of Heat Transfer: International Publication
6. Christopher A. Long: Essential Heat Transfer: Pearson Education Publication
7. Manuals of Fluent Software related to Heat Transfer Analysis
8. M. Necati Ozisic: Heat Transfer, A Basic Application: Mc.Graw Hill Publication

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ME 1313	**WORKSHOP PRACTICE**	L	T	P	C
	Sixth Semester	0	0	3	3

(Mechanical Engineering Branch)

Pre-requisite- ME 1111

All areas of Thermal Engg / Design / Manufacturing / Production Engg

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ME 1314	**ME LAB-IV**	L	T	P	C
	Sixth Semester	0	0	3	3

(Mechanical Engineering Branch)

Pre-requisite- ME 1311, ME 1312, All theory subjects in previous semesters

All areas of Thermal Engg / Design / Manufacturing / Production Engg

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SEMESTER - VII					
Code	**Course**	**L**	**T**	**P**	**C**
ME 1401	*Industrial Engg. and Operation Research*	*3*	*0*	*0*	*6*
ME 1402	*Power Plant Engg.*	*3*	*0*	*0*	*6*
ME 14XX	*Dept. Elective-I*	*3*	*0*	*0*	*6*
ME 14XX	*Dept. Elective-II*	*3*	*0*	*0*	*6*
XX 14XX	*Open Elective-I*	*3*	*0*	*0*	*6*
ME 1411	*ME Lab-V*	*0*	*0*	*2*	*2*
ME 1490	*Project-I*	*0*	*0*	*8*	*8*
		15	**0**	**10**	**40**

N.B.: Industrial Training after Sixth Semester for a period of 4-6 weeks as an audit course

DEPARTMENTAL ELECTIVE – I	
Code	**Course**
ME 1421	*Refrigeration*
ME 1422	*Principles of Combustion*
ME 1423	*Advanced Solid Mechanics*
ME 1424	*Fundamental of Industrial Design*
ME 1425	*Production Management*
ME 1426	*Numerical Control of Machine Tools*
ME 1427	*Engineering Inspection and Quality Control*

DEPARTMENTAL ELECTIVE – II	
Code	**Course**
ME 1431	*IC Engines*
ME 1432	*Gas Dynamics*
ME 1433	*Robotics and Robot Applications*
ME 1434	*Holistic Approach to Engineering Design*
ME 1435	*Metal Forming and Metal Cutting Technology*
ME 1436	*Mechanics of Composite Materials*
ME 1437	*Advanced Fluid Mechanics*

OPEN ELECTIVE – I (*Offered by Mech. Engg. Deptt.*)	
Code	**Course**
ME 1471	***Finite Element Method***
ME 1472	***Project Management***
ME 1473	***Reliability Engineering***
ME 1474	***Environmental Pollution and its Control***
ME 1475	***Mechatronics***

ME 1401 **INDUSTRIAL ENGG. AND OPERATION RESEARCH** L T P C

Seventh Semester 3 0 0 6

(Mechanical Engineering Branch)

Pre-requisite- HS 1301, MA1101, MA1102, MA1201

Work Study & Motion Study: Historical background; Work study definition; Role of work study in improving productivity; Ergonomics and work study. Work study procedure: selection of jobs; Information collection and recording; Recording techniques -charts and diagrams; critical analysis; developing better method; installation and follow up of standard method. Memomotion and micromotion study; therbligs; cyclegraph and chronocycle graph; simochart; Principles of motion economy; Design of work place layout.

Work measurement: Definition; Procedure; Performance rating; Concept of normal time; allowances. Work sampling technique of work measurement. Introduction to pre -determined motion time system.

Quality & Reliability: Introduction and definitions of quality, Evolution of Quality: Inspection, Quality Control, Customer-Orientation: Internal & External Customer Concept, Life cycle approach to quality costs- Prevention; Appraisal and Failure costs. Seven QC tools (Histogram, Check sheets, Ishikawa diagrams, Pareto, Scatter diagrams, Control charts). Process capability concepts. Reliability: Introduction, Definitions, reliability evaluation, maintainability, and availability concepts.

Facilities Design: Site Selection: Factors influencing the selection, rural and urban locations of sites, optimum decision on choice of site and analysis. Plant Layout: Types of production, types of layouts, advantages and disadvantages of layout, factor affecting layout, systematic layout planning, Material handling: importance, principles of material handling

Operations Research: Introduction, general methodology of OR, application of OR, Formulation of linear programming, deterministic models, graphical solution, simplex algorithm

Capacity Planning: Introduction, measures of capacity, capacity strategies, A systematic approach for capacity decisions, Long range capacity planning and control, Medium range capacity planning and control, Short range capacity planning and control.

Inventory Management: Introduction, Inventory related costs, EOO model, EPO model, Inventory models allowing shortages, Inventory models allowing price discounts, Inventory model under risk conditions, Inventory control systems: continuous review, periodic review, optional replenishment etc., Inventory classification systems: ABC, FMS, VED etc, MRP.

CPM / PERT: Introduction, Project scheduling with CPM, Project scheduling with PERT. Loading and Scheduling , General scheduling problem, Significance of loading and scheduling, Factors

affecting scheduling, Scheduling system, Flow shop scheduling, Job shop scheduling, Sequencing, Line balancing.

Forecasting: Introduction, Demand patterns, Factors affecting demand, Subjective forecasting methods, Casual forecasting methods, Time series forecasting methods, Routine short term forecasting methods, Selection of forecasting model.

PPC: Introduction, System approach, Type of manufacturing systems, Factors affecting manufacturing systems. Product design and development, Introduction, marketing aspects, functional aspects, operational aspects, durability and dependability, aesthetic aspects, economic analysis, profit and competitiveness, the three S's, break even analysis, economics of a new design, production aspects.

Texts/Reference:

1. S.N. Chary: Production And Operations Management: McGraw Hill Publ, 5th Edition
2. Chase: Operations and Supply Management (SIE): McGraw Hill Publ, 12/e
3. Saxena: Production and Operations Management: McGraw Hill Publ, 2/e
4. O.P. Khanna: Industrial engineering and management: Dhanpat Rai & Sons

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ME 1402	**POWER PLANT ENGINEERING**	L	T	P	C
	Seventh Semester	3	0	0	6

(Mechanical Engineering Branch)

Pre-requisite- ME 1206, ME 1302, ME 1306, ME 1309

Power Plant In General: Introduction to different power plants, Load and Load duration curves, Location factors for power Plants, Power plant economics, Indian energy scenario.

Steam Power Plant: Introduction, Rankine cycle, Carnot cycle, Reheating of steam, Regeneration, Steam power plant appraisal, Deaeration, Typical layout of steam power plant, Efficiencies in steam power plant, Different types of fuel used for steam Generation, Draught system, Classification of boilers, Boiler accessories, Classification of steam turbines and their working, Co-generation plant for power and process heat, Combined cycle plant for power generation.

Gas Turbine Power Plant: Introduction, Classification of different gas turbine power plants, Analysis of closed cycle and open cycle constant pressure gas turbine plant, components of gas turbine plants.

Diesel Electric Power Plants: Introduction, Application of diesel engines in power field, Advantages and disadvantages of diesel engine power plant, General layout, Performance characteristics, Supercharging and Turbocharging.

Hydro-Electric Power Plant: Introduction, Classification of hydro-electric power plant, Site selection, Hydrographs, Flow duration curves, Elements of hydro-electric power plant, Advantages of hydro-electric power plant, Classification of hydraulic turbines and its selection.

Nuclear Power Plant: Introduction to nuclear engineering, Types of nuclear reactors, Pressurized water reactor, Boiling water reactor, CANDU reactor, Gas-cooled reactor, Liquid metal fast breeder reactor, India`s nuclear power programme.

Non-Conventional Power plants: Prospect of renewable energy source, Types of non-conventional power plants, Solar thermal and solar photovoltaic plants, Wind power plants, Bio-mass plants, Geo-thermal power plant, Tidal power plant.

Texts/Reference:

1. R.K. Rajput: Power Plant Engineering: Laxmi Publication
2. P.K. Nag: Power Plant Engineering: Tata McGraw Hill Publisher
3. R.K. Yadav: Steam & Gas Turbines & Power Plant Engineering: Central Publishing House, 7th ed
4. Arora & Dom Kundwar: A Course In Power Plant Engineering: Dhanpat Rai & Sons
5. P.C. Sharma: Power Plant Engineering: S.K. Kataria & Sons

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ME 1411	**ME Lab - V**	L	T	P	C
	Seventh Semester	0	0	2	2

(Mechanical Engineering Branch)

Pre-requisite- ME 1311, ME 1312, ME 1314, All theory subjects in previous semesters

All areas of Thermal Engg / Design & Manufacturing / Production Engg

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ME 1421	**REFRIGERATION**	L	T	P	C
	(Departmental Elective – I)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1201, ME 1206, ME 1309

Introduction: History, Methods of refrigeration, Ice production, Units of refrigeration, Review of thermodynamics, Difference between heat engine refrigerator and heat pump.

Air Refrigeration System: Carnot and Brayton cycles, Air – craft refrigeration systems - Simple, Boot-strap, Regenerative and reduced ambient system, Advantages and disadvantages.

Vapour Compression System: Analysis of simple cycles, Representation on T-s and p-h plan and its use, Methods of improving COP, Actual cycle, Introduction to compound compression and multiple evaporator system, Expression for COP and power required.

Vapour Absorption System: Theoretical analysis of VAR. system, Advantages and disadvantages, Practical VAR system, Aqua- ammonia and Lithium- Bromide- Water VAR systems.

Refrigerants: Nomenclature, Classification, Desirable properties, Environmental regulations.

Application of Refrigeration: Domestic, commercial, industrial and medical refrigeration, Cold-storage, etc.

Texts/Reference:

1. C. P. Arora: Refrigeration and Air conditioning: TMH, 3/e
2. M. Prasad: Refrigeration and Air conditioning
3. Stocker & Jones: Refrigeration and Air conditioning: TMH
4. Jordan & Preister: Refrigeration and Air conditioning
5. P. N. Ananthanarayan: Refrigeration and Air conditioning: TMH
6. S. K. Kulshrestha: Refrigeration and Air conditioning
7. ASHRAE: ASHRAE Hand Book Of Fundamentals
8. M. Prasad: Refrigeration and Air conditioning Data Book

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ME 1422	**PRINCIPLES OF COMBUSTION**	L	T	P	C
	(Departmental Elective – I)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1206, ME 1305, ME 1309, CH 1101

Introduction: Review of chemical thermodynamics and chemical kinetics: heat of formation, heat of reaction, calculation of adiabatic flame temperature equilibrium calculations, Conversation equations for multicomponent systems.

Pre-mixed systems: Flammability limits; Detonation and deflagration; Detonation wave structure; Transition from deflagration-to-detonation; Methods of solving laminar flame problems; Effects of different variables on flame speed; Methods of measuring flame velocity; Flame quenching. Non-Pre-mixed systems; Burke-Schumann's theory of laminar diffusion flames; Droplet burning; Laminar diffusion flames. Burning of solids, spray combustion. Practical aspects of combustion; Combustion and the environment; fire and combustion; Practical devices; burners, explosives, propulsion methods, combustion chambers.

Texts/Reference:

1. Turns: An Introduction to Combustion: Concepts and Applications: McGraw-Hill Education, 3/e

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ME 1423	**ADVANCED SOLID MECHANICS**	L	T	P	C
	(Departmental Elective – I)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1209

Thick cylinders: Derivation and solution of differential equations of equilibrium, stresses produced by shrink fit, compound cylinders

Rotating rims and discs: Stresses on thin rotating rims and rotating discs of uniform thickness, derivation, solution of differential equations rotating discs of variable thickness, stresses in flywheel.

Columns and struts: Definition, basic structures, Euler's Equation and Rankin's formula.

Curved beams: Difference between straight and curved beam theories, pure bending of curved beams, Winkler Back theory, bending of curved beams by forces acting in the plane of symmetry, particular cases of curved beam sections.

Unsymmetrical bending: Product second moment of area, principal second moment of area, Mohr's circle of second moment of areas, determination of resultant stresses at a point, orientation of neutral axis, cases of symmetrical and unsymmetrical sections, shear center.

Introduction to Fracture mechanics, Contact stresses and Finite element methods. Application of energy method.

Texts/Reference:

1. L.S. Srinath: Advance d Mechanics of solids: TMH, 3/e
2. S. S. Rattan: Strength of Material: McGraw-Hill
3. Beer & Johnston: Mechanics of Materials: Tata McGraw-Hill, 5/e
4. Roy R. Craig, Jr: Mechanics of Materials: John Whiley
5. Krishnaswamy, Kulkarni & Gharpure: Advanced Strength of Materials: Khanna Publishers,
6. E. P. Popov: Mechanics of Materials: Pearson
7. Krishna Raju & Gururaja: Advance Mechanics of Solids & Structures: Narosha Publishing House

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ME 1424	**FUNDAMENTAL OF INDUSTRIAL DESIGN**	L	T	P	C
	(Departmental Elective – I)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1304, ME 1308, ME 1204, HS 1201

Introduction: The design process, Steps in design process, Morphology of design, Mechanical engineering design, Traditional design methods, Design synthesis, Aesthetic and ergonomic considerations in design, Use of standards in design, Selection of preferred sizes, design for Maintenance (DFM).

Sources of Information and Communicating the Design: The information problem, Copyright and copying, Sources of information, Patents, Elements of communication system, Recording of results, Writing the technical report, Conducting a meeting, Oral presentation, Visual aids and graphics.

Materials Selection: Performance characteristics of materials, Materials selection process, Economics of materials, Evaluation methods of materials selection – cost versus performance relation, weighted index, value analysis etc.

Manufacturing Considerations in Design: Role of processing in design, Types of manufacturing processes, Economics of manufacturing, Design for castings, Forgings, Sheet metal forming, Design

for machining, Powder metallurgy, Welding, Heat treatment, Assembly, Corrosion resistance, Designing with plastics, Concurrent engineering approach.

Value Engineering: Introduction, Categories of costs, Methods of developing cost estimates, Cost indexes, Cost-capacity factors, Factor methods of cost estimation, Manufacturing costs, Overhead costs, Standard costs, How to price a product, Life cycle costing.

Economic Design Making: Mathematics of time value of money, Cost comparison, Depreciation, Taxes, Profitability of investments, Inflation, Sensitivity and break-even analysis, Uncertainty in economic analysis, Benefit cost analysis.

Texts/Reference:

1. George Ellwood Dieter: Engineering Design: A Materials and Processing Approach: McGraw-Hill; 4th edition
2. V. B. Bhandari: Design of Machine Elements: TMH, 3/e

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ME 1425	**PRODUCTION MANAGEMENT**	L T P C
	(Departmental Elective – I)	3 0 0 6
	Seventh Semester	
	(Mechanical Engineering Branch)	
	Pre-requisite- HS 1301, HS 1201	

Introduction: Introduction to Production Systems and a Generalized Model of Production, Life cycle of a Production System and Major managerial Decisions, Role of Models in Production Management

Financial Evaluation of Capital Decisions: Performance Measures of a Production System, Financial Evaluation of Capital Decisions, Decision Trees and evaluation of risk

Designing Products & Services: Introducing New Products and Services, Economic Evaluation of New Products & Services, Product Mix Decisions, Product & Process Design

Facility Location and Layout: Plant Location, Process Layouts, Product Layouts and Assembly Line Balancing, Cellular Layouts, Layouts for Advanced Manufacturing Systems

Production Planning over Medium Term Horizon: Demand Forecasting, Aggregate Production Planning

Operational Decisions over the Short Term: Inventory related Decisions, Material Requirements Planning, Scheduling of Job Shops

Project Management: An Overview, Project Identification and Screening, Project Appraisal, Project Selection, Development of Project Network, Project Representation, Consistency and Redundancy in

Project Networks, Basic Scheduling with A-O-A Networks, Basic Scheduling with A-O-N Networks, Project Scheduling with Probabilistic Activity Times, Linear Time-Cost Tradeoffs in Projects: A Heuristic Approach, Resource Profiles and levelling, Limited Resource Allocation, Project Monitoring and Control with PERT / Cost, Team Building and Leadership in Projects, Organizational and Behavioral Issues, Project Completion, Review and Future Directions.

Texts/Reference:

1. Panneerselvam R Publisher: Production & Operations Management: PRENTICE H, Second Edition
2. Chary, S N: Theory And Problems In Production And Operations Management: Tata McGraw-Hill
3. V K Dubey: Production Management-A New Concept: Commonwealth Publishers
4. Kanishka Bedi: Production And Operations Management:: Oxford University Press
5. Muhlemann, Oakland & Lockyer: Production & Operation Management: Macmillan
6. Riggs, J. L: Production Systems: Planning & Control: John Wiley & Sons
7. Mukherjee & Kachwala: Operations Management and Productivity Techniques: PHI
8. Richman: Project Management Step by Step: PHI
9. Chase: Operations and Supply Management (SIE) (with DVD), McGraw-Hill, 12/e
10. Saxena: Production and Operations Management: McGraw-Hill, 2/e

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ME 1426	**NUMERICAL CONTROL OF MACHINE TOOLS**	L	T	P	C
	(Departmental Elective – I)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1303, ME 1301, EE 1101, EC 1101, ME 1208

Introduction: Fundamentals of Numerical Control (NC), Computer Numerical control (CNC), Direct Numerical control (DNC), comparison between conventional and CNC systems, Classification of CNC system, Design consideration in CNC machine tools, Industrial applications of CNC, Economic benefit of CNC.

System Devices: Drives, Feed back devices, Counting devices, Data Input Devices, Lead screws.

Control Systems: Fundamental problems of control, Position or point to point, straight line and contouring control, Machine tool control, Open and closed loop control, Adaptive Control system.

Interpolation: Digital differential analyzers (DDA) integrator, DDA hardware interpolator, CNC software interpolators, Software DDA interpolator, Linear and Circular interpolation.

NC Part Programming Concepts: NC coordinate system, Part programming terminology, preparatory and miscellaneous Codes, Part programming formats, procedures and methods, Manual programming, Computer aided programming, APT programming and practice.

Associated Systems of CNC: Introduction to Flexible manufacturing systems (FMS), CAD/CAM, Industrial robots, CIM systems.

Texts/ Reference:

1. Mehta: Machine Tools Design and Numerical Control: McGraw-Hill, 3/e,
2. Yoram Koren: Computer control of manufacturing system: Mc Graw Hill Book Co.
3. B. L. Jones: Computer Numerical Control: John Wiley and Sons.
4. Chen and Lin: Computer Numerical Control: Glory Educational Resource Inc.
5. Rao, Tiwari and Kunda: Computer Aided Manufacturing: Tata Mc Graw Hill
6. Groover and Zimmer: CAD/CAM: PHI
7. Groover: Automation, Production systems and computer integrated manufacturing: PHI
8. Chang, Wysk and Wang: Computer aided manufacturing: PHI

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ME 1427	**ENGINEERING INSPECTION AND QUALITY CONTROL**	L	T	P	C
	(Departmental Elective – I)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1208, ME 1304, ME 1308

Interchangeable system of manufacture, types of interchangeability, limit gauge, Taylo's gauging principle, design of inspection gauges

Surface textures, numerical assessment of surface texture, use of stylus type instruments, measurement of gear elements, gear errors, measurement of thread elements, thread errors.

Mechanical, optical, optical mechanical comparators, pneumatic comparator, Optical principles of measurement, toolmaker's microscope. interferometry.

Causes of variation in quality characteristics, principles of quality control by the use of control charts.

Texts/Reference:

1. Bewoor: Metrology & Measurement: McGraw-Hill Publishers
2. Gupta: Total Quality Management: McGraw-Hill Publisher, 2/e
3. Mahajan: A text book of metrology: Dhanpat Rai and Co.
4. Halpern: The assurance sciences: Prentice hall of India private limited

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ME 1431	**I.C. ENGINE**	L	T	P	C
	(Departmental Elective – II)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1206, ME 1305

Introduction: Basic design components and nomenclature, Review of Classifications of I.C. engines, working principles of engines, comparison of S.I. and C.I. engine, comparison of two stroke and four stroke cycle engine, engine performance parameters.

*Air Standard Cycles and their Analysis:*Review of Carnot cycle, Otto cycle, Diesel cycle, Limited pressure cycle, Brayton cycle, Stirling cycle, and other cycles.

Fuel Air Cycles and their Analysis: Significance, Effect of operating variables, Actual cycles, Various losses in actual cycles, Fuels- important qualities of engine fuels.

Carburetion: Factors affecting carburetion, Air-fuel mixtures, The simple carburettor, Essential parts of modern carburetors, Working of various carburetors.

Injection: Air injection system, Solid injection system, Common rail system, Injection pump, Nozzle, Quantity of fuel and size of nozzle orifice, Injection in S.I. engine, Battery ignition system, Spark plug, Magneto ignition system, Modern ignition systems, Ignition timing and ignition parameters.

Combustion Chamber: Stages of combustion in S.I. engines, Combustion chambers for S.I. engines, Combustion in C.I. engines, Stages of combustion in C.I. engines, Phenomenon of knock in S.I. and C.I. engines.

Engine Friction And Lubrication: Lubrication of engine components, Lubrication system, Wet sump and dry lubrication, Properties of lubricants.

Measurements and Testing: William`s line method, Morse test, Motoring test, Retardation test, Prony brake, Rope brake, Hydraulic dynamometer, Emission, Fuel consumption, Volumetric type flow meter, Fuel consumption and air consumption measurements, Combustion phenomenon, Performance parameters and characteristic, Two stroke engines, Air pollution due to I.C. engines.

Texts/Reference:

1. V. Ganeshan: I. C. Engines: TMH, 4/e
2. Heywood: Internal Combustion Engine Fundamental: TMH, 1/e
3. W. W. Pulkrabek: Engineering Fundamentals of I. C. Engines
4. M. L. Sharma & R.P. Sharma: A course in I. C. Engines

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ME 1432	**GAS DYNAMICS**	L	T	P	C
	(Departmental Elective – II)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1206, ME 1302

Concept from Thermodynamics: Thermodynamics systems, variables of state, the first principal law, irreversible and reversible processes, perfect gases, the first law applied to reversible processes. specific Heats, the first law applied to irreversible processes, the concept of entropy. The second law, The cononical equation of state. Free energy and free enthalpy, reciprocity relations, entropy and transport processes, equilibrium conditions, mixtures of perfect gases, The law of mass action, dissociation, condensation, real gases in gas dynamics.

One-Dimentional Gasdynamics: Introduction, the continuity equation, the energy equation, reservoir conditions, Euler's equation. The momentum equation, isentropic conditions, speed of sound; Mach number, the area-velocity relation, results from the energy equation, Bernoulli equation; Dynamic pressure, flow at constant area, the normal shock relations for a perfect gas, Hugomot equation, one-dimentional flow with heat addition, one-dimentional flow with friction.

Oblique shock and expansion waves, source of oblique waves, oblique shock relations, supersonic flow over wedges and cones, shock polar, regular reflection from a solid boundary, pressure-deflection diagrams, intersection of shocks of opposite families, intersection of shocks of the same family, mack reflection, detached shock wave in front of a blunt body, three-dimentional shock waves, Prandtl-Meyer expansion waves, shock-expansion theory, solution of mack angle.

Numerical techniques for steady supersonic flow-supersonic nozzle design, method of characteristics for axisymmetric irrotational flow, method of characteristics for rotational (Non-isentropic and non-adiabatic) Flow, introduction to finite differences, Mac-Cormack's technique, boundary conditions, rayleigh flow, Fanno flow, effects of viscosity and conductivity, measurement in compressible flow.

Texts/Reference:

1. Robert D. Zucker Oscar Biblarz: Fundamentals of gas dynamics: John Wiley & Sons, Inc.
2. John D. Anderson, Jr: Modern Compressible Flow: McGraw-Hill Publishing Company.
3. H. W. Liepmann A. Roshko: Elements of Gas Dynamics: John Wiley & Sons, Inc.
4. E Rathakrishnan: Gas Dynamics: Prentice Hall of India Ltd., New Delhi.

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ME 1433	**ROBOTICS AND ROBOT APPLICATIONS**	L	T	P	C
	(Departmental Elective – II)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1301, ME 1303, ME 1307, EC 1101, ME 1208

Introduction: Brief History, Types of robots, uses of robots, Present status and future trends in robotics, Overview of robot subsystems.

Issues in designing and controlling robots: resolution, repeatability and accuracy, transmission, Robot configurations and concept of workspace, Mechanisms and transmission.

Robot Anatomy: End effectors and actuators, Different types of grippers: vacuum and other methods of gripping. Pneumatic, hydraulic and electric actuators.

Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder, camera. Micro-controllers, DSP, centralized controllers, real time operating systems.

Task specification: Point to point and continuous motion specifications for typical applications, joint interpolation, task space interpolation, executing user specified tasks

Robot analysis: Position and orientation of rigid bodies, spatial mechanism description, Denavit-Hartenberg notation, homogenous transformation.

Forward and inverse position analysis, velocity mapping, static force analysis, singularities, acceleration mapping.

Robot control: Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, issues in nonlinear control, force feedback, hybrid control

Motion planning: Obstacle avoidance, configuration space, road map methods, graph search algorithms, potential field methods.

Robot vision: Camera model and perspective transformation, image processing fundamentals for robotic applications, image acquisition and preprocessing.

Segmentation and region characterization, object recognition by image matching and based on features, Problem of bin-picking.

Futuristic topics in Robotics: Micro-robotics and MEMS (Micro electro mechanical systems), Fabrication technology for micro-robotics, stability issues in legged robots, under-actuated manipulators

Case studies: Robot in assembly (Puma), Mobile robot (Nataraj)

Texts/Reference:

1. M. P. Groover: Industrial Robotics: Mc Graw Hill Book Co, 2/e
2. Mittal: Robotics & Control: McGraw-Hill
3. Saha: Introduction to Robotics: McGraw-Hill
4. M. P. Groover: Automation, Production systems and Computer Integrated Manufacturing: PHI
5. J. J. Craig: Introduction to Robotics: Addison Wesley
6. S. R. Deb: Robotics Technology and Flexible Automation: McGraw-Hill, 2/e

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ME 1434	**HOLISTIC APPROACH TO ENGINEERING DESIGN**	L	T	P	C
	(Departmental Elective – II)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1304, ME 1308

Design Process Introduction, The Design Process steps, Detailed Morphology of Design, Considerations in Design, A design example The Engineering designer-tasks and activities, design Process position and trends, Necessity for systematic Design, Historical Background, Current Methods.

Study of processes involved in design realization, problem solving process, Study of different methodologies in problem solving process, analysis, synthesis and communication, Study of different case studies on the various aspects of the problem solving in design.

Ergonomics: Overview of the subject with its design relevant, Man – the primary system, component, Human compatibility, Comfort and adaptability, Physical(Anthropometry), Physiological and psychological (Behavioral acceptance factors) consideration, Principles of fitting design configuration to the users, Determining lay-out component principles, Man machine environment system and user friendly design practice, Stages of design development, Ergonomics design principles and criteria.

Texts/Reference:

1. George E. Dieter: Engineering Design: Mc Graw Hill Book Co.
2. R. C. Mishra Simant: Mechanical System Design: PHI
3. Geoffrey Jordan: System Simulation: PHI
4. Paynee: Introduction to Simulation Programme and Method of Analysis: PHI
5. G. Pahl, W.Beitz, J. Feldhusenm K.H.Grote: Engineering design: Springer

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ME 1435	**METAL FORMING & METAL CUTTING TECHNOLOGY**	L	T	P	C
	Seventh Semester (Elective – II)	3	0	0	6
	(Mechanical Engineering Branch)				
	Pre-requisite- ME 1203, ME 1303				

Metal Forming: Classification of forming process, Stress, strain and strain rules, laws, Yield criterion and flow rules, effect of parameters such as strain rate, temperature etc, workability, anisotropy. Friction and lubrication in metal forming processes, Indirect compression processes e.g., Drawing and Extrusion processes, Direct compression processes e.g., forming and rolling, Theory of deep drawing, Load bounding techniques and upper bound estimates of field theory, Bending and forming, High-energy rate forming techniques and their applications, Recent advances in metal forming.

Mechanics of Metal Cutting: Tool geometry, Mechanics of orthogonal and oblique cutting, Shear angle relations in orthogonal cutting, Shear angle and chip flow direction in oblique cutting, Chip control methods, Analysis of cutting process, Machining with rotary tools, Thermodynamics of chip formation, Machining at super high speeds, Theories of tool wear, Basic action of cutting fluids, tool life, Factors governing tool life, Machinability-definition and evaluation.

Economics of Metal Cutting: Single and multipass machining operations, Criteria, variables, and restrictions for the economical conditions.

Dynamic metal cutting: Comparison of steady and dynamic process, Shear angle and force relationships, Grinding mechanics, Wheel characteristics and theory of wheel wear, Lapping, Honning, High speed grinding theory, Grinding of drills, form cutters etc., Problems associated with machining of plastics, Tools for plastic cutting,

Texts/Reference:

1. G K Lal: Introduction to Machining Science: New Age International
2. P K Mishra: Non-Conventional Machining: Narosa Publishing House

3. G. C. Sen and A.Bhattacharya: Principles of Metal Cutting/Principles of Machine Tools: New Central Book Agency, Kolkata.
4. Production Technology:: HMT Publication: TMH
5. A.Ghosh and A.K.Mallik: Manufacturing Science: Wiley Eastern.
6. K. Jain: Manufacturing Engineering Technology: Pearson Education
7. P. N. Rao: Manufacturing Technology: Foundry, Forming and Welding: TMH.
8. De Garmo et al.: "Materials and Processes in Manufacturing", Prentice Hall of India, Eight Edition, 1998.
9. Richara R. Kibbe, John E.Neely, Roland O. Meyer and Warrent T. White: Machine Tool Practices: Prentice Hall of India, VI Edition, 1999.
10. N. K. Mehta: Machine Tool Design and NC: Tata McGraw Hill Publishing Co. Ltd., 3/e 1999.

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ME 1436	**MECHANICS OF COMPOSITE MATERIALS**	L	T	P	C
	(Departmental Elective – II)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1204

Introduction: Classification of composite materials; Fibrous, laminated and particulate composites; Applications of composite materials.

Fabrication of Composite Materials: Properties of composite fibres; Fabrication of composites with thermosetting and thermo-plastic resin matrices, metal matrix and ceramic matrix; Experimental characterization of composites, such as uniaxial tension and compression, in-plane shear and bending strength, inter-laminar shear strength and fracture toughness; Damage identification using non-destructive techniques.

Macro mechanical behavior of lamina: Stress-strain relations, engineering constants for orthotropic materials, transformation of stress and strain, strength and stiffness of an orthotropic lamina; Biaxial strength theories.

Micromechanical behavior of lamina: Introduction, Volume and mass fractions, density and void content, Evaluation of elastic moduli, role of mixtures, ultimate strengths of a unidirectional lamina, coefficients of moisture expansion.

Macro mechanical behaviour of laminate: Single layered configurations, symmetric laminates, anti symmetric laminates; Strength of laminates; Inter laminar stresses, Hygrothermal analysis of both lamina as well as laminates.

Texts/Reference:

1. Budynas: Advance Strength & Applied Stress Analysis: McGraw-Hill, 2/e
2. Kaw A. K: Mechanics of Composite Materials: CRC press
3. I. M. Daniel and O. Ishai: Engineering Mechanics of Composite materials: Oxford University Press

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ME 1437	**ADVANCED FLUID MECHANICS**	L	T	P	C
	(Departmental Elective – II)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1207, ME 1302

Review of Basic Fluid Mechanics, Navier-stokes equations. Potential flow theory flow around bodies, cylinders and aerofoils, Prediction of velocity and pressure distribution, boundary layer concepts, laminar and turbulent boundary layers, separation criterion, introduction to compressible flow. Velocity of sound and mach number, isentropic flow, flow with friction and heat transfer, analysis of flows with normal & oblique shock waves. Hydraulic machines, classifications, theories & applications.

Texts/Reference:

1. Pati: Textbook of Fluid Mechanics & Hydraulic Machines: McGraw-Hill, 1/e
2. Som & Biswas: Introduction to Fluid Mechanics and Fluid Machines: McGraw-Hill, 3/e
3. Cengel: Fluid Mechanics:, McGraw-Hill, 2/e
4. White: Fluid Mechanics: McGraw-Hill, 7/e
5. Streeter: Fluid Mechanics: McGraw-Hill, 9/e
6. Subramanya: Hydraulic MachinesMcGraw-Hill: 1/e
7. Pati: Textbook of Fluid Mechanics & Hydraulic Machines: McGraw-Hill, 1/e
8. Som & Biswas: Introduction to Fluid Mechanics and Fluid Machines: McGraw-Hill, 3/e,

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ME 1471 **FINITE ELEMENT METHOD** L T P C

(Open Elective – I) 3 0 0 6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1209, ME 1309, MA1101, MA1102, MA1201

Introduction, historical background, applications, advantages, finite element softwares. Theory of elasticity - stress and equilibrium, stress-strain relationship, strain-displacement, relationship, plane stress, plane strain and axi-symmetric approximation. Temperature effects. Potential energy and equilibrium, Principle of minimum potential energy. Discrete and Continuous systems, Rayleigh-Ritz method, Galerkin method. Solution of Algebraic equations, Banded and skyline solutions. Global, Local and Natural coordinates in 1, 2 and 3 dimensions - Area coordinates. Numerical Integration using Gauss quadrature. Finite element modeling - types of elements, Discretization, Mesh generation and numbering. Shape functions - types and properties.

Iso parametric formulation. Largrangean and Serendipity elements.

One dimensional elasticity problems - discretisation of domain into elements – generalized coordinates approach - derivation of elements equations - assembly of element equations - transformation matrices - global equations, load vector, properties of stiffness matrices, imposition of Boundary conditions - penalty and elimination approach, multi-point constraints. Finite element formulation of plane trusses, beams and beams on elastic supports.

Finite element formulation of 2D problems using constant strain triangle element and isoparametric quadrilateral element. Axi-symmetric solids subjected to axi-symmetric loading. Features of 3D problems in stress analysis. Scalar field problems - one dimensional heat conduction through composite walls and fins, potential flow. Dynamic problems- Hamilton’s principle, Mass matrices, lumped and consistent formulations.

Texts/Reference:

1. Reddy: An Introduction to Finite Element Method: McGraw-Hill, 3/e
2. Hutton: Fundamentals of Finite Element Analysis: McGraw-Hill, 1/e
3. Krishnamoorthy: Finite Element Analysis: Theory and Programming: McGraw-Hill, 2/e,
4. T. K. Chandrupatla and A. D. Belegundu: Introduction to Finite Elements In Engineering: Prentice Hall of India Pvt. Ltd., New Delhi
5. S. Rajasekaran: Finite Element Analysis in Engineering Design: Wheeler Publishing,
6. K. S. Bathe & E. L. Wilson: Finite Element Method: Prentice Hall of India
7. R. D. Cook: Concepts and Applications of Finite Element Analysis: Wiley.

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ME 1472	**PROJECT MANAGEMENT**	L T P C
	(Open Elective – I)	3 0 0 6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- HS 1201, HS 1301

Project Planning: Project Management scenario, Project Asset – issues & problems, Gantt Chart & LOB, Network Analysis, PERT / CPM, Resource Monitoring & Control.

Contract Management: principles of Project Contracts, compilation of Project Contracts, practical aspects of Contract, legal aspects of Project Management, global tender, negotiations for Projects, insurance for Projects.

Project Buying: Projects Procurement Process, Life – cycle Costing, Project Cost Reduction methods, Project Stores, organization & HRD issues, Computerization.

Investment Feasibility Studies: managing Project Resources Flow, Project Feasibility studies, Project Cost – Capital & Operating , Forecasting Income, Estimation of Investment & ROI, Project Evaluation, Financial Sources, Appraisal Process.

Issues in Project Management: Project Audit, Project Monitoring & MIS, Cost Control, Real Time Planning, Intangibles.

Project Management: Case Studies.

Tests/Reference:

1. Chandra: Projects: McGraw-Hill, 7/e
2. Chitkara: Construction Project Management: Planning, Scheduling and Control (With CD): McGraw-Hill, 2/e
3. Gray: Project Management: The Managerial Approach (SIE): McGraw-Hill, 4/e,
4. P Gopalkrishnan & V E Ramamurthy: Text Book of Project Management: McMillan.
5. N Singh: Project Management & Control: Himalaya
6. V Desai: Project Management:
7. B M Patel: Project Management: Vikas.

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ME 1473	**RELIABILITY ENGINEERING**	L	T	P	C
	(Open Elective – I)	3	0	0	6

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1208, MA1101, MA1102, MA1201

*Reliability Concept***:** Reliability and probability, Maintainability and availability, The tasks of reliability, Decision making and failure statistics, Failure probability, Survival probability and age specific future rate, Weibull pdf, Application of failure statistics to reliability prediction for complex plants, Plant availability assessment, Stand- by systems, Multi unit stand-by systems, Derating and maintenance, Reliability testing, Accelerated testing, Sequential testing project management, Human reliability, Super reliability, Safety factor and reliability, Reliability allocation, Effects of environment in reliability assessment, Solutions of reliability to a variety of real engineering problems, Making, Installation and use of computers, Programming, Management prospective.

Texts/Reference:

1. Balaguruswamy E: Reliability Engineering: TMH
2. Ebeling: An Introduction to Reliability and Maintainability Engineering: McGraw-Hill, 1/e
3. Birolini A: Reliability Engineering - Theory and Practice: Springer

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ME 1474	**ENVIRONMENTAL POLLUTION AND ITS CONTROL**	**L**	**T**	**P**	**C**
	(Open Elective – I)	**3**	**0**	**0**	**6**

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- CH 1101, ME 1307

Causesm effects and control measures- Air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear pollution, solid waste management, causes, effects and control measures of urban and industrial wastes, pesticides pollutions, air pollution – SOx, NOx, CO, particulates Solid and water pollution, formation of pollutants, measurement and controls; sources of emissions, effect of operating and design parameters on emission, control methods, exhaust emission test, procedures, standards and legislation; environmental audits; emission factors and inventories

global warming. CO_2 emissions, impacts, climate change, global warming, acid rain, ozone layer depletion, laws related to environmental pollution.

Texts/Reference:

1. Cunninghum: Principles of Environmental Science: Inquiry & Applications: (by McGraw-Hill, Special Indian Edition), 4/e
2. Keily: Environmental Engineering: McGraw-Hill, (Special Indian Edition),1/e
3. K.P. Srivastava: An Introduction to Environmental Study: Kalyani Publishers, Ludhiana
4. J.A. Nathanson: Basic Environmental Technology: Prentice Hall of India, New Delhi.
5. A. R. W. Jackson and J.M. Jackson: Environmental Sciences: The Environment and Human Impact: Longman Publishers.
6. J. A. Nathanson: Basic Environmental Technology: PrenticeHall of India, New Delhi

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ME 1475	**MECHATRONICS**	**L**	**T**	**P**	**C**
	(Open Elective – I)	**3**	**0**	**0**	**6**

Seventh Semester

(Mechanical Engineering Branch)

Pre-requisite- EE 1101, EC 1101, ME 1301, ME 1304, ME1308

Introduction: Definition – Trends - Control Methods: Standalone, PC Based (Real Time Operating Systems, Graphical User Interface, Simulation) - Applications: SPM, Robot, CNC, FMS, CIM.

Signal Conditioning: Introduction – Hardware - Digital I/O, Analog input – ADC, resolution, sped channels Filtering Noise using passive components – Resistors, capacitors - Amplifying signals using OP amps – Software - Digital Signal Processing – Low pass , high pass , notch filtering

Precision Mechanical Systems: Pneumatic Actuation Systems - Electro-pneumatic Actuation Systems - Hydraulic Actuation Systems - Electro-hydraulic Actuation Systems - Timing Belts – Ball Screw and Nut - Linear Motion Guides - Linear Bearings - Harmonic Transmission - Bearings- Motor / Drive Selection.

Electronic Interface Subsystems: TTL, CMOS interfacing - Sensor interfacing – Actuator interfacing – solenoids , motors Isolation schemes- opto coupling, buffer IC's - Protection schemes – circuit breakers, over current sensing, resetable fuses, thermal dissipation - Power Supply - Bipolar transistors / mosfets

Electromechanical Drives: Relays and Solenoids - Stepper Motors - DC brushed motors – DC brushless motors - DC servo motors - 4-quadrant servo drives, PWM's - Pulse Width Modulation – Variable Frequency Drives, Vector Drives - Drive System load calculation.

Microcontrollers Overview: 8051 Microcontroller , micro processor structure – Digital Interfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications. Programming – Assembly, C (LED Blinking, Voltage measurement using ADC).

Programmable Logic Controllers: Basic Structure - Programming: Ladder diagram - Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection - Application.

Programmable Motion Controllers: Introduction - System Transfer Function – Laplace transform and its application in analysing differential equation of a control system - Feedback Devices: Position , Velocity Sensors - Optical Incremental encoders - Proximity Sensors : Inductive , Capacitive, Infrared - Continuous and discrete processes - Control System Performance & tuning - Digital Controllers - P, PI, PID Control - Control modes – Position, Velocity and Torque - Velocity Profiles – Trapezoidal - S. Curve - Electronic Gearing - Controlled Velocity Profile - Multi axis Interpolation , PTP , Linear, Circular - Core functionalities – Home, Record position, Go to Position - Applications : SPM, Robotics.

Texts/Reference:

1. Mahalik: Mechatronics: McGraw-Hill
2. W Bolton: Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering: Pearson Education Press, 3rd edition, 2005.
3. M.D.Singh/J.G.Joshi: Mechatronics: PHI.
4. Newton C Braga: Mechatronics Source Book: Thomson Publications, Chennai.
5. N. Shanmugam / Anuradha: Mechatronics: Agencies Publisers.
6. Devdas shetty/Richard: Mechatronics System Design: Thomson

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SEMESTER - VIII					
Code	**Course**	**L**	**T**	**P**	**C**
ME 1403	***Computer Aided Design & Manufacturing***	***3***	***0***	***0***	***6***
ME 14XX	***Dept. Elective-III***	***3***	***0***	***0***	***6***
ME 14XX	***Dept. Elective-IV***	***3***	***0***	***0***	***6***
ME 14XX	***Dept. Elective-V***	***3***	***0***	***0***	***6***
XX 14XX	***Open Elective-II***	***3***	***0***	***0***	***6***
ME 1491	***Project-II***	***0***	***0***	***10***	***10***
		15	**0**	**10**	**40**

DEPARTMENTAL ELECTIVE - III	
Code	**Course**
ME 1441	***Diagnostic Maintenance of Mechanical Equipments***
ME 1442	***Mechanical Vibrations***
ME 1443	***Compressor and Gas Turbines***
ME 1444	***Convective Heat and Mass Transfer***
ME 1445	***Production Processes***
ME 1446	***Total Quality Management***
ME 1447	***Experimental Stress Analysis***

DEPARTMENTAL ELECTIVE - IV	
Code	**Course**
ME 1451	***Computational Fluid dynamics***
ME 1452	***Energy Engineering and Management***
ME 1453	***Advanced Machining Processes***
ME 1454	***Air Conditioning***
ME 1455	***Design of Mechanical Systems***
ME 1456	***Tribology***
ME 1457	***Material Handling Systems***

DEPARTMENTAL ELECTIVE - V	
Code	**Course**

ME 1461	***Nonconventional Energy***
ME 1462	***Viscous Fluid Flow***
ME 1463	***Advanced Refrigeration Systems***
ME 1464	***Metal Cutting and Cutting Tool design***
ME 1465	***Theory of Elasticity and Plasticity***
ME 1466	***Air Conditioning System Design***
ME 1467	***Rapid Prototyping***

OPEN ELECTIVE – II (*Offered by Mech. Engg. Deptt.*)	
Code	**Course**
ME 1481	***Entrepreneurship Development***
ME 1482	***Hydraulic Machines***
ME 1483	***Solar Architecture***
ME 1484	***Introduction to Optimum Design***
ME 1485	***MEMS and Nano-Technology***

ME 1403 **COMPUTER AIDED DESIGN AND MANUFACTURING** L T P C

Eighth Semester 3 0 0 6

(Mechanical Engineering Branch)

Pre-requisite- ME 1303, ME 1301, ME 1401

Introduction: Introduction to CAD/CAM, need of CAD/CAM, product cycle, automation in CAD/CAM and CAD/CAM integration.

Computer Aided Design: Computer graphics, principles of geometric modeling, transformations, wire frame, surface and solid modeling, Rapid Prototyping and tooling.

Group Technology (GT): Introduction, part families, parts classification and coding systems, GT machine cells, benefits of GT.

Process Planning: Basic concepts of process planning, computer aided process planning (CAPP), Retrieval or variant and generative approach of CAPP, Implementation consideration of CAPP.

Numerical Control of Machine Tools: Principles of Numerical control (NC), Computer Numerical control (CNC), Direct Numerical control (DNC), comparison between conventional and CNC systems, Classification of CNC system, NC coordinate system, positional control, system devices, interpolators, adaptive control system.

NC Part Programming: Concept, format, preparatory and miscellaneous codes, manual part programming, APT programming.

FMS and CIM: Introduction to flexible manufacturing system (FMS), the manufacturing cell, tool management and workpiece handling system, transfer lines, types and application of industrial robots, end effectors and grippers of robots, types of manufacturing systems, components of computer integrated manufacturing (CIM), hierarchical computer system, benefits of CIM.

Texts/Reference:

1. Mehta: Machine Tools Design and Numerical Control: McGraw-Hill, 3/e,
2. Yoram Koren: Computer control of manufacturing system: Mc Graw Hill Book Co.
3. B. L. Jones: Computer Numerical Control: John Wiley and Sons.
4. Chen and Lin: Computer Numerical Control: Glory Educational Resource Inc.
5. Rao, Tiwari and Kunda: Computer Aided Manufacturing: Tata Mc Graw Hill
6. Groover and Zimmer: CAD/CAM: PHI
7. Groover: Automation, Production Systems and Computer Integrated Manufacturing: PHI
8. Chang, Wysk and wang: Computer Aided Manufacturing: PHI

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ME 1441 **DIAGNOSTIC MAINTENANCE OF MECHANICAL EQUIPMENTS** L T P C

(Departmental Elective-III) 3 0 0 6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1208, ME 1473

Introduction: Unplanned and planned maintenance – objectives of planned, preventive and predictive maintenance – conditioned based maintenance and signature analysis, concept of reliability, Availability and maintainability, Fault analysis planning – failure mode and effect analysis, fault tree analysis, case studies, applications in industry.

Maintenance: Basic definitions, preventive, operating and shutdown maintenance, level of maintenance, factor influencing Preventive Maintenance, data processing technique, focus on implementing with examples, measuring maintenance effectiveness and maintenance control.

Non destructive testing: Its importance testing to maintenance, principal methods- dye penetrant, magnetic particle testing and ultrasonic tests, Tero- technological approach to maintenance.

Fluid Condition and Contaminant Analysis: Carrier fluid degradation, spectroscopy and spectrometric oil analysis procedure, Ferrography, Magnetic Chip detection.

Visual testing, Liquid Penetrant inspection, X-ray photography, Application of ultrasonic and acoustic emission for fault detection.

Wear: Different types of wear and technique for minimisation of wear with examples Diagnostic Data processing and decision making, statistical distribution, approach to automated data processing, pattern recognition, Neural net work and expert system, case studies.

Texts/Reference:

1. B. C. Majumdar: Introduction to Tribology of Bearings: A. H. Wheeler & Co. Ltd
2. A. Cameron and C. M. Mc Ettles: Basic Lubrication Theory: Wiley Eartern Ltd., New Delhi
3. S. Branned: Mechanical Signature Analysis: Theory and Application: Academic Publishers, London
4. B. C. Nakra and K. K. Chaudhary: Instrumentation measurements and Analysis: Tata Mcgraw Hill Publishing company
5. Sushil Kumar Srivastava: Maintenance Engineering and Management: S. Chand & Company Ltd, NewDelhi
6. R. C. Mishra and K. Pathak: Maintenance Engineering and Management: Prentice Hall of India, New Delhi
7. Gowda: Vibration: McGraw-Hill

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ME 1442	**MECHANICAL VIBRATION**	L	T	P	C
	(Departmental Elective-III)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1101, ME 1202, ME 1301

Introduction: Basic Concepts, Classification of Vibrations and vibrating Systems, Importance and scope ,Free and forced Vibrations, Linear and Non linear Vibrations, Deterministic and random Vibrations, Elementary Parts Of Vibrating Systems, Examples of harmonic motion, Periodic motion, Discrete and Continuous Systems,

Single Degree Of Freedom System:

Free vibration Undamped – D.Alembert`s principle and energy method, Natural frequency, Response of equivalent systems and torsional systems. Energy method, Rayleigh's Method.

Damped Free vibration with viscous damping – Logarithmic decrement ,torsion System with Viscous damping, Free vibration with Coulomb damping, damped torsional vibrations, Equivalent Viscous damping, overdamped, critically damped and underdamped vibration.

Forced Vibration: Undamped Systems and Damped Systems, Steady state forced vibration, Source of excitation, Impressed harmonic force due to unbalance and motion excitation, Rotating and reciprocating Unbalance, Whirling of Rotating Shafts, Vibration Isolation and Force Transmissibility, Response of vibrating Systems under Coulomb and hysteresis damping, Vibration Measuring instruments, Accelerometer and vibrometer.

Two Degree of Freedom System: Free vibrations of Undamped Systems, torsional Systems, Coordinate Coupling and Principal Coordinates, damped free Vibrations, Forced vibrations of Undamped Systems, Forced vibrations with harmonic excitation, Dynamic Vibration Absorber, Orthogonality principle, Generalized co-ordinates

Multi degree of Freedom System: **U**ndamped free vibration of multidegree of freedom system, Classical method, flexibility influence coefficients and stiffness Influence coefficients, Stiffness matrix, Matrix iteration method, Adjoint of Matrix Method, Orthogonality Principle, Analysis of multi degree of freedom system by numerical method, Rayleigh`s upper bound approximation and Dunkerley`s lower bound approximation.

Critical speed of shafts: Whirling of uniform shaft, Critical speed of a light shaft with single disc without Damping, Critical speed of shaft with multiple discs, Secondary critical speed.

Texts/Reference:

1. Gowda: Mechanical Vibrations: McGraw-Hill, 1/e
2. Kelley: Mechanical Vibrations (SIE) (Schaum's Outline)
3. I.E. Morse And Hinkle: Mechanical Vibration- theory & application: CBS Publishers New Delhi
4. W. T. Thomson: Theory of Vibration with Application: CBS Publishers New Delhi
5. G. K. Grover: Mechanical: New Chand & Brothers, Roorkee
6. K. Pujaria: Vibration and Noise For Engineers: Dhanpat Rai & Sons
7. J. S. Rao & G. K.Guptam: Introductory Courses On Theory And Practice of Mechanical Vibration: Willey Eastern Publishing Ltd
8. Rao V. Dukkipati, J. Srinivas: Mechanical Vibrations: Prentice Hall India
9. R. K. Singal: Mechanical Vibrations: S. K. Kataria & Sons

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ME 1443	**COMPRESSOR AND GAS TURBINE**	L T P C
	(Departmental Elective-III)	3 0 0 6
	Eighth Semester	
	(Mechanical Engineering Branch)	
	Pre-requisite- ME 1206, ME 1302, ME 1306, ME 1402	

Gas Turbine Cycles: Analysis of closed and open cycles gas turbines, thermal refinement of gas turbine cycles, regeneration, reheating and intercooling, comparison between open and closed cycles gas turbines, combined steam and gas turbine cycle and its analysis**.**

Propulsion systems: Various types of propulsion devices, turbojet, turboprop and Ram jet engine, thrust power, propulsion efficiency, overall efficiency, effect of altitude, thrust augmentation, rocket propulsion ,liquid propellant and solid propellant rocket engines, uses of rocket propulsion devices.

Principles of rotating machines: General energy equation, review of concept of of static and stagnation head properties, review of concept of aerofoil theory, flow and pressure distribution over aerofoil sections.

Centrifugal compressor: Basic components, working principle, velocity triangle, enthalpy-entropy diagram, slip, power input factor, compressor efficiency, pressure coefficient, flow coefficient, degree of reaction, pre-whirl, effect of impeller blade shape on performance, vaned and vaneless diffuser, phenomenon of surging and choking.

Axial compressor: Basic components, principle of working, velocity triangle, enthalpy-entropy diagram, work done factor, degree of reaction, polytropic efficiency, pressure coefficient, flow coefficient, compressor stalling.

Axial and radial flow turbines: Enthalpy-entropy diagram, turbine and nozzle efficiencies, blade speed ratio, velocity ratio and torque, velocity compounded turbine, reaction turbine, reheat factor, working principle of radial flow turbine, comparison of turbine types.

Gas turbine fuels and combustion chamber: Fuels for gas turbines, combustion mechanism, combustion efficiency, combustion chamber requirements, types of combustion chambers, combustion chamber pressure loss.

Gas turbine blade materials: Different blade materials for gas turbine, factors influencing the selection of blade materials, cooling of blades, different types of cooling.

Performance of gas turbine power plants and its application in different fields: Performance characteristics of compressor and turbine, matching of components, equilibrium running diagram, application of gas turbines in different field

Texts/Reference:

1. By Ganesan: Gas Turbine: McGraw-Hill Education, 3/e:
2. S.M. Yahya: Turbines, Compressors and Fans: Satyaprakashana Publishers, New Delhi, 4/e
3. H Rogers: Gas turbine theory: Pearson education
4. Khajuria and Dubey: Gas turbine and Propulsive Systems: DhanpatRai and Sons

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ME 1444	**CONVECTIVE HEAT AND MASS TRANSFER**	L	T	P	C
	(Departmental Elective-III)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1207, ME 1302, ME 1309, ME1471

Conservation equations and boundary conditions, One-dimensional solutions, Heat transfer in laminar developed and developing duct flows, Laminar boundary layers, Similarity and integral solutions, Turbulence fundamentals and modeling, Heat transfer in turbulent boundary layers and turbulent duct flows, Laminar and turbulent free convection, Fundamentals of boiling and condensation, Numerical methods.

Text/Reference:

1. W. M. Kays & E. M. Crawford: Convective Heat & Mass Transfer: McGraw-Hill
2. Louis C Burmeister: Convective Heat Transfer

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ME 1445	**PRODUCTION PROCESS**	L	T	P	C
	(Departmental Elective-III)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1203, ME 1303, ME 1307

Producibility, Automation and Design principles: Processes, Costs and Producibility, Automation and Design principles, Design for Assembly, Measuring and Gauging Parts, Design for N/C, Design for recycling.

Metal Removal Methods: Flame Cutting, Contour Sawing, Planing, Shaping and Slotting, Automatic and Shape Turning, Turret Lathe Machining, Automatic Bar and Chucking Machining, Swiss Automatic Machining, Production Milling, Drilling and Boring, Hobbing, Broaching, Gear Shaper Generating, Abrasive Belt Grinding, Production Grinding, Mass finishing, Honing, Lapping, Super finishing.

Metal Forming Methods: Metal Spinning, Brake Forming, Roll Forming, Section Contour Forming, Stamping, Deep Drawing, Rotary Swaging and Hammering, Wire Forming.

Metal Working and Forging Methods: Die forging, Hot Upsetting, Die Rolling, Hot Extrusion, Cold and Impact Extrusion, Cold Drawing, Cold Heading, Thread and Form Rolling.

Metal Deposition Methods: Electroforming, Metal Spraying.

Casting Methods: Sand Casting, Permanent Mould Casting, Centrifugal Casting, Die Casting, Plaster Mould Casting, Investment Casting.

Moulding Methods: Powder Metallurgy, Plastic Moulding, Rubber Moulding, Ceramic Moulding.

Fabrication Methods: Welding, Spot Welding, Seam Welding, Projection Welding, Butt Welding, Brazing.

Treating Methods: Heat Treating Steels, Heat Treating Non-ferrous Metals, Shot Peening.

Unconventional Methods: Chemical Machining, Electric Discharge Machining.

Finishing Methods: Drawing Finish Notes, Cleaning, Powder Brushing, Polishing and Buffing, Painting and Coating.

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Texts/Reference:

1. Rozer William Bolz: Production Processes: The Productivity Hand BookL 5th Edition, Industrial Press Inc.
2. Parashar, B.S. Nagendra, Mittal, R. K: Elements of Manufacturing Processes: PHI
3. NIIT: An Introduction to Engineering Materials and Manufacturing Processes: PHI
4. Kaushish: Manufacturing Processes: PHI, 2/e
5. P.C. Pandey and H.S. Shah: Modern Machining Process: Tata McGraw Hill
6. Lindberg: Process and Materials of Manufacture:– PHI, 4th Ed
7. Degramo, Kohser and Black: Materials and Processes in Manufacturing: PHI, 8th Ed
8. Amstead Ostwald, and Bageman: Manufacturing Processes: John Wiley and sons.
9. HMT: Production Technology

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ME 1446	**TOTAL QUALITY MANAGEMENT**	L	T	P	C
	(Departmental Elective-III)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1401, ME 1425

Introduction: Definition of TQM, Principles of TQM, operational model, TQM system, organization, structure for TQM.

World Class Quality & TQM: Customer focus, strategic quality planning, executive leadership, managing for quality, outcome & financial gains; measurement & management – prescriptive to Realistic approach; improved measurement systems.

Tools & techniques: 5-S campaign, TQC, Total employee involvement (TEI), problem–solving process, Quality Circles (QC), statistical tools in quality control, quality function deployment (QFD); House of quality – product planning matrix, Taguchi technique, failure mode & effect analysis (FMEA), Poka-Yoke, Kaizen, PDCA cycle.

Process capability, Just- in -time (JIT) & TQM: quality production through JIT & Kanban, JIT methods – Waste & its elimination, Jidoka, TPM, TQM Implementation barriers, Total Customer Satisfaction (TCS), Implementing TQM – Case studies

Evaluation of standards & ISO-9000 series of standards: History of standards, ISO-9000 series of standards, structure of ISO-9000 series, Benefits of ISO-9000 series.

ISO-9001 Quality Management System: Management responsibility, quality system, contract review, design control, document & data control, product identification & traceability, process control,

inspection & testing, control of non-conformity products, corrective & preventive action. Quality records, quality audits, training, servicing

Texts/Reference:

1. Grant: Statistical Quality Control: McGraw-hill, 7e
2. Jivan: Quality Planning & Analysis
3. Feigenbaum AV: Total Quality Control
4. Ishikawa: What is TQC
5. R. P. Mohanty & R R Lakhe: Hand book of TQM

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ME 1447	**EXPERIMENTAL STRESS ANALYSIS**	L	T	P	C
	(Departmental Elective-III)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1208, ME 1209, ME 1423, ME 1427

Strain Analysis Methods: Three element rectangular strain rosette, correction, stress gauges, over-deterministic methods for strain analysis, residual stress determination Applications: Application of strain gauges for measurement of load, temperature, pressure, vibration, stress and strain etc.

Optical Methods of Stress Analysis: Basic of Optics, Optical Instrumentation Moire Fringe technique-theory and experimental procedures, Fractional fringe measurement- Tardy's Method Babinet Soleil Method.

Theory of Photoelasticity: Polariscope- Plane polariscope, Circular polariscope, Different Arrangements photoelastic photography, Photoelastic materials-properties, selection, casting methods, calibration. Analysis Techniques-Determination of direction of Principal stresses at given point, Determination of exact fringe order N and the principal stress Separation methods, Method based on Hooke's Law, Electrical analogy method, Oblique incidence method, Shear difference method, Scaling model results to prototype Application of photoelasticity to 2-D and 3-D Stress analysis

Optical methods for Determining Fracture Parameters: Irwins methods, application of moiré and isopachic fringe pattern to determine stress intensity factor, mixed mode intensity factors

Coating Techniques: Bifringent coating- stress-optic and strain-optic relation, sensitivity and coating materials, fringe order determination. Brittle coating technique. Strategy.

Holography: Plane and spherical waves - coherence - holographic setup – Interferometry - Displacement measurement - obtaining Isopachics,

Texts/Reference:

1. Budynas: Advance Strength & Applied Stress Analysis: McGraw-Hill, 2/e
2. R. S. Sirohi, HC Radhakrishna: Mechanical Measurements: New Age International (P) Ltd. 1997
3. F. K Garas, J.L. Clarke and GST Armer: Structural Assessment: Butterworths, London, 1987
4. Dove and Adams: Experimental Stress Analysis and Motion Measurement: Prentice Hall of India, 1965
5. Sadhu Singh: Experimental Stress Analysis: Khanna Publishers, New Delhi, 1996

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ME 1451	**COMPUTATIONAL FLUID DYNAMICS**	L	T	P	C
	(Departmental Elective-IV)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1207, ME 1302, ME 1309, CS 1101, MA1101, MA1102, MA1201

Goals of CFD; Problem definition and sources of error; Spatial discretization- interpolation and function approximation, method of weighted residuals for function approximations, Fourier (spectral) interpolation and function approximation, derivatives of functions, finite volume and finite difference schemes for linear/non linear & incompressible/compressible flows; Solution of systems of equations- classical iterative techniques, introduction to multigrid, basic convergence analysis; Navier-Stokes equations- Discretization methods and grids, performance metrics, designing methods, pressure in incompressible flow, implicit convection, specific methods for incompressible flow- fractional step, stream function /vorticity form; turbulence modelling

Texts/Reference:

1. Anderson: Computational Fluid Dynamics: McGraw-Hill Publisher
2. Wendt, John F: Computational Fluid Dynamics: Springer Verlag publication, 3rd Ed
3. Joel H. Ferziger & Milovan Peric: Computational Methods for Fluid Dynamics: Springer Verlag publication
4. S. Patankar: Numerical Heat Transfer and Fluid Flow: Taylor & Francis publication
5. P. Niyogi, S. K. Chakrabartty & M. K Laha: Introduction to Computational Fluid Dynamics: Pearson publication

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ME 1452	**ENERGY ENGINEERING AND MANAGEMENT**	L	T	P	C
	(Departmental Elective-IV)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1206, ME 1309, ME 1402

Trends in energy use patterns, energy and development linkage. Energy economics – simple payback period, time value of money, IRR, NPV, life cycle costing, cost of saved energy, cost of energy generated, examples from energy generation and conservation, importance of energy management. Energy audition: methodology, analysis of past trends plant data, closing the energy balance, laws of thermodynamics, measurements, portable and on line instruments. Energy economics – discount rate, payback period, internal rate of return, life cycle costing. Steam systems: Boiler – efficiency testing, excess air control, steam distribution & use steam traps, condensate recovery, flash steam utilization. Thermal Insulation. Electrical systems: Demand control, power factor correction, load scheduling/shifting, motor drives motor efficiency testing, energy efficient motors, motor speed control. Lighting – lighting levels, efficient options, fixtures, daylighting, timers, energy efficient windows. Energy conservation in pumps, fans (flow control), compressed air systems, refrigeration & air conditioning systems. Waste heat recovery: recuperators, heat wheels, heat pipes, heat pumps. Cogeneration-concept, options (steam/gas turbines/diesel engine based), selection criteria, control strategy. Heat exchanger networking-concept of pinch, target setting, problem table approach, composite curves. Demand side management. Financing energy conservation.

Texts/Reference:

1. World energy assessment: Energy and the Challenge of Sustainability: UNDP, New York
2. A. K. N. Reddy, RH Williams, TB Johanson,: Energy after Rio, Prospects and challenges: UNDP, United Nations Publication, New York, 1997
3. Arnulf Grubler and Alan McDonald edited by Nebojsa Nakicenovic: Global energy perspectives: Cambridge University Press, 1998

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ME 1453	**ADVANCED MACHINING PROCESS**	L	T	P	C
	(Departmental Elective-IV)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1303, ME 1307

Introduction, characteristics, and need of advanced machining processes, classification.

Mechanical Processes: Abrasive Jet Machining (AJM) – Operating principle, equipments, process parameters, applications and limitations.

Ultrasonic Machining (USM) – Working principle, equipments, transducers, amplifications, concentrator, feed mechanism, acoustic head clamping, process parameters, applications and limitations.

Water Jet Machining (WJM) – Operating principle, equipments, process parameters, applications and limitations.

Abrasive flow machining (AFM) - Working principle, equipments, process capabilities and applications.

Chemical Processes: Chemical Machining (CHM) – Operating principle, equipments, applications and limitations.

Electrochemical Machining (ECM) – Operating principle, equipments, power supply and control, tool design, process parameters, applications and limitations.

Electrothermal Processes: Electrical Discharge Machining (EDM) – Operating principle, electrode materials, dielectric fluid, gap flushing, equipments, different EDM operations, power generator, WEDM, process parameters and their effects, applications and limitations.

Laser Beam Machining (LBM) – Laser fundamentals and the industrial lasers, lasing materials, processing with lasers, machining applications of laser.

Electron Beam Machining (EBM) – Process, equipments, process parameters, applications and limitations.

Plasma Arc Machining (PAM) –Principle of plasma arc, plasma arc torches, process parameters, advantages and disadvantages.

Ion Beam Machining (IBM) – Process, beam source, ion guns, IBM setup, operating principle, process parameters, applications.

Texts/Reference:

1. Pandey: Modern Machining Process: McGraw-Hill
2. G. F. Benedict, Marcel Dekker Inc: Nontraditional Manufacturing Processes
3. P. K. Mishra: Nonconventional Machining: Narosa Publishing House

4. A. Ghosh & A. K. Mallik: Manufacturing Science: Affiliated East-West Press Pvt. Ltd.
5. G. Boothroyd & W.A. Knight: Fundamentals of Machining and Machine Tools: CRC Press, Taylor & Francis Group
6. J. A. McGeogh: Advanced Methods of Machining: Chapman & Hall

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ME 1454 **AIR CONDITIONING** L T P C

(Departmental Elective-IV) 3 0 0 6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite-ME 1206, ME 1421

Psychometry & Psychrometric Processes: Psychrometric properties, Representation of psychrometric properties in charts, Preparation of psychrometric chart, Constant sensible and latent heat processes, Adiabatic saturation, Adiabatic mixing of air streams, Air-Washer, Sensible heat factors, Apparatus dew point, By pass factor, Humidifying efficiency.

Load Calculations: Inside and outside design conditions, Load classification, Summer cooling loads, Introduction to the methods of calculating cooling load and heating load.

Comfort Air conditioning: Various comfort indices, Effective temperature, Parameters governing human comfort, Comfort charts and its limitation.

Duct Design And Air Distribution: Pressure drop calculation for various types of duct, Enlargements, Contractions, Branch tube- offs etc., Duct design methods – velocity deduction, equal friction and static regulation, Duct design procedure – dynamic loss coefficient method, equitable length method, air distribution system in rooms, supply and return grills, Air distribution terminology.

Air Conditioning Systems: Central and unitary air conditioning, Special features of residential, commercial and industrial air conditioning system, Year round air conditioning.

Texts/Reference:

1. C.P. Arora: Refrigeration and Air conditioning
2. M. Prasad: Refrigeration and Air conditioning
3. Stocker & Jones: Refrigeration and Air conditioning
4. Jordan & Preister: Refrigeration and Air conditioning
5. P.N. Ananthanarayan: Refrigeration and Air conditioning
6. S.K. Kulshrestha: Refrigeration and Air conditioning
7. ASHRAE: ASHRAE Hand Book of Fundamentals

8. M. Prasad: Refrigeration and Air conditioning Data Book
9. W. Jones: Air Conditioning

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ME 1455	**DESIGN OF MECHANICAL SYSTEMS**	L	T	P	C
	(Departmental Elective-IV)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1304, ME 1308, ME 1401, ME 1434

Engineering process and system approach: Basic concepts of systems,Attributes characterizing a system, system types, Application of system concepts in Engineering, Advantages of system approach, Problems concerning systems, concurrent Engineering.

Problem Formulation: Nature of engineering problems, Need statement, hierararchial nature of problem environments, problem scope and constraint.

A case study: Heating duct insulation system, High speed belt drive system.

System theories: System analysis, Black box approach, state theory approach, component integration approach, Decision process approach, A case study – automobile instrumentation panel system.

System Modelling: Need of modelling, model types and purpose, linear systems

Mathematical modeling, concepts, A case study compound bar system.

Graph modeling and analysis: Graph modeling and analysis process, path problem, Network flow problem,

A case study: Material handling concept.

Optimization concepts: Optimisation processes, selection of goals and objectives – criteria, methods of optimization, analytical, combinational, subjective.

A case study: Aluminium extrusion system.

System evaluation: Feasibility assessment, planning horizon, time value of money, Financial Analysis.

A case study: Manufacture of maize starch system.

Calculus Method for optimization: Model with one decision variables, model with two decision variables, model with equality constraints , model with inequality constraints,

A case study: Optimization of an insulation system.

Decision Analysis: Elements of a decision problem, decision making, under certainity, uncertainity and conflict probability, density function, expected monetary value, utility value, Bayes theorem.

A case study: Installation of machinery.

System simulation: Simulation concepts, simulation models, computer application in simulation, simulation process, problem definition, input model construction and solution, limitation of simulation approach.

A case study: Inventory in production plant.

Texts/Reference:

1. Ullmann: Mechanical Design Process: McGraw-Hill, 4/e
2. D D Reredith, KV Wong, RW Woodhead, and Rrworthman: Design and planning of engineering systems: Prentice hall inc: Eagle wood cliffs, New Jersey
3. J R Dixon: Design Engineering: New Delhi.
4. S S Rao: Optimization technique
5. Divid I Cleland, William R kind: System Analysis and project management: McGraw Hill.
6. Robert Matousck: Engineering Design: Blackie and son ltd., Glasgow.

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ME 1456	**TRIBOLOGY**	L	T	P	C
	(Departmental Elective-IV)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1204, ME 1301, ME 1308

Introduction: Historical background and introduction to Tribology of bearings.

Properties and Testing of Lubricants: Types of lubricants and their properties, Viscometry.

Basic equations: The generalized Reynolds Equation, Continuity Equation, Energy Equation

Idealized Hydrodynamic Bearings: Mechanism of Pressure Development, Plane slider Bearing, Idealized slider bearing with a pivoted shoe, Step bearing, Infinitely long journal bearing, Infinitely short journal bearing.

Finite Bearings: Analytical and Numerical Solution, Cavitation and cavitation boundary condition.

Oil Flow and Thermal equilibrium: Circumferential flow and axial flow, Heat generation and heat balance, effective temperature of lubricant..

Bearing Design: Practical considerations in bearing design, Design of journal bearings

Squeeze Film bearings: Parallel surface bearing, step bearing, some situation under squeeze film lubrication

Hydrodynamic Instability: Mechanism of hydrodynamic Instability, Stiffness and damping coefficients

Externally pressurized Oil Bearings: Systems of hydrostatic lubrication, Circular step bearings

Gas-lubricated Bearings: Governing equations, Limiting solutions, Finite journal bearings, perturbation method.

Intorduction of Elastohydrodynamic: Lubrication, Surface Roughness, Effect on Hydrodynamic Bearings and Elastohydrodynamic Line contacts. Ball Bearings, Roller Bearings.

Friction of Metals: Laws of friction, Friction Theories, Frictional heating Effect of sliding speed on friction

Wear of Metals: Classification of wear, Mechanism of wear, Quantitative laws of wear

Texts/Reference:

1. B. C. Majumdar: Introduction to Tribology of Bearings: A. H. Wheeler & Co. Ltd., New Delhi,1999
3. A. Cameron and C. M. Mc Ettles: Basic Lubrication Theory: Wiley Eastern Ltd., New Delhi, 1987.

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ME 1457	**MATERIAL HANDLING SYSTEMS**	L	T	P	C
	(Departmental Elective-IV)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1202, ME 1304, ME 1308, ME 1433, ME 1475

Materials Handling and Storage: Introduction, Scope and Application of Material Handling, Function of material handling, Principles of Material Handling, Factors for Consideration in Material Handling System Design (Engineering factors, economics factor), Roles and Responsibilities of Manager/Supervisor/Foreman, Employees, Material Handling Department, General Requirements such as Personal Protective Equipment, Operating Requirements, Manual Material Handling, Maintenance Requirements

Facilities Design: Site Selection- Factors influencing the selection, rural and urban locations, Optimum decision on choice of site and analysis. Plant Layout- Types of production, types of layouts, advantages and disadvantages of layout, factor affecting layout, systematic layout planning

Material Handling Devices and Equipments: Vertical devices, Horizontal devices, Combination devices, Material Handling Equipment- Storage and handling equipment, Engineered systems, Industrial trucks, Bulk material handling, On-Rails Transfer Cart, Conveyors, Slings, Pallets, Cantilevered Crane Loading Platform, Cranes, Hoists & Auxiliary Equipment, Excavation Equipment

Material Handling System: Unit Load Principle, Unit load specification, Throughput, Response time, Cost, Space and cube utilization, Flexibility, Expandability

Material Handling Costs: Total Cost of Ownership, Initial purchase price, Operating expenses (fuel, disposables, etc.), Maintenance costs, Direct and indirect labour costs, Miscellaneous associated costs, Training, Insurance, Damage costs

Automated Material Handling: Introduction to Automated Guided Vehicles (AGVs), Components of AGVs, Types of AGVs, Guidance Systems for AGVs, Routing of AGVs, AGVs Control Systems, Robotic Applications in the Industry, Double-Gripper Robot in a Single-Machine Cell

Automation and Transfer Machine: Manufacturing system (Mass production, large scale production, small scale production), Conventional machine layout, Flow line system, Transfer machine (in-line transfer machine, rotary indexing table transfer machine, drum type transfer machine), constructional features of a transfer machine

Hazards & Hazard Controls and Safety: Definitions, Requirements, Potential hazards for workers, Storage hazards, Lifting Hazards and Safe Lifting Techniques, Safe Material Stacking, Safe Material Storage, Role of Ergonomics in Safe Materials Handling, Proper Use of Mechanical Material Handling Equipment, Application of Hazard Controls in Materials Handling and Storage, Safety and Health Principles, fire safety

Texts/Reference:

1. Courtney: Mechanical Behavior of Materials: McGraw-Hill, 2/e
2. Robert M Eastman: Materials Handling: Taylor & Francis publishing
3. K C Arora: Aspects of Materials Handling: Laxmi publishing.
4. Allegri: Materials Handling Principles and Practice: CBS publishing.
5. Sidhartha Ray: Introduction to Materials Handling: New Age International Publishing.
6. Richard Platts: Computing Needs for Automated Material Handling: Blackwell Publishing
7. John R Immer: Materials Handling: McGraw-Hill, publishing.
8. Matthew P Stephens, Fred E Meyers: Manufacturing Facilities Design and Material Handling: Prentice Hall Publishing, 4th Edition
9. K H E Kroemer, Karl Kroemer: Ergonomic Design for Material Handling Systems: CRC Press Publishin
10. Ray T K: Mechanical Handling Of Materials: Asian Books Pvt Ltd Publishing

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ME 1461	**NONCONVENTIONAL ENERGY**	L	T	P	C
	(Departmental Elective-V)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1201, ME 1206, ME 1207, ME 1302, ME 1402

Introduction: Various non-conventional energy resources, potential of renewable energy sources-global as well as Indian scenario.

Solar energy: Solar radiation, measurement of solar radiation, solar collector-flat plate and concentrating, collector efficiency, storage of solar energy, application of solar energy. Solar PVS

Wind energy: Principles of wind energy conversion, various types of wind machines.

Energy from bio-mass: Bio-mass conversion technologies, different types of bio gas plants, thermal gasification of boi-mass.

Geothermal energy: Geothermal resources, advantages and disadvantages over other non-conventional energy resources.,

Energy from the ocean: Ocean thermal energy conversion, open and closed cycle, hybrid cycle, introduction to tidal energy.

Hydrogen energy: Production, storage of hydrogen energy, application.

M H D power generation: Principle of MHD power generation, open and closed cycle systems.

Texts/Reference:

1. Khan B.H: Non-Conventional Energy Resources: McGraw-Hill, 2e
2. Sukhatme: Solar Energy : Principles of Thermal Collection and Storage: McGarw-Hill
3. Grag: Solar Energy: Fundamentalsand Applications: McGraw-Hill, 1st Revised Edition)
4. Kristoferson, LA & Bokalders, V Pergamon: Renewable energy Technologies
5. S Hasan Saeed & D.K. Sharma: Non-conventional Energy Resources: S.K. Kataria & Sons.

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ME 1462	**VISCOUS FLUID FLOW**	L	T	P	C
	(Departmental Elective-V)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1207, ME 1302

Preliminary concepts, Conservation of mass, momentum and energy, Exact solutions of the viscous flow equation : Couette flows, Poiseuille flow through ducts, unsteady duct flows, Laminar boundary-layers integral analysis and similar solutions, Laminar free- shear flows: jet, wake and plume, Stability of laminar flows, Turbulent flow : fundamentals, Reynolds- averaged equations, velocity profile in well- bounded flows, turbulent flow in pipes and channels, turbulent free- shear flows (jet, wake and plume), Turbulence modelling: zero, one, two equation models of turbulence, Numerical methods.

Texts/Reference:

1. Frank M White: Viscous Fluid Flow: McGraw Hill Publication, 3rd Ed

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ME 1463	**ADVANCED REFRIGERATION SYSTEMS**	L	T	P	C
	(Departmental Elective-V)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME1206, ME 1421

Air-Craft Refrigeration System: Simple, Boot-strap, Regenerative and reduced ambient system, Actual cycles, Comparison and selection of air-craft refrigeration systems, Advantages and disadvantages.

Vapour Compression System: Actual cycle and its deviation from theoretical cycle, Compound compression systems, Multiple evaporator systems, Binary refrigeration systems, Production of dry ice, Thermodynamic analysis of these systems, practical applications.

Vapour Absorption System: Thermodynamic analysis of practical VAR system, Components, Single-stage and multi-stage Aqua- ammonia VAR system, Single-stage and multi-stage Lithium- Bromide-Water VAR systems, Three-fluid systems.

Non-Conventional Refrigeration System: Steam jet refrigeration system, Thermometric refrigeration system, Vortex- tube refrigeration system, Thermodynamic analysis of these systems, Merits and demerits of each system and their applications.

Refrigerants: Important refrigerants and their comparisons, Selection of refrigerants, Effect of environmental regulations on selection of refrigerants, Replacement, recycling of refrigerants.

Refrigerating Equipments: Compressors, Condensers, Expansion devices, Evaporators, Pipings, Line valves, Solenoid valves, Oil separators, Defrosting, Filters, Moisture indicators, purging 2 T.P. & controls.

Application of Refrigeration: Domestic, commercial, industrial, transport, and medical refrigeration, Preservation of food spoilage, Method of preservation, Cold- storage, Low temperature refrigeration.

Texts/Reference:

1. C.P. Arora: Refrigeration and Air conditioning
2. M. Prasad: Refrigeration and Air conditioning
3. Stocker & Jones: Refrigeration and Air conditioning
4. Jordan & Preister: Refrigeration and Air conditioning
5. P.N. Ananthanarayan: Refrigeration and Air conditioning
6. S.K. Kulshrestha: Refrigeration and Air conditioning
7. ASHRAE: ASHRAE Hand Book of Fundamentals
8. M. Prasad: Refrigeration and Air conditioning Data Book

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ME 1464	**METAL CUTTING AND CUTTING TOOL DESIGN**	L	T	P	C
	(Departmental Elective-V)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1303, ME 1435,

Tool geometry, The essential features of metal cutting, the chip, technique for study of chip formation, chip shape, chip formation, the chip tool interface, chip flow under condition of seizure, Merchant circle diagram, stress on the shear plane, forces in flow zone, the shear plane angle and minimum energy theory, tool wear, types of tool wear, tool life criteria, work-piece interaction in machining tests, design of the tool shape on the basis of machining responses.

Texts/Reference:

1. A, Bhattacharyya: Metal cutting, Theory and practice: Central book publishers, 8/1, Chintamoni Das Calcutta
2. E.M. Trent: Metal Cutting: Butterworths
3. K.P. Sinha, S.C. Prasad: Theory of Metal Forming and Metal Cutting: Dhanpat Rai & Sons

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ME 1465	**THEORY OF ELASTICITY AND PLASTICITY**	L	T	P	C
	(Departmental Elective-V)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1209, ME 1423

Theory of Elasticity: Concept of stress, stress tensors, equilibrium equations, octahedral stresses, concept of strain, strain tensors, generalized Hooke's law, elastic strain energy.

Constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases.

Transformation of stress and strain at a point, Principal stresses and principal strains, invariants of stress and strain.

Plane stress and plane strain: Airy's stress function approach to 2-D problems of elasticity, simple problems.

Solution of axi-symmetric problems, stress concentration due to the presence of circular hole in plates.

Elementary problems of elasticity in 3-D, stretching of a prismatic bar by its own weight, torsion of circular and non-circular shafts, membrane analogy.

Theory of Plasticity

Introduction to ideally plastic solids: Ideally plastic solid, stress space and strain space, General nature of the yield locus, Yield surfaces of Tresca and Von Mises, plastic work, effective stress, effective strain, stress-strain relations (plastic flow), principle of normality, Prandtl-Reuss equations, Saint Venant – Von Mises equations, incremental and deformation theories, convexity of yield surface.

Theory of instability during plastic deformation.

Slip line field theory: introduction, basic equations for incompressible two dimensional flow, stresses in conditions of plain strain, convention for slip lines, solutions of plastic deformation problem, Geometry of slip line field, Properties of the slip lines, construction of slip line fields and hodographs.

Elastic-Perfect Plasticity: Introduction, elastic-plastic bending of beams, elastic-plastic torsion, thick-walled, pressurized cylinder, thin disc under pressure and rotating disc.

Texts/Reference:

1. Timoshenko & Goodier: Theory of Elasticity: McGraw Hill
2. Srinath L. S: Advanced Mechanics of Solids: Tata McGraw Hill
3. Popov EP: Introduction of Mechanics of Solids: PHI Pvt. Ltd, New Delhi
4. Chakraborty: Theory of Plasticity: Elsevier
5. Narayanasamy and Ponalagusamy: Theory of Engineering Plasticity: Ahuja Book Co. Pvt. Ltd
6. Rees D.W.A: Basic Engineering Plasticity: Elsevier

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ME 1466	**AIR CONDITIONING SYSTEM DESIGN**	L	T	P	C
	(Departmental Elective-V)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1206, ME 1309, ME 1421, ME 1434

Psychrometric Processes: Review of psychrometric properties, Review of psychrometric processes.

Design Conditions: Choice of inside and outside design conditions, Parameters governing human comfort, Various comfort indices, Choice of supply design conditions, Clean spaces.

Design of Air Conditioning Apparatus: Design of cooling and dehumidifying coils, Air washer and Cooling Towers.

Load Analysis: Inside and outside design conditions, Load classification, Summer cooling loads, Solar terminology, Sun motion, Solar angles and their relationships, Calculation of solar radiation intensities, Solar heat gain through transparent bodies (e,g, glass), Transmission heat gain through building materials, Flywheel effect of building materials, Methods of calculating cooling load through building material, Loads due to human beings, Electric equipments and appliances, Infiltration and ventilation loads, Product loads, Miscellaneous loads such as duct heat gain, air leakage, pumps, Winter heat load- computation of loads, Cooling and heating load calculation methods.

Duct Design: Pressure drop calculation for various types of duct, Enlargements, Contractions, Branch tube- offs etc., Duct design methods – velocity deduction, equal friction and static regulation, Duct design procedure – dynamic loss coefficient method, equitable length method, Case studies on duct design.

Room Air Distribution: Air distribution terminology, air distribution system in rooms, supply and return grills, Case studies.

Air Conditioning Systems: Central and unitary air conditioning, Special features of residential, commercial and industrial air conditioning system, Year round air conditioning.

Equipments: Fans- types, characteristics, fan selection, Air filter and cleaner, Cooling tower, Condensers, Cooling coil and chemical dehumidifiers, Heaters, etc.

Instruments And Control: Temperature, Humidity, Air velocity measuring instruments, Thermostats, Humidistats, By pass and damper control, Dew point control, Noise control, Pneumatic control, etc.

Texts/Reference:

1. C.P. Arora: Refrigeration and Air conditioning
2. M. Prasad: Refrigeration and Air conditioning
3. Stocker & Jones: Refrigeration and Air conditioning
4. W. Jones: Air conditioning
5. P.N. Ananthanarayan: Refrigeration and Air conditioning
6. ASHRAE: ASHRAE Hand Book of Fundamentals

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ME 1467	**RAPID PROTOTYPING**	L T P C
	(Departmental Elective-V)	3 0 0 6
	Eighth Semester	
	(Mechanical Engineering Branch)	
	Pre-requisite- ME 1307	

Current Trends in Design and Manufacturing; the role of Rapid Prototyping and Rapid Tooling; General features and classifications of Generative Manufacturing Processes.

Two dimensional Layer by Layer Techniques: Stereo Lithography with photopolymerisation, liquid thermal polymerisation, solid foil polymerisation, selective laser sintering, selective powder binding, ballistic particle manufacturing, fused deposition modelling, shape melting, laminated object manufacturing, solid round curing, repeatative masking and deposition.

Three Dimensional Techniques for Rapid Prototyping: Beam Interference Solidification, Ballistic particle manufacturing, Holographic Interference Solidification.

Rapid Tooling: Techniques and procedures; Economics of Rapid Prototype and Rapid Tooling.

Texts/Reference:

1. Amitabha Ghosh: Rapid Prototyping - A Brief Introduction: East West Publishers
2. Frank W: Rapid Prototyping and Engineering Applications: A Toolbox for Prototype Development: Liou, Crc Press
3. Chua: Rapid Prototyping: Cambridge

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ME 1481	**ENTREPRENEURSHIP DEVELOPMENT**	L	T	P	C
	(Open Elective-II)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- HS 1301, HS 1201, ME 1401

Evolvement of entrepreneurship from economic theory, Entrepreneurship and characteristics of entrepreneurs, Need for education on entrepreneurship, Competency and entrepreneurial competencies.

Creativity as a prerequisite to innovation, Innovation and entrepreneurship.

Self-assessment and window Self-reflecting self- awareness, Decision-making, Leadership, Motivation.

Concept of a planning paradigm for a new venture, Founstase growth model, Fundamentals of feasibility plan.

An introduction to patents, trademarks and spy rights, intellectual property right, Business opportunity identification, Need, scope and characteristics of a small scale business industry.

Marketing concept, Fundamentals of marketing, Distribution, Promotion, Pricing, Marketing strategy, Break-even analysis.

Total quality management, ISO standards, Management information system, Concept of Intellectual Property Right (IPR), Patent, Copyright, and Trademark.

Project planning and preliminary project report.

Texts/Reference:

1. Shankar: Entrepreneurship: Theory & Practice: McGraw-Hill
2. Hisrich: Entrepreneurship, by: McGraw-Hill, (Special Indian Edition), 6e
3. A.K. Singh: Entrepreneurship Development & Management: Laxmi Publication
4. David H. Holt: Entrepreneurship: - new venture creation: Prentice Hall Publication

5. Randolph & Ponker: Effective Project Planning & Management: Longman Higher Education

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ME 1482	**HYDRAULIC MACHINES**	L T P C
	(Open Elective-II)	3 0 0 6
	Eighth Semester	
	(Mechanical Engineering Branch)	
	Pre-requisite- ME 1302, ME 1306	

Principles of Hydraulic Machines: Impulse momentum equation, Impact of jet force on stationary flat plates and curved vanes, Force on moving fixed plate and curved vanes, Force on a series of moving flat plates and curved vanes, Euler`s equation of turbo- machines, Jet propulsion of ships.

Hydro- electric Developments: Water wheels- their types and working principles, Advantages and disadvantages of water wheels, Development of water turbines- their classifications and working principles, Advantages of water turbines, Hydro-electric plants- their classification, essential components and layouts, Advantages of hydro- electric plants, Pumped storage plants.

Impulse Turbines: Work done by impulse turbine, Power produced by impulse turbine, Efficiencies of an impulse turbine, Design of Pelton wheel turbine, Other impulse turbines.

Reaction Turbines: Differences between an impulse and a reaction turbine, Classification of reaction turbines, Power produced by a reaction turbine, Efficiencies of reaction turbine, Francis turbine, Kaplan turbine, Cavitation in reaction turbines, Draft tubes, Types of draft tubes, Efficiencies of draft tube, Other reaction turbines.

Governing of Turbines: Purpose of governing, Elements of governing system, Double regulation of turbines, Governing of impulse turbines, Governing of reaction turbines, Relief valve or pressure regulator.

Performance of Turbines: Characteristic of turbines, Unit power, Unit speed and unit discharge, Specific speed of a turbine- their significances, Selection of turbines based on Head of water and also based on specific speed, Characteristic curves of turbines.

Reciprocating Pumps: Pumps and its classification, Reciprocating pump- types, discharge and power required, Slip of the pump, Indicator diagram, Variation of pressure in the suction and delivery pipes on the indicator diagram, Maximum speed of the rotating crank with air vessels, Work done against friction with or without air vessels, Work saved against friction.

Centrifugal Pump: Advantages of centrifugal pump over reciprocating pump, Components of centrifugal pump, Working of a centrifugal pump, Working by the impeller, Heads of pumps, Losses and efficiencies, Multistage centrifugal pumps, Specific speed, Characteristic of a centrifugal pump, Priming, Minimum starting speed, Selection of pumps, operational difficulties in centrifugal pumps.

Miscellaneous Types of Pumps: Multi- cylinder pumps, Rotary pumps, Air lift pumps, Jet Pumps, Gear pumps.

Hydraulic Devices: Hydraulic accumulator, Hydraulic intensifier, Hydraulic press, Hydraulic coupling, Torque converter, Hydraulic brakes, Hydraulic cranes.

Texts/Reference:

1. Subramanya: Hydraulic Machines: McGraw-Hill
2. Jagdish Lal: Hydraulic Machines: Metropolitan Publication
3. Banga & Sharma: Hydraulic Machines: Khanna Publishers
4. R.K. Bansal: Fluid Mechanics & Hydraulic Machines: Laxmi Publication, 9th Ed
5. Vasandani: Hydraulic Machines Theory & Design: Khanna Publishers
6. S.S. Rattan: Fluid Machines: Khanna Publishers

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ME 1483	**SOLAR ARCHITECTURE**	L	T	P	C
	(Open Elective-II)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- PH 1101, ME 1206, ME 1309

Thermal Comfort: General introduction, Parameters governing thermal comfort, Heat exchange of body with environment, Various comfort indices, Psychometric and psychometric chart, Comfort chart.

Climate & Solar Nomenclature: Climate change due to land, water, wind etc. Classification of climates, Sun motion, Solar angles and their relationships, Calculation of solar radiation intensities, Basic solar collectors, Shading devices.

Building with Solar Exposures: Various building forms and surface areas, Mutual shading of buildings, Building orientations with respect to sun, Efficiencies of building forms, Building fenestration and its effect.

Passive Concepts & Components: Passive heating concepts- direct gain, indirect gain, sun space and indirect gain, Passive cooling concepts – minimization of beam radiation, Thick walls and roofs, Evaporative cooling, Radiative cooling, Cavity walls, Exploitation of wind, water earth for cooling, Sky therm, Vary therm wall, Earth shattered structure, Earth – air tunnels, Ventilation components.

Heat Transfer in Buildings: Modes of heat transfer- basic concepts, Surface coefficients, Overall thermal transmittance for various walls and roofs, Heat transfer due to ventilation/infiltration, Intermittent heat transfer.

Mathematical Modelling of Passive Concepts: Approximate methods- degree day method, steady state method, Correlation methods, Analytical methods- thermal circuit analysis, Finite difference approach, Response factor method, Periodic solution method.

Evaporative Cooling: Historical background, Basic principle and classification, Climate conditions, Direct types of E.C, Indirect type of E.C, 2- stage E.C, Earth cooling, Earth air tunnel systems.

Typical Design of Solar Passive Buildings: Case studies – For cold climate- the hedge type, ware house type, solarium and trembe wall type etc. For tropical climate – skytherm systems, For arid climate and for humid climate.

Texts/Reference:

1. M. S. Sodha, N. K. Bansal & A. Kumar: Solar Passive Building- Science & Design
2. N.K. Bansal & G. Hanser: Passive Building Design- A Hand Book of Natural Climate Control
3. C.P. Arora: Refrigeration and Air conditioning
4. ASHRAE: ASHRAE Hand Book of Fundamentals

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ME 1484	**INTRODUCTION TO OPTIMUM DESIGN**	L	T	P	C
	(Open Elective-II)	3	0	0	6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1401, ME 1425, MA1101, MA1102, MA1201

Introduction: Need of optimum designs. Basic terminologies - design variables, objective functions, constraints, and variable bounds. Different types of optimization problems - single variable, multivariable, linear, non-linear, real/integer/discrete, single-objective, and multi-objective. Problem formulation. Fundamental concepts - global/absolute optimum point, local/relative optimum point, inflection point, and convex programming problems.

Single-variable unconstrained optimization: Graphical method. Exact method based on necessary condition. Direct search methods - bracketing the optimum point by exhaustive search method and bounding phase method, and refining the optimum point by interval halving method and golden section search method. Gradient-based methods - Newton-Raphson method, bisection method, and secant method.

Multi-variable unconstrained optimization: Fundamental concepts - gradient vector and Hessian matrix. Exact method based on necessary condition. Direct search methods - Simplex search method, Hooke-Jeeves pattern search method, and Powell's conjugate search method. Gradient-based methods - Cauchy's steepest decent method, Newton's method, and Marquardt's method.

Multi-variable constrained optimization: Linear programming problems - Graphical and Simplex methods. Non-linear programming problems - Kuhn-Tucker conditions and sensitivity analysis. Transformation methods - Penalty function method and method of multipliers (augmented Lagrangian method). Direct search methods - Variable elimination method, complex search method, and random search method. Gradient-based linearized methods - Taylor series expansion and unidirectional search, move limit method, Frank-Wolfe method, cutting plane method, and feasible direction method.

Integer programming Methods: Penalty function method, cutting plane method, and branch-and-bound method.

Texts/Reference:

1. Kalyanmoy Deb: Optimization for Engineering-Algorithms and Examples: Prentice-Hall of India Pvt. Ltd., New Delhi.
2. Ashok D. Belegundu and Tirupathi R Chandrupatla: Optimization: Concepts and Applications in Engineering: Pearson Education, New Delhi.
3. Christos H. Papadimitriou and Kenneth Steiglitz: Combinatorial Optimization: Algorithms and Complexity: Prentice-Hall of India Pvt. Ltd., New Delhi.
4. Conley. W: Computer Optimization Techniques: Pntrecelli Book, 1980

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ME 1485	**MEMS AND NANO-TECHNOLOGY**	L T P C
	(Open Elective-II)	3 0 0 6

Eighth Semester

(Mechanical Engineering Branch)

Pre-requisite- ME 1204, ME 1307, EE 1101, EC 1101

Overview of MEMS and microsystems, microelectronics, microfabrication, miniaturization, typical MEMS and microsystems products.

Working principles of microsystems: microsensors, microactuation, MEMS with microactuators, microfluidics, microvalves, micropumps, micro-heatpipes.

Overview of materials for MEMS and microsystems: atomic structure of matter, ions and ionization, doping of semiconductors, diffusion process, electrochemistry.

Microsystem fabrication: photolithography, ion implantation, diffusion, oxidation, chemical vapor deposition, physical vapor deposition, sputtering, etching.

Micromanufacturing: bulk micromanufacturing, surface micromanufacturing, LIGA process.

Assembly, packaging and testing of microsystems: overview of microassembly, microassembly processes, major technical problems of microassembly, microsystem packaging and its levels, essential packaging technologies, reliability and testing in MEMS packaging.

Nanotechnology: Introduction, introduction to physics of the solid state, properties of individual nano particles, carbon nano-tubes, and bulk nano structured materials.

Texts/Reference:

1. Mahalik: MEMS:, McGraw-Hill, 1/e
2. Tai-Ran Hsu: MEMS and Microsystems: Design, Manufacture, and Nanoscale Engineering: McGraw-Hill
3. Pradeep: A Textbook of Nanoscience and Nanotechnology: McGraw-Hill, 1/e
4. N. P. Mahalik: Micromanufacturing and Nanotechnology: Springer
5. Nadim Maluf, Kirt Williams: An Introduction to Microelectromechanical Systems Engineering: Artech House, Inc.
6. Mark Ratner, Danier Ratner: Nanotechnology: Pearson Education Inc.
7. Charles P. Poole Jr. & Frank J. Owens: Introduction to Nanotechnology: John Wiley & Sons, Inc.
8. Roger, Pennathur, Adams: Nanotechnology Understanding Small systems: CRC Press
9. Stephen Beeby, Graham Ensell, Michael Kraft, Neil White: MEMS Mechanical Sensors: Artech House, Inc.
10. Mohamed Gad-el-Hak: MEMS Introduction and Fundamentals: CRC Press

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