

## MECHANICAL ENGINEERING

5 <sup>th</sup> Semester				6 <sup>th</sup> Semester			
<i>Subject Code</i>	<i>Theory</i>	<i>Contact Hrs.</i>	<i>Credit C</i>	<i>Subject Code</i>	<i>Theory</i>	<i>Contact Hrs.</i>	<i>Credit C</i>
MA-301 OR CY-301	Optimization in Engg. OR Bio-Environmental Engg.	3-0-0	3	CY-301 OR MA-301	Bio Environmental Engg. OR Optimization in Engineering	3-0-0	3
ME-301	Mechanics of Solids	3-1-0	4	ME-310	Mechanical System Design	3-0-0	3
ME-351	Internal Combustion Engines	3-0-0	3	ME-352	Heat Transfer	3-1-0	4
ME-331	Metal Removal Processes	3-0-0	3	ME-332	Machine Tools and Tool Design	3-0-0	3
ME-313	Design of Machine Elements	3-0-0	3	ME-312	Machine Dynamics-II	3-0-0	3
ME-353	Theory of Turbo machineries	3-0-0	3	EL-I	Elective-I	3-0-0	3
	<b>TOTAL</b>	19	19		<b>TOTAL</b>	19	19
<i>Subject Code</i>	<i>Practicals / Sessional</i>	<i>Contact Hrs.</i>	<i>Credit</i>	<i>Subject Code</i>	<i>Practicals / Sessionals</i>	<i>Contact Hrs.</i>	<i>Credit</i>
ME-371	Machine Element Design Lab	0-0-3	2	ME-372	Heat Transfer and Machine Dynamics lab.	0-0-3	2
ME-373	Machine Shop	0-0-3	2	ME-380	Tool Design Project	0-0-3	2
ME-375	I.C. Engines & Hydraulic Machines Lab.	0-0-3	2	ME-374	Mechanical System Design Lab.	0-0-3	2
	Total	9	6		Total	9	6
	<b>Grand Total</b>	28	25		<b>Grand Total</b>	28	25

**MODULE-I (15 Hours)**

Two variable LP model, Graphical sensitivity analysis, The Simplex method, Computational details, Simplex algorithm, Artificial Starting solution, Degeneracy, Alternative optima, unbounded solution. Duality and Sensitivity analysis, primal Dual relation, Transportation Model, Non-traditional transportation model, Assignment model, Hungarian method, Networks, Shortest route problem, Maximal flow method.

**MODULE-II (13 Hours)**

Integer linear programming, Illustration Branch & Bound Algorithm, Cutting-plane algorithm, Dynamics programming, Knapsack model, Decision analysis & Game Theory, Simulation modelling, Monte-Carlo simulation for discrete events.

**MODULE-III (12 Hours)**

Nonlinear programming, Unconstrained optimizations, unimodal function, Necessary & sufficient conditions, Newton Raphson method, constrained algorithm, Direct search method, gradient method.

**TEXT BOOKS**

1. H. A Taha, Operations Research: An Introduction, Pearson Education, (7<sup>th</sup> Edition); Ch-2[2.1,2.2 (2.2.1, 2.2.2), 2.3], Ch-3[3.1, 3.3, (3.3.1, 3.3.2) 3.4, 3.5], Ch-4[4.1, 4.2, 4.4 (4.4.1), 4.5 (4.5.1, 4.5.2)], Ch-5[5.1, 5.3(5.3.1, 5.3.2), 5.4(5.4.1)], Ch-6[6.1, 6.3 (6.3.1, 6.3.2), 6.4 (6.4.1, 6.4.2)], Ch-9 [9.1, 9.2(9.2.1, 9.2.3)], Ch-10 [10.3.1 Ch-14 :14.3, 14.4], Ch-18 [18.1, 18.4], Ch-20[20.1(20.1.1), 20.2 (20.2.1, 20.2.2) ], Ch-21[21.1]

**REFERENCE BOOKS**

1. F.S Hiller, G. J. Libermen, An Introduction to Operations Research: Concepts & Cases, (8<sup>th</sup> Edition), TMH Publication.
2. Kalyanmayee Dev, Optimization for Engineering Design, PHI Publications

**MODULE –I (22 hours)**

**Fundamentals of Ecology:** Components and structures of Eco-system. Levels of organization in the biotic components of the Eco-system. Eco-system processes- Energy flow-primary and secondary production, tropic level, food chain & food web and Bio-magnification. Decomposition and Nutrient Cycling- Biogeochemical cycles of nature- Carbon cycle, Nitrogen cycle and Hydrological cycle.

**Fundamentals of Chemistry and Microbiology**

Water chemistry : Concentration expressions, mole concept and Stoichiometry. Physical & chemical properties of water. Organic chemical properties and their measurement, parameters like BOD, COD, and TOC & TOD Inorganic properties like pH, Alkalinity, Hardness, conductivity and Solubility.

Atmospheric chemistry – structure of atmosphere, chemistry of primary and secondary air pollutants.

Chemical Reaction- Chemical & Bio-chemical Reactions fundamentals of reaction kinetics, Reactor configurations and material balances.

Microbiology – Important microbes in Environmental Engineering, Microbial growth and decay rates, Aerobic & Anaerobic group of bacteria.

**ENVIRONMENTAL POLLUTION**

Water Pollution:- Water quality standard and parameter (Indian Standard Drinking Water Specifications, IS 10500, 1991), Physical, Chemical and Biological methods of assessment of water

quality, Aquatic Pollution, Fresh Water Pollution:- Organic Pollution, Oxygen Sag Curve, Eutrophication and Acidification, Estuarine water quality, Marine Pollution and Ground water pollution. Parameters of organic content of water quality, DO and BOD in streams, Deaeration and Reaeration kinetics in streams (Streeter – Phelps oxygen sag formula)

Air Pollution:- Primary and Secondary pollutants, units of concentration, Global air pollution-Acid rain , Global warming and ozone layer depletion. Air pollution meteorology – Ambient and Adiabatic lapse rate, Atmospheric stability Lapse rates and Dispersion, Atmospheric Dispersion.

Noise Pollution: Sources of noise, Physical properties of sound, resultant and equivalent sound levels , Noise control measures and impact of noise on human health.

## **MODULE-II (14 Hours)**

### **ENVIRONMENTAL POLLUTION CONTROL**

Water Treatment:- Conventional water treatment comprising of Pre-treatment – Screenings, Aeration and Equalisation Primary Treatment – Sedimentation, Coagulation, Filtration Disinfection – Chlorination, Breakpoint chlorination Advanced water treatment – Fluoridation, Defluoridation, Ion-Exchange and Reverse Osmosis.

Wastewater Treatment (Domestic waste water) : Wastewater flow and characteristics Pretreatment-Screenings, Grit chamber, Equalisation and storage. Primary treatment – Sedimentation and coagulation Biological treatment (Aerobic) Activated Sludge Process (ASP) with complete mix reactor and design parameters. Biological treatment ( Anaerobic)

Municipal Solid Waste (MSW) : Physical, Chemical and Energy properties of MSW, MSW Management – Composting, MSW Management – Landfill Operations

Hazardous Waste Management: Characterization, Hazardous Waste Treatment – Incineration

Industrial Air Emission Control : Gaseous Emission Control – Absorption, Adsorption and Condensation, Particulate Emission Control – Gravity Settling Chamber, Cyclone Separator, Bag Filter and Electrostatic Precipitator, Flue gas desulphurisation, NO<sub>x</sub> Emission Control and Fugitive Emission

## **MODULE-III (6 Hours)**

### **ENVIRONMENTAL MANAGEMENT**

Evolution of environmental legislation in India, Environment, Development and Sustainable Development, ISO 14,000- Environmental Management Systems – Life Cycle Assessment

Elements of waste minimization- strategy-Reduction at source, Recycling/Reuse/ Recovery, Waste treatment and Disposal, Waste minimization program, Cost benefit analysis and advantage of clean technology

Environmental Impact Assessment

Stages of EIA procedure – Screening, Scoping, Environmental Impact Statement (EIS), Public Participation and Review, Generic Structure of EIA report:- Project Profile, Baseline Data Collection, Impact Prediction and Assessment, Environmental Management Plan (EMP) and Post EMP Monitoring.

### **TEXT BOOKS**

1. Gerard Kiely, Environmental Engineering, Tata McGraw Hill Publishing Company Limited
2. Peavy, Rowe and Tchobanoglous, Environmental Engineering, Tata McGraw Hill Company Ltd.1981,(International Edition).
3. C.S.Rao, Environmental Pollution Control Engg., Wiley Eastern Ltd, New Delhi,1999.

**Module – I (10 hours)****Basic notions and theorems of Mechanics of solids:**

Real object and design scheme; Representative volume; External and internal forces; Method of sections, Concept of stress tensor and strain tensor; Compatibility relations; Equations of equilibrium, Principal axes of strains and stresses; Principal strains; Principal stresses; Classification of stress and strain states (uniaxial, plane, three-dimensional), Stress and strain transformations, Mohr's circle.

**Mechanical properties of materials:**

Saint-Venant principle; Tensile test, Isotropic and Anisotropic materials; Stress-Strain curve; True stress and true strain; Main characteristics of stress-strain curve; Elasticity; Generalized Hooke's Law for isotropic material (multi axial loading); Elastic constants; Plasticity, Residual Stresses; Creep; Effect of temperature and time on mechanical characteristics of material.

**Failure criteria:**

Design considerations; Safety factor; Allowable stress; Equivalent stress; Maximum Shear-stress theory; Maximum Distortion-energy theory; Maximum Normal-stress theory; Mohr's theory; Comparison of the failure theories.

**Module – II (12 hours)****Axially Loaded Members:**

Stress Analysis in Axially loaded bars, Method of sections, Axial load diagram; Stresses on Inclined sections in axially loaded bars, Deformation of Axially loaded bars, Statically Indeterminate axially loaded members, Thermal stresses; Strain energy.

**Torsion:**

Torsion in solid and hollow circular shafts; Torque diagram; Simplifying assumptions; Stress and strain distribution; Twisting moment; Angle of twist; Transmission shafts; Critical velocity, Statically indeterminate torque-loaded members; Strain energy; Analysis and design solid and hollow circular shafts for torsion.

**Module – III (14 hours)****Symmetric Bending of Straight Beams:**

Pure bending of straight beams; Main assumptions; Distribution of the normal stress across the section of the beam.

**Stress analysis:**

Calculation of the reactions (statically determinable); Main geometrical characteristics of cross-sections, Centroid, Principle axis and principle moments of inertia, Bending moment and shear force; Relation between shear force and bending moment, Method of sections, Shear force and Bending moment diagrams. Critical cross section, maximum compressive and tensile stresses; Neutral line, Analysis and design beams for bending.

**Deflection of Beams:**

Equation of the Elastic curve; .Statically Indeterminate Beams; Method of superposition; Moment-area theorems.

**TEXT BOOKS**

1. Beer F.P., Johnson E.S., DeWolf J.T., Mechanics of Materials, TATA McGraw Hill
2. Hibbler R.C., Mechanics of materials, PEARSON Education

**REFERENCE BOOKS**

1. Shames I. and Pitarresi J.M., Introduction to Solid Mechanics, Prentice-Hall of India
2. Popov E.P., Engineering Mechanics of Solids, Pearson Education

**MODULE – I (12 hours)****Introduction**

Basic nomenclatures; Working principle of 4-stroke, 2-stroke spark ignition (SI) and compression ignition (CI) engines; classification of I.C. Engines; Comparison of 2-stroke and 4-stroke engines; valve timing diagram of S.I. and C.I. engines; Methods of cycle analysis : Ideal cycle, Air cycle, Fuel-air cycle, Actual cycle; variation between the air cycle and actual cycle; Variation of specific heat, Dissociation, Non-instantaneous burning, Heat losses, Valve timing and blow-down losses, Pumping loop.

**Engine Fuels**

Introduction; Solid, gaseous and liquid fuels, chemical structure of petroleum fuels; Ratings of S.I. and C.I. engine fuels; Important qualities of S.I. and C.I. engine fuels.

**Carburetion**

Introduction; the induction system; Theoretical carburettor considerations; Engine air-fuel mixture requirements; Distribution, Acceleration, Simple float type carburettor

**Fuel-Injection**

Introduction, Types of injection system; Requirements of a diesel injection system, injector nozzles; Petrol injection.

**MODULE – II (10 hours)****Ignition**

Introduction, Requirements of an ignition system; Battery ignition system, Magnetic ignition system, Electronic ignition system; Ignition timing, Spark advance mechanisms.

**Combustion in S.I. Engines**

General combustion theory; stages of combustion in S.I. engines; Flame front propagation; Factors affecting flame speed, Rate of pressure rise; Abnormal combustion, Combustion chambers for S.I. engines.

**Combustion in C.I. Engines:** Introduction, Stages of combustion in C.I. engines; Factors affecting delay period; Knocking in C.I. engines; C.I. engine combustion chambers

**MODULE – III (11 hours)****Engine Cooling & Lubrication**

Introduction; Air cooling and water cooling systems; Effect of cooling on power output; Properties of lubricants and different types of lubricating systems.

**Engine Emissions**

Engine emissions and their harmful effects; Emissions from S.I. engines; Diesel emissions; Emissions control methods: Thermal convertors; catalytic convertors; EGR, PCV (Positive crankcase ventilation) system.

**Engine Testing & Performance**

Measurement of friction power by Willan's line method; Morse test; Measurement of I.P., B.P. fuel consumption, Air consumption, speed, S.I. & C.I. engine performance; Engine efficiencies, Engine performance curves, Variables affecting engine performance, Methods of improving engine performance.

**TEXT BOOK**

1. Mathur & Sharma, I.C. Engine; Dhanpat Publication

**REFERENCE BOOKS**

1. Ganeshan V. , I.C. Engines, TMH
2. Hewitt, I.C. Engine; Mc.Graw Hill

**ME-331****METAL REMOVAL PROCESSES****(3-0-0)****MODULE-I (14 hours)**

Introduction to Machining and classification of Metal Removal Processes, classification of cutting tools, tool materials, Geometry of single point cutting tools, ASA and ORS system of tool signature, Mechanism of chip formation and types of chips, Orthogonal and oblique cutting , Use of chip breaker in machining, Machining forces and Merchant's Circle Diagram (MCD) , Analytical and Experimental determination of cutting forces , Dynamometers for measuring cutting forces, Cutting temperature : causes, effects, assessment and control , cutting fluids and its application, Concept of Machinability and its Improvement, Failure of cutting tools and tool life.

**MODULE-II (14 hours)**

Basic working principle, configuration, specification and classification of machine tools: lathe: facing, turning, taper turning, thread cutting. Milling Machine: simple and compound indexing, up milling, down milling, gear cutting, limitations of gear milling. Drilling machine, shaping: Principles of quick return mechanism, crank and slotted gear and hydraulic quick return mechanism planning, Slotting Machines and Broaching. Abrasive Processes (Grinding): Basic principle, purpose and application of grinding, Selection of wheels and their conditioning, Classification of grinding machines and their uses. Super finishing processes: Honing, Lapping Buffing and super finishing.

**MODULE-III (8 hours)**

Non-conventional machining: Introduction, Abrasive Jet Machining, Ultrasonic Machining (USM) Water Jet and Abrasive Water Jet Machining, Electro Chemical Machining, Electro Discharge Machining ,Electron Beam and Laser Beam Machining

**TEXT BOOKS**

1. Bawa, Workshop Technology, vol.2, TMH
2. Rao P. N., Manufacturing technology: Metal cutting and machine tools, TMH

**REFERENCE BOOKS**

1. Sharma P.C. Chand S., Production engineering, TMH
2. Raghuwanshi B.S., Workshop Technology, Vol.2, Dhanpat Rai & Co
3. Pandey P.C. ,Shan H.S., Modern Machining Processes, Tata McGraw Hill

**ME-313****DESIGN OF MACHINE ELEMENTS****(3-0-0)****MODULE-I (14 hours)****Principles of Mechanical Design and Basic Properties of Materials:**

Phases and interactions of the design processes; Standards and codes; Strength, stiffness, stability; Design factor and factor of safety; Reliability; Dimensions and tolerances. Material strength and stiffness; Hardness; Impact properties; Alloy steels; Casting materials; Nonferrous metals; Composite materials; Materials selection.

**Strength analysis:**

Internal forces in the deformed parts; Stress tensor and its components; Mohr's circles; General three-dimensional stress state; Failure theories for ductile and brittle materials. Stress state analysis: Plane bending, Unsymmetrical bending, Curved beams, Thin walled beams, Eccentric axial loading, Stresses in pressurized cylinders and rotating disks and shrink fits. Stress concentration, Temperature effects.

**Stiffness analysis:**

Spring constant; Deflection due to bending; Beam deflection methods; Beam deflection by superposition; Beam deflections by singularity functions; Strain energy; Castigliano's theorem; Deflection of curved members; Statically indeterminate problems; Compression members – General;

Long columns with central loading; Intermediate-length columns with central loading; Columns with eccentric loading; Struts; Elastic stability; Shock and impact; Suddenly applied loading.

#### **MODULE – II (12 hours)**

##### **Design of shaft and shaft components:**

Shaft materials, shaft layout, Strength design for shafts (combined torsion and bending loading); Stress concentrations; Deflection considerations; Critical speeds for shafts; Miscellaneous shaft components.

##### **Fatigue failure resulting from variable loading:**

Fatigue in metals; Methods of fatigue design: Fatigue-life methods; Stress life methods, strain life methods, Endurance limit; Fatigue strength; Stress concentration and notch sensitivity; Fatigue failure criteria for fluctuating stresses; Combination of loading.

#### **MODULE – III (10 hours)**

##### **Buckling of the columns:**

Critical load; Columns having various types of supports; Inelastic buckling; Design of columns for concentric and eccentric loading.

##### **Design of nonpermanent joints and permanent joints:**

Thread standards and definitions; Mechanics of power screws; Threaded fasteners; Joints – fastener stiffness; Joints – member stiffness; Bolt strength; Tension joints – the external load; Relating bolt torque to bolt tension; Statically loaded tension joint with preload; Gasketed joints, Bolted and riveted joints loaded in shear.

Butt and fillet welds; Stresses in welded joints in torsion; Stresses in welded joints in bending; The strength of welded joints.

#### **TEXT BOOKS**

1. Shigley J.E., Mischke C R, Budynas R G & Nisbett K J, Eighth edition in SI Units, Mechanical Engineering design, Tata McGraw-Hill Publishing Company, New Delhi, 2008.

#### **REFERENCE BOOKS**

1. Spotts M.F., Design of machine elements, Prentice Hall India
2. Burr A.H. & Cheathon J.B., Mechanical analysis and design, Prentice Hall India
3. Bhandari V.B., Design of machine elements, TMH

**DATA BOOK:** (Only Data Book is allowed in the examination)

1. Design Data, PSG college of technology, Coimbatore

## **ME-353                      THEORY OF TURBO MACHINERIES                      (3-0-0)**

#### **MODULE – I (12 hours)**

**INTRODUCTION:** Definition of a Turbomachine; parts of a Turbomachine; Comparison with positive displacement machine; Classification: Application of First and Second Laws to Turbomachines, Efficiencies. Dimensionless parameters and their physical significance; Effect of Reynolds number; Specific speed; Illustrative examples on dimensional analysis and model studies.

**ENERGY TRANSFER IN TURBO MACHINE:** Euler Turbine equation; Alternate form of Euler turbine equation – components of energy transfer; Degree of reaction; General analysis of a Turbo machine – effect of blade discharge angle on energy transfer and degree of reaction; General analysis of centrifugal pumps and compressors – Effect of blade discharge angle on performance; Theoretical head – capacity relationship;

**GENERAL ANALYSIS OF TURBO MACHINES:** Axial flow compressors and pumps – general expression for degree of reaction; velocity triangles for different values of degree of reaction; General

analysis of axial and radial flow turbines – Utilization factor; Vane efficiency; Relation between utilization factor and degree of reaction; condition for maximum utilization factor – optimum blade speed ratio for different types of turbines

#### **MODULE - II (14 hours)**

**THERMODYNAMICS OF FLUID FLOW AND THERMODYNAMIC ANALYSIS OF COMPRESSION AND EXPANSION PROCESSES:** Sonic velocity and Mach number; Classification of fluid flow based on Mach number; Stagnation and static properties and their relations; Compression process – Overall isentropic efficiency of compression; Stage efficiency; Comparison and relation between overall efficiency and stage efficiency; Polytropic efficiency; Preheat factor; Expansion Process – Overall isentropic efficiency for a turbine; Stage efficiency for a turbine; Comparison and relation between stage efficiency and overall efficiency for expansion process; polytropic efficiency of expansion; Reheat factor for expansion process.

**STEAM TURBINES:** Classification, Single stage impulse turbine; Condition for maximum blade efficiency, stage efficiency. Compounding – Need for compounding, method of compounding. Impulse Staging – Condition for maximum utilization factor for multi stage turbine with equiangular blades; effect of blades and nozzle losses. Reaction turbine; Parson's reaction turbine, condition for maximum blade efficiency, reaction staging.

**HYDRAULIC TURBINES:** Classification; Pelton Turbine-velocity triangles, Design parameters, turbine efficiency, volumetric efficiency; Francis turbine – velocity triangles, runner shapes for different blade speeds, Design of Francis turbine; Function of a Draft tube, types of draft tubes; Kaplan and Propeller turbines – Velocity triangles and design parameters.

#### **MODULE – III (10 hours)**

**CENTRIFUGAL COMPRESSORS:** Classification; Expression for overall pressure ratio developed; Blade angles at impeller eye root and eye tip; Slip factor and power input factor; width of the impeller channel; Compressibility effect – need for pre-whirl vanes; Diffuser design: Flow in the vaneless space, determination of diffuser inlet vane angle, width and length of the diffuser passages; Surging of centrifugal compressors;

**AXIAL FLOW COMPRESSORS:** Classification; Expression for Pressure ratio developed per stage – work done factor, radial equilibrium conditions.

**CENTRIFUGAL PUMPS:** Definition of terms used in the design of centrifugal pumps like manometric head, suction head, delivery head, pressure rise, manometric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency, multistage centrifugal pumps, minimum starting speed, slip, priming, cavitation, NPSH,

#### **TEXT BOOKS**

1. Kadambi V. and Prasad Manohar, **An Introduction to energy conversion**, Volume III – Turbo machinery, New Age International Publishers (P) Ltd.
2. Yahya S. M., **Turbines, Compressors & Fans**, Tata-McGraw Hill Co., 2<sup>nd</sup> Edition (2002).

#### **REFERENCE BOOKS**

1. Shepherd D. G., **Principles of Turbo Machinery**, The Macmillan Company (1964)
2. Peng William W, **Fundamentals of Turbomachinery**, John Wiley & Sons, Inc. 2008.
3. Dixon S. L., **Fluid Mechanics and Thermodynamics of Turbomachinery**, Butterworth-Heinemann
4. Venkanna B. K., **Turbo Machineries**, PHI.

**MODULE – I (14 hours)****Mechanical springs:**

Stresses in helical springs; Curvature effect; deflection of helical springs; compression springs; stability; spring materials; helical compression spring design, critical frequency of helical springs; fatigue loading of helical springs

**Rolling contact bearings:**

Bearing types; Bearing life; Bearing load life at rated reliability; Bearing survival – Reliability versus life; Relating load, life and reliability; Combined radial and thrust bearing; Variable loading; Selection of ball and cylindrical roller bearings; Selection of tapered roller bearings; Lubrication.

**Lubrication and Journal bearings:**

Types of lubrication; Viscosity; Petroff's equation; Stable lubrication; Thick film lubrication; Hydrodynamic theory; Design considerations; Relations of the variables; Steady-state conditions in self-contained bearings; Clearance; Pressure-fed bearings; Loads and materials; Bearing types; Thrust bearings; Boundary-lubricated bearings.

**MODULE – II (12 hours)****Gears – General:**

Types of gears; Nomenclature; Fundamentals; Contact ratio; Interference; Gear trains; Force analysis in gear systems.

**Spur and Helical gears:**

Lewis bending equation; Surface durability; AGMA stress equations; AGMA strength equations; Various factors; Design of a gear mesh.

**Bevel and worm gears:**

Bevel gearing; Bevel gear stresses and strengths; AGMA equation factors; Straight-bevel gear analysis; Design of a straight-bevel gear mesh; Worm gearing – AGMA equation; Worm-gear analysis; Designing a worm-gear mesh.

**MODULE – III (10 hours)****Clutches, Brakes, Couplings and Flywheels:**

Static analysis of clutches and brakes; Internal expanding rim clutches and brakes; External expanding rim clutches and brakes; Band-type clutches and brakes; Frictional-contact axial clutches; Disk brakes; Cone clutches and brakes; Energy considerations; Temperature rise; Friction materials; Miscellaneous clutches and couplings; Flywheels.

**Flexible mechanical elements:**

Belts; Flat and round belt drives; V-belts; Roller chain; Wire rope.

**Power transmission case study:**

Design sequence for power transmission; Power and torque requirement; Gear specification; Shaft layout; Force analysis; Material selection; Stress analysis; Deflection analysis, Bearing selection; Final analysis.

**TEXT BOOKS**

1. Shigley J.E., Mischke C R, Budynas R G & Nisbett K J Mechanical Engineering design, Eighth edition in SI Units, Tata McGraw-Hill Publishing Company, New Delhi, 2008.

**REFERENCE BOOKS**

1. Spotts M.F., Design of machine elements, Prentice Hall India
2. Burr A.H. & Cheathon J.B., Mechanical analysis and design, Prentice Hall India
3. Bhandari V.B., Design of machine elements, TMH

**DATA BOOK: (Only Data Book is allowed in the examination)**

1. Design Data, PSG College of Technology, Coimbatore

**MODULE – 1(12 Hours)**

**Introduction:** The three modes of heat transfer and their mechanisms. The Fourier heat conduction law.

**Governing equation and boundary conditions for heat conduction:** The general heat conduction in Cartesian, polar-cylindrical and polar-spherical coordinates, simplification of the general equation for one and two dimensional steady/transient conduction with constant/variable thermal conductivity with/without heat generation. Boundary conditions applicable to heat conduction problems.

**One dimensional steady state heat conduction:** Solution of the one dimensional steady state heat conduction problem in case of plane walls, cylinders and spheres for simple and composite cases. Electrical analogy, Critical insulation thickness, Analysis of extended surfaces and fins for various boundary conditions.

**MODULE-II (14 Hours)**

**Two dimensional steady state heat conduction:** Solution of Cartesian problems in two dimensions (steady state conduction with constant thermal conductivity and no heat generation) by variable separation method. Numerical methods for heat conduction analysis. Lumped capacitance and simple transient models.

**Convective heat transfer:** Introduction to convective heat transfer. Dimensional analysis of forced and free convective heat transfer.

Conservation equations for mass, momentum and energy for 2-dimensional convective heat transfer in case of incompressible flow, Hydrodynamic and thermal boundary layers for flow over a flat plate. Boundary layer equations for 2-dimensional incompressible flow over a flat plate and boundary conditions. Momentum and energy integral equations for flow over a flat plate and their solution (local and average values of drag and heat transfer coefficients). Reynold's analogy.

Experimental heat transfer correlations for forced and free convection in the following cases.

Vertical and horizontal plates. Inside and outside flows in case of tubes.

**Heat transfer form boiling liquids and condensing vapours:**

Qualitative study of boiling heat transfer and Nusselt analysis of consideration on vertical plates, vertical tubes and horizontal tubes.

**MODULE-III (10 Hours)****Radiative heat exchange:**

Introduction, Radiation properties, Emissive power & Emissivity Kirchhoff's identity, Planck's relation for monochromatic emissive power of a black body, Derivation of Stefan-Boltzmann law and Wien's displacement law from Planck's relation, Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium Gray bodies and real bodies, heat exchange between gray bodies. Radiosity and Irradiation, Electrical analogy and radiation network for 2-body and 3-body radiations exchange in non-absorbing medium, Radiation shields.

**Heat Exchanger:**

Introduction, The overall heat transfer coefficient and fouling factors, Types of heat exchangers LMTD and E-NTU analysis of heat exchangers. Heat exchanger design considerations.

**TEXT BOOKS**

1. Ozisik Necatiz, Basic Heat Transfer, Mc-Graw Hill.
2. Holman J.P., Heat Transfer, Mc-Graw Hill.

**REFERENCE BOOKS**

1. Incropera Frank P., Dewitt David P., Fundamentals of Heat and Mass Transfer, 5<sup>th</sup> Edition, Wiley Publication.
2. Nag P.K., Heat Transfer, TMH

**ME-332**

**MACHINE TOOLS AND TOOL DESIGN**

**(3-0-0)**

**MODULE-I (14 hours)**

Principles of Machine Tools, Kinematics of machine tools, cutting tools used for different machine tools, Design of a single point cutting tool, Broach tool, Milling cutter and Form tool, Design of limit Gauges, Product design considerations, Product design for Sand Casting, Design of Gating and Riser Systems.

**MODULE-II (14 hours)**

Forging product design considerations and principles, Die design for drop forging and upset forging. Sheet metal working, principle and definition of shearing, Blanking, piercing, Drawing operation, Press tool design for sheet metal operations, progressive and compound Die, strippers, stops, strip lay out.

**MODULE-3 (8hours)**

Design of Jigs and Fixtures, Principle of location and clamping, methods, Drill jig bushing, Indexing type Drilling jig. Product planning, Product development, value analysis, process planning-selection of processes, machines and tools, Design of sequence of operations, Time and cost estimation,

**TEXT BOOKS**

1. Donaldson, Tool Design, TMH
2. Rao P.N., Manufacturing Technology, TMH

**REFERENCE BOOKS**

1. Sharma P.C., A text book of production Engineering, S.Chand and CO.
2. Basu S.K, Mukherjee S.N., Mishra R., Fundamentals of Tool Engineering Design, oxford and IBH Publishing co.
3. Sharma, Saxena & Sharan Forging die design Principle.

**ME-312**

**MACHINE DYNAMICS - II**

**(3-0-0)**

**MODULE – I (12 Hours)**

**Synthesis of linkages:**

Type, number and dimensional synthesis; Function generation, path generation and body guidance; Two-position synthesis of slider-crank mechanisms, Two-position synthesis of crank-and-rocker mechanisms; Crank-and-rocker mechanisms with optimum transmission angle; Three-position synthesis; Four-position synthesis, Point-position reduction; Precision positions, Structural error, Chebychev spacing; The overlay method; Coupler-curve synthesis; Cognate linkages, The Roberts-Chebychev theorem; Bloch's method of synthesis; Freudenstein's equation; Synthesis of dwell mechanisms; intermittent rotary motion.

**Spatial mechanisms:**

Exceptions in the mobility of mechanisms; The position-analysis problem; Velocity and acceleration analyses; The Eulerian angles; The Denavit-Hartenberg parameters; Transformation-matrix position analysis; Matrix velocity and acceleration analysis.

**Robotics:**

Topological arrangements of robotic arms; Forward kinematics; Inverse position analysis; Inverse velocity and acceleration analysis; Robot actuator force analysis.

## **MODULE – II (12 hours)**

### **Dynamics of reciprocating engines:**

Engine types; Dynamic analysis-general; Gas forces; Equivalent masses; Inertia forces; Bearing loads in a single-cylinder engine; Crankshaft torque; Engine shaking forces.

### **Balancing:**

Static unbalance; Equations of motion; Static balancing machines; Dynamic unbalance; Analysis of unbalance; Dynamic balancing; Balancing machines; Balancing a single-cylinder engine; Balancing multicylinder engines; Analytical technique for balancing multicylinder reciprocating engines; Balancing linkages; Balancing of machines.

## **MODULE – III (12 hours)**

### **Cams:**

Classification of cams and dwellers; Displacement diagrams; Graphical layout of cam profiles; Kinematic coefficients of the follower motion, High-speed cams; Standard cam motions; Matching derivatives of displacement diagrams; Plate cam with reciprocating flat-face follower; Plate cam with reciprocating roller follower.

### **Cam dynamics:**

Rigid and elastic body cam systems; Analysis of an eccentric cam; Effect of sliding friction; Analysis of disc cam with reciprocating roller follower; Analysis of elastic cam systems; Unbalance, spring surge and windup.

### **Vibration analysis:**

Rayleigh's Method to find frequency of vibration; First and second critical speeds of a shaft; Torsional systems.

## **TEXT BOOKS**

1. Shigley J.E. & Uicker J.J., Theory of machines and mechanisms, McGrawHill, 2009
2. Mallick A. K., Ghosh A & Dittrich G., Kinematic analysis and synthesis of mechanisms, CRC Press

## **REFERENCE BOOKS**

1. Ambekar A G, Mechanism and machine theory, Prentice Hall of India Pvt Ltd, 2007
2. Norton R L, Kinematics and Dynamics of machinery, Tata Mcgraw Hill, First Edition, 2009.
3. Rattan S S, Theory of machines, Tata Mcgraw Hill, New Delhi

**ELECTIVE-I**  
**(Any one of following)**

<b>ME-322</b>	<b>AUTOMOBILE ENGINEERING</b>
<b>ME-342</b>	<b>INDUSTRIAL ENGINEERING</b>
<b>ME-362</b>	<b>GAS DYNAMICS</b>
<b>ME-314</b>	<b>FINITE ELEMENT METHODS</b>
<b>ME-324</b>	<b>ADVANCED MECHANICS OF SOLIDS</b>
<b>ME-334</b>	<b>ADVANCED FLUID MECHANICS</b>
<b>ME-344</b>	<b>MATERIALS MANAGEMENT</b>
<b>CY-201</b>	<b>ENGINEERING MATERIALS</b>

**ME-322**

**AUTOMOBILE ENGINEERING**

**(3-0-0)**

**MODULE-I (14 Hours)**

Introduction, Main units of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act, Resistance to motion, rolling resistance, air resistance, gradient resistance, power required for propulsion, tractive effort and traction, road performance curves.

Layout of the transmission system, main function of the different components of the transmission system, transmission system for two wheel and four wheel drives

Gear box : Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission, hydraulic transmission, universal coupling

**MODULE II (14 hours)**

Hookes joint, propeller shaft, differential, rear axles, types of rear axles, semi floating, there quarter floating and full floating types.

Hydraulic breaking system, breaking of vehicles when applied to rear, front and all four wheel, theory of internal shoe brake, design of brake lining and brake drum, different arrangement of brake shoes, servo and power brakes.

Front wheel Geometry and steering systems : Camber, castor, kingpin inclination, toe-in, centre point steering condition for true rolling, components of steering mechanism, power steering.

**MODULE III (8 hours)**

Electrical system of an automobile : Starting system, starting drive, generation system, ignition system, other electrical system.

Advance system in automobiles : Electronics, computers, robots and emission control in automobiles, CNG engine, recent research and development, Speedometer, fuel gauge, types of chassis, shock absorber.

**TEXT BOOKS**

1. Narang G.B.S., Automobile engineering, Khanna Publisher.
2. Heitner J., Automobile Mechanics, Affiliated East-west Press Pvt Ltd
3. Gupta K.M., Automobile Engineering, Vol I & II (Umesh Publication)

**REFERENCE BOOKS**

1. Newton and Steeds, The motor vehicle.
2. Crouse, Automotive mechanics.
3. Singh Kirpal, Automobile Engineering, Standard Publishers & Distributors.

**ME-342**

**INDUSTRIAL ENGINEERING**

**(3-0-0)**

**MODULE-1 (18 hours)**

**Scope and application of industrial engineering**

Principles of Operations research, application, formulation of lpp, Graphical method, simplex method. Work study: Productivity and it's measurement, Procedure for work study, recording techniques, charts and diagrams, principles of motion economy. Work measurement: definition, Procedure; Performance rating; Concept of normal time; allowances. Work sampling technique of work measurement, calculation of standard time. Introduction to pre determined motion time system.

**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, aggregate planning, chase and level strategies, pure and mixed strategies, Short range capacity planning and control.

**MODULE-2 (10 hours)**

**Facility location and layout:** Site Selection: Factors influencing the locations, optimum decision on choice of site and quantitative methods. Plant Layout: types of layouts, advantages and disadvantages, factors affecting layout, systematic layout planning, and Material handling: importance, principles of material handling, Transportation models.

**MODULE-3 (8 hours)**

**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. Cost analysis, depreciation analysis, make or buy decision, replacement analysis.

**TEXT BOOKS**

1. Richard B chase, Robot Jacobs, Nicholas J Aquilano and Nitin K agarwal Operations Management For Competitive Advantage, TMH.
2. Monks, Operations Management, Mcgraw Hill ISE.

**REFERENCE BOOK**

1. Paneerselvam R., Production and operations management. PHI

**ME-362**

**GAS DYNAMICS**

**(3-0-0)**

**MODULE – I (14 hours)**

**Introduction:** What is Compressible Flow?, Why Compressible Flow is Important?, Historical Background, Early Developments, The Shock wave puzzle, Choking Flow, External flow, Filling and Evacuating Gaseous Chambers.

**Fundamentals of Basic Fluid Mechanics:** Introduction, Fluid Properties, Control Volume, Reynold's Transport Theorem.

**Speed of Sound:** Motivation, Introduction, Speed of sound in ideal and perfect gases, Speed of Sound in Real Gas, Speed of Sound in Almost Incompressible Liquid, Speed of Sound in Solids, Sound Speed in Two Phase Medium.

**Isentropic Flow:** Stagnation State for Ideal Gas Model, General Relationship, Relationships for Small mach Number, Isentropic Converging-Diverging Flow in Cross Section, The Properties in The Adiabatic Nozzle, Mass Flow Rate (Number), Isentropic Tables, Isentropic Isothermal Flow Nozzle, General Relationship, The Impulse Function, Impulse in Isentropic Adiabatic Nozzle, The Impulse Function in Isothermal Nozzle, Isothermal Table, The effects of Real Gases,

**MODULE – II (14 hours)**

**Normal Shock:** Solution of the Governing Equations, Informal model, Formal Model, Prandtl's condition, Operating Equations and Analysis, The laminations of The Shock Wave, Small Perturbation Solution, Shock Thickness, The Moving Shocks, Shock Result From A Sudden and Complete Stop, Moving Shock Into Stationary Medium (Suddenly Open Valve), Partially Open Valve, Partially Close Valve, Shock Tube, Shock with Real Gases, Shock in Wet Steam, Normal Shock in Ducts.

**Normal Shock in Variable Duct Areas:** Nozzle efficiency, Diffuser Efficiency.

**Nozzle Flow With External Forces:** Isentropic Nozzle( $Q=0$ ), Isothermal Nozzle ( $T=\text{constant}$ )

**Isothermal Flow:** The Control Volume Analysis/Governing equations, Dimensionless Representation, The Entrance Limitation of Supersonic Branch, Comparison with Incompressible Flow, Supersonic Branch, Unchoked situation.

**Module-III (8 hours)**

**Fanno Flow:** Introduction, Model, Dimensionalization of the equations, The Mechanics and Why The Flow is Choke? The working equations, Supersonic Branch, Maximum length for the supersonic flow, Working Conditions, Variations of the Tube Length, The Pressure Ratio, Entrance Mach number,  $M_1$ , effects, The Approximation of the Fanno flow by Isothermal Flow.

**Rayleigh Flow:** Introduction, Governing Equation, Rayleigh Flow Tables.

**TEXT BOOKS**

1. Balachandran P., Fundamentals of Compressible Fluid Dynamics, PHI.
2. Robert D. Zucker & Oscar Biblarz, Fundamentals of Gas Dynamics, John Willy.

**REFERENCE BOOKS**

1. Yahya S.M., *Fundamentals of Compressible Flow*, Wiley Eastern Ltd.
2. Lipman and Rosco, *Gas Dynamics*, Mc Graw Hill

**ME-314**

**FINITE ELEMENT METHOD**

**(3-0-0)**

**MODULE – I (14 hours)**

Introduction; Discretisation; Shape functions for linear and quadratic elements in one-dimension, two-dimensions and three-dimensions; Isoparametric elements; Serendipity elements; Strain-displacement matrix; Jacobi operator; Treatment of boundary conditions in finite element equations.

Stress and equilibrium; Boundary conditions; Strain-displacement relations; Stress-strain relations; Temperature effects; Potential energy and equilibrium, Rayleigh-Ritz method; Galerkin's method; Principle of virtual work.

**Module – II (12 hours)**

Finite element analysis of one-dimensional rods; Element stiffness matrix and load vector for 2-noded bar element and 3-noded bar element; Global stiffness matrix and global load vector; Multipoint constraints. Plane trusses; Beam and frames.

**Module – III (10 hours)**

One and two-dimensional steady state heat transfer; Torsion; Steady state irrotational fluid flow.

**TEXT BOOK**

1. Chandrupatla T.R. & Belegundu A.D., Introduction to finite element in engineering, Pearson Education Inc.

**REFERENCE BOOKS**

1. Segerlind L.J., Applied finite element analysis, John Wiley
2. Cook R.D., Finite element modeling for stress analysis, John Wiley & Sons, NY

**MODULE – I (12 hours)****Energy Methods:**

Strain energy due to axial load, bending moment and twisting moment; Principle of virtual work; Castigliano's theorem; Unit load and unit couple method (virtual work method) for determining deflection and slope; Statically indeterminate systems.

**Frames:**

Internal loading diagrams for plane and 3D frames; determining deflection and slope at different points of the frames using energy methods; stress state in different parts of the frames.

**Unsymmetrical Bending:**

Main geometrical characteristics of cross-sections, Centroid, Principal axis and principal moments of inertia, Shear force and Bending moment diagram in the planes of principal axis of inertia; Stress distribution, maximum compressive and tensile stresses, neutral line; Deflection; Analysis and design beams for unsymmetrical bending.

**MODULE – II (12 hours)****Curved Beams:**

Bending of beam with large initial curvature; Internal loading diagrams (axial force, shear force, bending moment); Critical cross section, Stress distribution in beam with different cross-sections; Location of the neutral line; Stresses in crane hooks, ring and chain links.

**Transverse shear:**

Shear stresses distribution in beams under bending. Stress analysis in thin-walled beams, Shear center, Design of the thin-walled members for bending.

**Combined loading:**

State of stress caused by combined loadings; Theories of failure; Strength analysis and design of combined loaded members; columns under eccentric compression; shafts under combined torsion and bending loading; Plane and 3D frames, Thin-walled vessels.

**MODULE – III (12 hours)****Biaxial State of Stress:**

Thick Walled Cylinders: cylinders subjected to internal and external pressure; Compound cylinders; Shrinkage, Shrinkage allowance; Rotating discs, Design of flywheels.

**Buckling of Columns**

Buckling and stability; Critical load; Columns having various types of supports; Elastic and inelastic buckling; Design of columns for concentric and eccentric loading.

**Experimental Analysis:**

Resistance strain gauges; Strain rosettes; Two-dimensional photoelastic methods of stress analysis; stress concentration; Acoustic non-destructive methods of analysis; Engineering and true stress-strain curve, Large deformations, tensile test, compression test, torsion test. Repeated stresses and fatigue in metals; Concept of stress concentration; Notch and stress concentration factors. Fatigue tests, creep tests, stress concentration tests. Dynamic (impact) loading tests, High temperature tests.

**TEXT BOOKS**

1. Beer F.P., Johnson E.S., DeWolf J.T., Mechanics of Materials, TATA McGraw Hill
2. Pytel A. and Kiusalaas J., Mechanics of Materials, CENAGE learning
3. Hibbler R.C., Mechanics of materials, PEARSON Education

**REFERENCE BOOKS**

1. Gere J. M. and Goodno B.J., Strength of Materials, CENAGE learning
2. Shames I.H and Pitarresi J.M., Introduction to Solid Mechanics, Prentice-Hall of India
3. Popov E.P., Engineering Mechanics of Solids, Pearson Education

**ME-334**

**ADVANCED FLUID MECHANICS**

**(3-0-0)**

**MODULE-I (12 Hours)**

Introduction to Navier Stokes equation in vector notation and cylindrical and Cartesian co-ordinates, Physical interpretation of each term of N.S equation, dot product and cross product, operator: gradient, divergence and curl.

**Exact solution of the N.S Equation :** Introduction

**Solution to the steady Viscous flow:** Plane Couette flow, circular Couette flow, Poiseuille flow between parallel plates, Poiseuille flow in a pipe, Taylor Couette flow.

**Solution to the unsteady viscous flow:** Startup plane Couette flow.

**MODULE -II (12 Hours)**

**Vorticity Dynamics:** Vortex lines and vortex tubes, Kelvin's circulation theorem and discussion, vorticity equation, interaction of vortices

**Laminar Boundary Layers:** Introduction, boundary layer equation, Blasius flow over a flat plate, wall shear and boundary layer thickness, momentum-integral equation for boundary layer, separation of boundary layer, Karman-Pohlhausen approximate method for solution of momentum integral equation over a flat plate, entry flow in a duct.

**MODULE - III (12 Hours)**

**Introduction to Turbulent Flow:** Introduction, characteristic of turbulent flow, averaging method (time averaging, spatial averaging, ensemble averaging), averaged equations of motion (RANS), Correlation function, derivation of governing equation for turbulent flow, turbulent boundary equation, shear stress models.

**TEXT BOOKS**

1. Som S.K , Biswas G, Introduction to Fluid Mechanics and Machines, TMH
2. Kundu Pijush K., Cohen Ira M. Fluid Mechanics, Academic Press

**REFERENCE BOOKS**

1. White F.M, Viscous Fluid Flow, Mc Graw Hill
2. Triton, Physical Fluid Dynamics, Oxford Science Publication.

**ME-344**

**MATERIALS MANAGEMENT**

**(3-0-0)**

**MODULE – I (12 hours)**

**Introduction:** Scope of material management, integrated material management, relation with other functional areas of organization, conventional and modern approaches to organizing material management.

**Material Identification:** Classification, codification, standardization and variety reduction of materials.

**Purchasing Management :** Planning for purchasing, CEI methodology, Japanese industry – Vendor selection and development – purchasing procedure and methods legal aspects-insurance of materials – supply chain management-source of supply-outsourcing.

**MODULE – II (12 hours)**

**Store Management:** Location, types of stores, method of storing, safety and security of materials, stores equipments, material handling equipment, store transaction policy, forms for issue and receipt, stores accounting and records, management of surplus, obsolete and scrap materials – methods of disposal.

### MODULE-III (12 hours)

**Cost reduction:** Computer application and evaluation (ERP package), value analysis,

**Inventory Control:** Techniques-FSN, VED, ABC-working capital management with reference to inventory.

**Sub Contracting:** Reasons for subcontracting, criteria for selecting subcontractors, rating, internal and external subcontract

#### TEXT BOOKS

1. Datta A.K., Integrated Materials Management, PHI
2. Pandey P.B., Material Management,

#### REFERENCE BOOKS

1. Gopala Krishnan P., Materials Management, PHI-2002.
2. Dobbler, Burt D.N.Purchasing and supply management, , TMI,
3. Leenders Fearon, Purchasing and Material Management, Universal Book Stall
4. Varma, Material Management, MM Sultan Chand and Sons.
5. Sharma H.C., Material Management,

## CY – 201

## ENGINEERING MATERIALS

(3-0-0)

### MODULE – I (16 Hours)

**Fuel and combustion:** Classification, calorific value, Solid fuels (Analysis of coal, manufacture of metallurgical coke),Liquid fuels (Refining of crude oil: fractional distillation, cracking, reforming, knocking, octane number and cetane number), Gaseous fuel (Producer gas, water gas, Biogas, LPG), Combustion calculations.

**Water treatment :** Hardness of water & its determination (EDTA method), Types of hardness, Disadvantages of hard water in boiler, Softening techniques (Soda lime, Zeolite and ion-exchange processes), Purification of Drinking water.

### MODULE –II (12 Hours)

#### Inorganic Engineering Materials:

1. Glass: Manufacture of glass, Types.
2. Ceramics: White wares, glazing, optical fibres.
3. Refractories: Classification, manufacture of silica, fire clay and carborundum bricks.
4. Abrasives: Natural and artificial (carborundum, Alundum, Norbide).

**Bio &Conducting polymers:** Bio-polymers (Starch, Cellulose), Conducting polymers (Polyacetylene, Polyaniline) Properties and application.

### MODULE – III (14 Hours)

1. **Composites :** Constituents of Composites, Types of composites fibre - Reinforced composites, (Fiberglass, Advanced composites, wood) , Aggregate composites , mechanical properties of composites. Processing of composites.
2. **Chromatography :** Thin layer chromatography, Gas-liquid chromatography, Column chromatography, High Performance Liquid Chromatography (HPLC).

#### TEXT BOOKS

1. Jain & Jain, Engineering chemistry, 15<sup>th</sup> Edition, Dhanpat Rai Publishing Co., 2007.
2. Shackelford & Muralidhara:Introduction to Materials Science for Engineers, Sixth Edition 2007, Pearson Education.

## 5<sup>th</sup> & 6<sup>th</sup> SESSIONAL

### **ME-371                      MACHINE ELEMENT DESIGN LABORATORY                      (0-0-3)**

1. Assembly drawing of tail stock of a lathe
2. Design and drawing of riveted joint
3. Design and drawing of bolted joint
4. Design and drawing of welded joint
5. Design and drawing of cotter joint
6. Design and drawing of knuckle joint
7. Design of shafts subjected to combined loading
8. Design of shaft using various theories of failure
9. Shaft design under fatigue loading
10. Design of pressure vessels

#### **DATA BOOK:**

1. Design Data, PSG college of Technology, Coimbatore

### **ME-373    MACHINE SHOP    (0-0-3)**

#### **(Any Eight Jobs)**

1. To make a job on lathe with taper Turning, Threading, Knurling and Grooving.
2. Gear Cutting on milling Machine by Simple and Compound Indexing methods.
3. To produce a v-Groove on a Work piece using Shaper.
4. To machine the surface of a cast Iron block using Planner
5. To make internal key way in the bore of a Spacer by Slotting machine
6. To make a parallel block using surface Grinding machine
7. To make a cylindrical pin using cylindrical Grinding machine
8. To produce a blind hole on a hardened block using EDM
9. To Generate 3-D Profile using ECM
10. To cut a glass plate using AJM
11. To cut ceramic material using USM

## **ME-375 I.C. ENGINE & HYDRAULIC MACHINE LABORATORY**

(Any Six from IC Engine and any four from Hydraulic machine Laboratory)

### **IC Engine Laboratory**

1. Study of cut section models of I.C. Engines
2. Determination of Brake power, indicated power, Brake thermal efficiency, Indicated thermal efficiency, volumetric efficiency & specific fuel consumption of two cylinder, 4-stroke diesel engine.
3. Determination of Brake Power, Brake thermal efficiency volumetric efficiency, specific fuel consumption of 4-stroke single cylinder air-cooled petrol engine with electrical resistance loading.
4. Determination of Brake Power, Brake thermal efficiency, volumetric efficiency, specific fuel consumption of a 2-stroke single cylinder air-cooled petrol engine.
5. Preparation of heat balance sheet for a single cylinder 4-stroke diesel engine.
6. Determination of indicated power of a 4-cylinder 4-stroke petrol engine by Morse test.
7. Study of engine emissions using Orsat apparatus.

### **Hydraulic Machine Laboratory:**

1. Performance characteristics of Pelton Turbine.
2. Performance characteristics of Gear Pump.
3. Performance characteristics of Francis Turbine.
4. Performance characteristics of Centrifugal Pump.
5. Performance characteristics of Reciprocating Pump.
6. Performance characteristics of Kaplan Turbine.

## **ME-372 HEAT TRANSFER AND MACHINE DYNAMICS LABORATORY (0-0-3)**

Total No. of Experiment = 10 (Five from each group)

### **Heat Transfer Laboratory :**

1. To determine thermal conductivity of insulating powder.
2. To determine the heat transfer coefficient of air for flow in a horizontal tube by forced convection.
3. To determine the heat transfer coefficient of air for flow in a vertical tube by natural convection.
4. To determine the emissivity of test disc.
5. To determine the Stefan Boltzmann Constant and compare it with theoretical value.
6. To determine the effectiveness of fin by using pin fin apparatus for natural and forced convection.
7. To determine the inside and outside overall heat transfer coefficients and effectiveness of parallel and counter flow heat exchangers.

**Machine Dynamics Laboratory.**

1. Experiments using dynamic balancing apparatus
2. Determination of natural frequency of undamped and damped vibration.
3. Undamped torsional vibration of single rotor shaft system.
4. Determination of damping coefficient by studying damped torsional oscillation.
5. Determination of critical speed of rotating shaft.
6. Performance characteristics of spring loaded governor (Hartnell, Porter)
7. Free/Forced vibration of equivalent spring-mass system.
8. Verifying Dunkerley's relation using Universal Vibration apparatus.

**ME-380****TOOL DESIGN PROJECT****(0-0-3)****(Any Eight)**

1. Design of a single point cutting tool
2. Design of a Circular form Tool
3. Design of Milling cutter
4. Design of Broach
5. Design of Progressive Die
6. Design of Compound Die
7. Design of Drill Jig
8. Gating and feeding system Design for a cast product
9. Design of Drop Forging Die for a forged product
10. Design of Up-set forging Die for a forged product

**ME-374****MECHANICAL SYSTEM DESIGN LAB****(0-0-3)**

1. Design and drawing of mechanical springs
2. Design of clutch
3. Design of Brake
4. Design and drawing of flange coupling
5. Design of fly wheel
6. Design of Journal Bearing
7. Design of straight helical gears
8. Design of gear box
9. Design of flat belt drive and V-belt drive
10. Design of piston, connecting rod and crankshaft

**DATA BOOK:**

1. Design Data, PSG College of Technology, Coimbatore

## MECHANICAL ENGINEERING

7 <sup>th</sup> Semester				8 <sup>th</sup> Semester			
<i>Subject Code</i>	<i>Theory</i>	<i>Contact Hrs.</i>	<i>Credit C</i>	<i>Subject Code</i>	<i>Theory</i>	<i>Contact Hrs.</i>	<i>Credit C</i>
ME-431	Metrology, Quality Control and Reliability	3-0-0	3	HS-402	Principles of Management	3-0-0	3
ME-451	Refrigeration & Air Conditioning	3-0-0	3	ME-402	Power Plant Engineering	3-0-0	3
ME-411	Mechanical Measurement and Control	3-0-0	3	EL-IV	Elective – IV	3-0-0	3
EL-II	Elective – II	3-0-0	3	EL-V	Elective – V	3-0-0	3
EL-III	Elective – III	3-0-0	3				
	<b>TOTAL</b>	<b>15</b>	<b>15</b>		<b>TOTAL</b>	<b>12</b>	<b>12</b>
<i>Subject Code</i>	<i>Practicals / Sessional</i>	<i>Contact Hrs.</i>	<i>Credit</i>	<i>Subject Code</i>	<i>Practicals / Sessional</i>	<i>Contact Hrs.</i>	<i>Credit</i>
ME-471	Metrology and CIM Lab	0-0-3	2	ME-492	Seminar-II	0-0-2	1
ME-473	Refrigeration and Air Conditioning Lab	0-0-3	2	ME-494	Major Project	0-0-10	7
ME-491	Seminar -I	0-0-2	1	ME-496	Comprehensive Viva-Voce	0-0-3	2
ME-493	Minor Project	0-0-5	3				
ME-495	Summer Training	0-0-3	2				
Total		<b>16</b>	<b>10</b>	Total		<b>15</b>	<b>10</b>
<b>TOTAL</b>		<b>31</b>	<b>25</b>	<b>TOTAL</b>		<b>27</b>	<b>22</b>

## **ME-431 METROLOGY, QUALITY CONTROL AND RELIABILITY (3-0-0)**

### **MODULE – I (12 Hours)**

#### **Metrology**

Line and End Standards, Principles of Measurements, Calibration, accuracy and Precision, Random error and systematic error Measurement of Surface Roughness, Screw thread and Gears.

Limits, Fits and Gauges, Assembly by full, partial and group interchangeability, geometric tolerances. Measurement of straightness, Flatness and circularity.

### **MODULE- II (12 Hours)**

#### **Quality control**

Some useful Probability Distribution, type I and type II errors, central limit theorem.

Cause of Variation, standard error of mean, process capability, PCR, Natural tolerance Limits, /Specification Limits, Trial and Revised control Limits, Rational subgroups, Control charts for variable (X,R,S,) Control charts for fraction non-conforming, control charts for non-conformation.

Design of single sampling plan, double, multiple and sequential sampling plans, O.C. Curve, AOQ, AOQL.

### **MODULE- III (12 hours)**

#### **Reliability:**

Definition, bath-tub-curve, system reliability, reliability improvement, maintainability and availability, Availability of single repairable system using Markov model, Life tests, acceptance sampling plan based on life tests, Sequential acceptance sampling plan based on MTTF.

Taguchi's loss function, Signal-to noise Ratio, ANOVA, TQM, TPM, ISO 9000, JIT.

#### **TEXT BOOKS**

1. Jain R.K., "Engineering Metrology", Khanna Publisher, Delhi
2. Montgomery D.C., "Introduction to Statistical Quality control", John Wiley & sons
3. Gupta A.K., "Reliability Engg. And Terotechnology", Macmillan India
4. Bagchi, T.P. "Taguchi methods Explained Practical steps to Robust design", PHI

#### **REFERENCE BOOKS**

1. Taher M.R., "Metrology, Measurement and Measuring Instruments", RNLBP. Allahabad.
2. Grant E.L. and Leavenworth R.S., "Statistical quality Control", 7<sup>th</sup> edition, Mc-Graw Hill.
3. Ebeling, E. "an Introduction to reliability and Maintainability Engg.", MC-Graw Hill.
4. Hansen B.L. and Ghare P.M., "Quality control and Application", Prentice Hall of India.
5. Srinath L.S., Reliability Engg. East west publication
6. Mitra, A. "Statistical Process Control and Improvement", Pearson
7. Paneerselvam R., "Production and Operation Management, Prentice Hall of India

## **ME-451 REFRIGERATION & AIR CONDITIONING (3-0-0)**

### **MODULE-I (14hours)**

Refrigeration, unit of refrigeration, Coefficient of performance, importance of refrigeration, Reversed Carnot cycle,. Limitations of reversed Carnot cycle.

**Air Refrigeration System:** Bell Coleman air refrigeration cycle, Air craft and Air conditioning system and their performance

**Vapour Compression refrigeration System:** Analysis of theoretical vapour compression refrigeration cycle, Representation of cycle on T-S and p-h charts, Simple saturation cycle, sub-cooled cycle and superheated cycle, Effect of suction and discharge pressure on performance, Actual vapour compression cycle.

**Multi pressure system:** Multistage compression and Multi-evaporator systems, Different arrangements of compressors, intercoolers, flash chambers and heat exchangers, Cascade refrigeration system.

#### **MODULE- II (8hours)**

**Vapour Absorption refrigeration System:** Simple Ammonia-absorption system, improved absorption System, Lithium bromide-water vapour absorption system Electrolux refrigeration system, comparison of absorption system with vapour compression system.

**Refrigerants:** Classification of refrigerants, Halocarbon compounds, Hydrocarbons, Inorganic compounds, Azeotropes, Properties of refrigerants, comparison of common refrigerants, uses of important refrigerants, Secondary Refrigerants, ozone friendly refrigerants, Green House effects, global warming and future refrigerants.

#### **MODULE- III (14hours)**

**Psychrometrics:** Properties of moist air, psychometric properties, Wet bulb temperature, Thermodynamic wet bulb temperature, psychometric relations, psychometric chart and its use, psychometric processes, air washers.

**Requirements of comfort air conditioning:** oxygen supply, heat removal, moisture removal, air motion, purity of air, Thermodynamics of human body, comfort and comfort chart, effective temperature, factors governing optimum effective temperature.

**Air conditioning System:** air conditioning processes, Summer air conditioning, Winter air conditioning and year round air conditioning, Cooling load calculations,

#### **TEXT BOOKS**

1. ARORA C.P, Refrigeration and Air Conditioning, Tata McGraw-Hill
2. . Dossat J Roy.; Principles of Refrigeration, Addison Wesley Longman Pvt. Ltd. Delhi.

#### **REFERENCE BOOKS**

1. Prasad Manohar, Refrigeration and Air Conditioning, New Age international Publishers
2. Stoecker H.F. A Text Book of Refrigeration and Air Conditioning Tata McGraw-Hill

### **ME-411                      MECHANICAL MEASUREMENT AND CONTROL                      (3-0-0)**

#### **MODULE-I (11 hrs)**

The significance of Mechanical Measurements, basic detector transducer elements : Electrical transducer, sliding contact devices, variable-inductance transducer elements, the differential transformer, variable reluctance transducer, capacitive transducer. The piezoelectric effect, photo-electric transducer, electronic transducer element.

**Intermediate modifying system:** Electrical intermediate modifying devices, Input circuitry. The simple current sensitive circuit the ballast circuit, The voltage-dividing potentiometer circuit, The voltage balancing potentiometer circuit, resistance bridges.

Terminating Devices and methods : Introduction, Meter indicators, The vacuum tube voltmeter, CRO, recording techniques, oscillographs.

#### **MODULE – II (15 hours)**

##### **Strain Measurement :**

The electrical resistance strain gauge. Metallic resistance strain gauge .Selection and installation factors for bonded metallic strain gauges. Circuitry for metallic strain gauge. : The strain gauge ballast

circuit, the strain gauge bridge circuit, Simple constant-current strain gauge circuit. Temperature compensation. Calibration, Stress-strain relationships.

Gauge orientation and interpretation of results.

#### **Measurement of Pressure :**

Pressure measurement systems, pressure measurement transducer, gravitation transducers. Elastic transducer, Elastic diaphragms, Secondary transducer used with diaphragms, Strain gauge pressure cells, Measurement of high pressure, measurement of low pressures, Calibration methods.

#### **Measurement of Fluid flow :**

Flow characteristics of obstruction meters: venturi, flow nozzle, orifice. The variable area meter, calibration of flow measurement devices.

#### **Temperature Measurement :**

Use of bimetals , Pressure thermometers, Thermocouples, Pyrometry, Calibration of temperature measuring devices.

#### **Vibration & Shocks :**

Measurement of motions – Vibrometers and accelerometers, elementary vibrometers and vibration detectors. Elementary accelerometers. The Seismic instrument for vibration measurement. Calibration.

#### **MODULE – III (10 hours)**

Description of open and closed loop control systems and their block diagrams. Use of block diagram and signal flow graph to find overall transfer function.

1<sup>st</sup> and 2<sup>nd</sup> order systems and their response to step and sinusoidal input, error analysis, static and dynamic error coefficients.

Routh's stability criterion. The Root-Locus method, Bode plot and Nyquist plot, Gain margin and phase margin.

#### **TEXT BOOKS**

1. Beckwith, Marangoni T.GR D and Lienhard V J H, Mechanical Measurements, Pearson Education
2. Ogata K.K., Modern Control Engineering, Prentice Hall India.

## **ELECTIVE – II**

<b>ME-413</b>	<b>COMPUTATIONAL FLUID DYNAMICS</b>
<b>MA-401</b>	<b>SIMULATION AND MODELING</b>
<b>ME-433</b>	<b>COMPUTER AIDED DESIGN AND MANUFACTURING</b>
<b>PH-301</b>	<b>INTRODUCTION TO NANOTECHNOLOGY</b>
<b>ME-453</b>	<b>RAPID PROTOTYPING</b>
<b>ME-463</b>	<b>PRODUCTION AND OPERATIONS MANAGEMENT</b>
<b>ME-421</b>	<b>LASER APPLICATION IN MANUFACTURING</b>

**ME-413**

**COMPUTATIONAL FLUID DYNAMICS**

**(3-0-0)**

**MODULE-1 (12 Hours)**

Mathematical modeling: Conservation Equations, Governing equations (the equation of continuity, the momentum equation, the energy equation), the general scalar transport equations. Boundary conditions, Mathematical classification of partial differential equations: Elliptic, Parabolic, and Hyperbolic.

Numerical Methods: Mesh terminology and types, Discretisation methods. Taylor's series formulation, Finite Difference operation, Solution of discretisation equations, direct methods, and iterative methods.

**MODULE-2 (12 Hours)**

One dimensional steady state system, Diffusive system, diffusive-convective system (fin problem)

Discrete Approximation of Derivative: Finite volume Approach, Diffusive system, diffusive-convective system: central differencing scheme, the upwind differencing scheme.

**MODULE-3 (12 Hours)**

The Finite Volume method for unsteady problems: One dimensional unsteady heat conduction, explicit scheme, Crank-Nicolson scheme, the fully implicit scheme.

Introduction to solution Algorithm for pressure-velocity coupling in steady flows, SIMPLE Algorithm. CFD Applications: Duct Flow, CFD in Manufacturing.

**TEXT BOOKS**

1. Versteeg H. K. and Malalasekera, W. Introduction to Computational Fluid Dynamics: The Finite Volume Method, Prentice Hall (2nd Edition), ISBN-10: 0131274988
2. Ghoshdastidar P.S., Computer Simulation of Fluid flow and Heat transfer, Tata McGraw Hill

**REFERENCE BOOKS**

1. Suhas V. Patankar, Numerical Heat Transfer and Fluid Flow by Taylor and Francis, ISBN-10: 0891165223
2. Minkowycz W.J., Sparrow E.M, & Murthy J.Y.: Handbook of Numerical Heat Transfer: (John Willy & Sons. INC.)

**MA-401**

**SIMULATION MODELLING**

**(3-0-0)**

**MODULE-I (14 Hours)**

Introduction to Systems, Models and simulations, Discrete-event simulation, simulation of a single server queuing system, Steps in a sound simulation study, Continuous, Discrete-continuous and Monte Carlo Simulation, Advantages, Disadvantages and pitfall of simulation. List processing in simulation, Single-Server queuing simulation with Simlib. Simulation Software (classification and desirable features)

**MODULE-II (14 Hours)**

Review of Statistics, Random variables, Simulation output data and stochastic processes, Estimation of means, variances and correlations, Confidence intervals and Hypothesis testing, strong law of large numbers, Building valid, credible and appropriately detailed simulation model , Instruction, level of model detail, verification of simulation computer programs Techniques for increasing model validity and credibility. Selection of input probability distributions, Hypothesizing, families of distributions, estimation of parameters, Determining how representative the fitted distributions are.

**MODULE-III (14 Hours)**

Random-number generators (Linear congruential generators, composite generators, Testing random-number generators) Generating random variates (Inverse transform, composition, convolution,

acceptance-rejection of methods), Output data analysis for a single system (Transient and steady) State behavior of stochastic process, Types of simulations with regard to output analysis, statistical analysis for terminating simulations.

#### **TEXT BOOKS**

1. A.M. Law, Simulation Modeling and Analysis, 4<sup>th</sup> Edition, TMH , 2008.
2. N.Deo- Simulation and Modeling (PE)
3. Banks, Earson, Nelson & Nicol : Discrete Event system simulation

### **ME-433            COMPUTER AIDED DESIGN AND MANUFACTURING            (3-0-0)**

#### **MODULE – I (15 hours)**

##### **Fundamentals of CAD:**

The design process; Applications of computer for design; Creating the manufacturing database; Benefits of computer-aided- design. The design workstation; Graphics terminal, Operator input devices : plotters and other input devices.

##### **Computer Graphics Software and database:**

Software configuration; Functions of graphics packages; Constructing the geometry; transformations. Data base structure and content. Wire frame versus solid modeling ,other CAD features and CAD/CAM integration.

#### **MODULE – II (15 hours)**

##### **Numerical Control:**

Basic components of an NC system; NC procedure; NC coordinate systems; NC motion control system; Applications of numerical control; Economics of numerical control.

##### **NC part programming:**

Manual and computer assisted part programming; APT language, NC programming with interactive graphics.

##### **Computer Controls in NC:**

Problems with conventional NC; NC controller technology; Computer numerical control; Direct numerical control; Combined DNC/CNC systems; Adaptive control machining systems.

#### **MODULE – III (10 hours)**

##### **Computer integrated manufacturing systems:**

Types of manufacturing systems; Machine tools and related equipment; Material handling system; Computer control system; Human labour in the manufacturing system.

CIMS benefits.

#### **TEXT BOOK**

1. Grover M.P and Zimmers E.W. Jr., CAD/CAM, Pearson Education.

### **PH-301    INTRODUCTIONS TO NANOTECHNOLOGY    (3-0-0)**

#### **MODULE-I**

Background and definition of Nanotechnology, Why nano? Top-down & Bottom –up approaches to nanotechnology, Application in different fields

##### ***Properties of Nanoscale structure***

Effect of nanoscale on electronic structure, band gap, conduction, Magnetic properties, Mechanical properties, Chemical properties, Optical properties, quantum size effect. Solid disorder Nanostructure

(Failure mechanism of conventional grain sized materials, Its different properties, Metal Nanocluster composite, porous Silicon)

***Nanomaterials Fabrication & Methods of measuring properties.***

Mechanical & Chemical approaches, (RF Plasma, Ball milling, Thermo lyses, Sol-gel, Pulse Laser deposition, Chemical vapour deposition) , Brief discussion of Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), X-ray Diffraction (XRD).Atomic Force Microscope (AFM).

**MODULE-II**

***Carbon Nanotubes and Nanowires***

Introduction, fabrications & purification, filling of Nanotubes, Structure, Electrical properties, Mechanical properties, Vibrational properties, Applications.

***NanoElectronics***

Introduction to Quantum Well, Wires, Dots, Preparation of Quantum nanostructure, Applications (Infra red detectors, Quantum dot laser), Spintronics: (Introduction, Materials for Spintronis, Applications), Molecular Electronics, Photonics & Optoelectronics,

**MODULE-III**

***Nanomachines***

Intoduction to MEMS/NEMS, Fabrication according to applications. Nanotribology:- Studying tribology at nanoscale, its applications, Nanofludies & Nanolubricant and their applications.

**Introduction to Nanomedicine**

(Medical Applications of Nanomaterials : drug delivery, Cancer, Surgery, Nano robots, Cell repair etc)

***Social Implications of Nanoscience & Nanotechnology***

Applications and Social Impacts, Technological Convergence, Major Socio-Technical Trends

**TEXT BOOK**

1. Introduction to Nanotechnology by C.P. Poole (Jr) & F.J. Owens, - John Villy & Sons, Publication.(2006)
2. Principles of Nanotechnology, G. Ali Mansoori , World Scientific (2005)

**REFERENCE BOOK**

1. Springer Hand book on Nanotechnology, Edited by Bharat Bhusan, Springer Verlag (2003)

**ME-453**

**RAPID PROTOTYPING**

**(3-0-0)**

**MODULE – I (12 Hours)**

Classification of manufacturing processes, different types of manufacturing systems, Introduction to rapid Prototyping (RP), FMS, CIM and its application.

Basic principles of RP steps in RP, Process chain in RP in integrated CAD-CAM environment, advantages of RP.

**MODULE - II (15 Hours)**

Classification of different RP techniques based on raw materials, layering technique (2D or 3D) and energy sources. Slicing, Internal Hatching, Surface skin films, support structure. Process technology and comparative study of stereo lithography (SL) with photopolymerisation, SL with liquid thermal polymerization, solid foil polymerization, selective laser sintering, selective powder binding, Ballastic particle manufacturing: both 2D and 3D, Fused deposition modeling, Shape melting, Laminated object manufacturing solid ground curing, Repetitive masking and deposition.

### **MODULE – III (10 Hours)**

Beam interference solidification, Holographic interference solidification special topic on RP using metallic alloys, Programming in RP modeling.

#### **TEXT BOOKS**

1. Ghosh Amitav, Introduction to Rapid Prototyping, North West Publication, New Delhi
2. Noorani I Rafiq.; Rapid Prototyping: Principles and Applications Wiley publications.

## **ME-463 PRODUCTION AND OPERATION MANAGEMENT (3-0-0)**

### **MODULE-1 (12 Hours)**

Introduction to production and operation management, Manufacturing v/s Service operation, Strategic role of operations to competitive advantages, operation quality and productivity, Production systems, project, job shop, batch, mass production systems and Assembly line, Product life cycle, FMS,CIM,CAD,CAM and GT, Basic principles and Concepts.

Plant facilities Location, selection factors, Location models, Break even Analysis, Single facility and multi facility location models Plant lay out, types, Systematic layout planning and CRAFT Concept of Group Technology, Cell formation by order clustering method, Concept of line balancing ,Rank positional weight method For line balancing

### **MODULE-2 (12 Hours)**

Forecasting, Factors, Types of forecasting, Methods of forecasting Simple moving average, double moving average, simple and double exponential smoothing methods , Winter's method for Seasonal demand ,Forecasting Error analysis.

Project management concept, Network analysis, PERT and CPM Crashing of project Network, Project scheduling with limited resources and resource leveling, Modern trend in manufacturing, JIT System, TQM and total productive Maintenance, ISO-9000 and quality Circle, Kaizen, Poke Yoke, Supply chain management, Make or buy decision

### **MODULE-3 (12 Hours)**

Manufacturing planning and control, Aggregate planning and Master production Scheduling, Material and capacity requirement planning, Sequencing 2 and 3 machine cases, Johnson's rule, Concept of Inventory Control, EOQ Models, Economic batch Quantity, Safety Stock reorder point, ABC analysis. Principle of work study, Time study technique, Principle of motion study, Predetermined motion time standards and work sampling, standard time estimation.

#### **TEXT BOOKS**

1. Noorani R. Noorani, Production and operation Management, Prentice-Hall of India
2. Bedi Kaniska, Production and operation management, Oxford

#### **REFERENCE BOOKS**

1. Charry S.N., Production and operation management, TMH
2. Charry P. Charry Production and Operation Management, New Age International

## **ME-421 LASER APPLICATIONS IN MANUFACTURING (3-0-0)**

### **MODULE-1(14 hours)**

Laser Fundamentals: spontaneous & stimulated emission/absorption, population inversion & pumping, cavity design, coherence and interference.

Common industrial lasers and their output characteristics: CO<sub>2</sub>, Ruby, Nd-YAG, Nd-glass, excimer & He-Ne. Overview of laser Applications: Laser application in various fields, advantages & disadvantages, economics. Laser processing fundamentals: beam characteristics, optical components and design of beam delivery systems, absorption characteristics of materials, heat flow theory and metallurgical considerations.

### **MODULE-2(14 hours)**

Cutting and drilling: Process characteristics, material removal modes, development of theoretical models and practical performance. Welding: Process mechanisms like keyhole & plasma, development of theoretical models, operating characteristics and process variation.

Surface modification: heat treatment, rapid solidification, alloying and cladding, surface texturing, development of theoretical models, LCVD, LPVD.

### **MODULE-3(8 hours)**

Introduction to interferometry: working principles of Michelson interferometer and Fabry-Perot interferometer and elementary holography. Special topics: detection and measurement of radiation, laser safety

### **TEXT BOOKS**

1. Steen W. M., Watkins K., *Laser Material Processing*, 3rd edition, Springer, London, 2003.
2. Caristan C. L., *Laser Cutting Guide for Manufacturing society of Manufacturing Engineers*, USA, 1st Ed. 2004

### **REFERENCE BOOKS**

1. John Ion, *Laser Processing of Engineering Materials: Principles, Procedure and Industrial Application*, Elsevier, Butterworth-Heinemann, 1st ed, 2005
2. Duley W. W., *Laser Welding*, Wiley-Interscience; 1 edition 1999

## **Elective – III**

<b>ME-461</b>	<b>TRIBIOLOGY</b>
<b>ME-415</b>	<b>ROBOTICS &amp; ROBOT APPLICATION</b>
<b>ME-425</b>	<b>FLUID POWER AND CONTROL</b>
<b>ME-435</b>	<b>MECHANICAL VIBRATION</b>
<b>ME-445</b>	<b>WASTE HEAT RECOVERY &amp; ENERGY UTILISATION</b>
<b>HS-403</b>	<b>HUMAN RESOURCES MANAGEMENT</b>
<b>ME-465</b>	<b>NON DESTRUCTIVE EVALUATION</b>
<b>ME-467</b>	<b>MICRO/NANO ELECTRO MECHANICAL SYSTEMS</b>
<b>IT-401</b>	<b>ESSENTIALS OF IT (IT-4XX)</b>

**MODULE-I (8 Hours)**

**Introduction :** Lubricant and lubrication, Types of bearings ., properties and testing of lubricants, equations of flow Hagenoise flow., flow between two parallel plates

**MODULE-II (12 Hours)****Hydro dynamic lubrication :**

Petroffs equation for a lightly loaded bearing mechanism, pressure development in an oil film, Reynold's equation in two dimensions, load carrying capacity of slider bearing, load carrying capacity of journal bearing, Heat balance of lubricants

**Hydrostatic Bearing :**

Principles, Component of hydrostatic lubrication, Hydrostatic circular thrust bearing , calculation of required in pressure , load carrying capacity, flow rate , power loss in bearing due to friction, concept of gas lubricated bearing ,rolling elements bearing, selection of antifriction bearing

**MODULE-III (10 Hours)****Friction and wear of metals :**

Theories of friction, Bowden and Taylors simple adhesion theory: junction growth, deformation theory: Ploughing, other mechanism stick-slip, measurements method, inclined plane rig, pin and disc rig, surface contaminants, Effect of sliding speed on friction, classification and mechanism of water resistant materials. Types of wear , Adhesion wear, Abrasion wear, corrosive wear, Fatigue wear

**TEXT BOOKS**

1. Majumdar B.C ., Introduction to Tribology of Bearing , AHW
2. Cameron A., Basic Lubrication theory, John Wiley & sons.
3. Rao J.S. & Dukki Patti R.V., Mechanism and machine Theory, New Age International publication

**MODULE –I (12 hours)**

Robotics: Definition, Law of Robotics, theoretical background, Robotic system and Robot anatomy-common robot configurations, Manipulator, Coordinate system, work envelope, controller, Teach Pendants, Human system and Robotics specifications of robots, machine intelligence, Safety measures.

Robot kinematics: Representing the position, Two-DOF, 2D manipulator, 3 DOF, 2D Manipulator, 4DOF, 3D Manipulator, Homogenous transformations.

Robot Drive System: Mechanics of Hydraulic systems, Positive displacement pump, other types of pumps.

**MODULE-II(10 hours)**

Actuators: Linear and Rotary hydraulic actuators, Directional control valves, Servo control valves, Flow control valve, Pressure control valve.

Pneumatic system: Positive displacement compressor, Rotary compressor, Pneumatic conditioner-Air filter, Pressure regulator, electrical motors, Control loops, Principle of servo control in a robot, Stepper motor-Principle and drive circuit.

End effectors: Drive system for grippers, mechanical magnetic, vacuum and adhesive grippers.

### **MODULE-III (8 hours)**

Sensors: Need to sensing systems, sensing devices, Types of sensors, Contract, Force and Torque, Proximity and Range, Electro-optical sensors, Robot vision system.

Robot language and programming: Types of programming, Lead through programming, Motion programming, Robot language and application programming examples.

Robot Applications: Material handling, Machine loading and on loading, machining, Assembly, Inspection and welding.

### **TEXT BOOKS**

1. Deb S.R., Robotic Technology and Flexible Automations, TMH
2. Sensing, Vision and Intelligence, Fu. Lee, Gonzalez, Robotics: Control, McGraw-Hill, 1987.

### **REFERENCE BOOKS**

1. Esposito Anthony, Fluid Power with Applications, Prentice Hall International, Inc
2. Majumdar S.R., Pneumatic Systems: Principles and Maintenance, TMH.

## **ME-425                      FLUID POWER AND CONTROL                      (3-0-0)**

### **MODULE –I (10 hours)**

**Introduction:** Fluid power, Comparison of Fluid Power system with Mechanical and electrical systems, Components of fluid power system and their Symbolic Representations/schematics, Typical Fluid Power Circuits and Fluid Power Control Systems, Pneumatics – properties of air, air preparation, air control valves, pneumatic activators.

**Fluid hydraulics:** Types and Properties of hydraulic fluids, Fire resistant fluids, Pascal’s law and its application.

**Distribution system:** Introduction, Conductor sizing for flow rate requirements, pressure rating of conductors, steel pipes, steel tubing, plastic tubing, flexible hoses, quick disconnect couplings.

**Hydraulic pumps:** Classification of pumps, Gear pumps, piston pumps, pump ideal and actual performance, pump selection, pump performance ratings.

### **MODULE- II (13 hours)**

**Fluid power actuators:** Linear hydraulic actuators, Mechanics of hydraulic cylinders, loading. Limited rotation hydraulic actuators, Gear motors, vane motors, Piston motors, Hydraulic motor transmission, hydrostatic transmission, Electro-hydraulic stepping motors, low- speed high- torque motors, hydraulic motors, Performance rating of motors.

**Control components in hydraulics:** Types of fluid power control system, Direction control valves, Pressure control valves, flow control valves, servo valves, cartridge valves, hydraulic flues, pressure and temperature switches, shock absorbers.

**Hydraulic circuits:** Linear, Regenerative, High-Low Circuits. Sequence Circuit, Control of single acting and double acting hydraulic cylinder, Speed Controlling by Metering in, Metering out and Bleeder arrangements, design of hydraulic circuit for specific application, hydraulic cylinder sequencing circuit, hydrostatic transmission system, accumulators and intensifiers – types and their circuits, Mechanical-hydraulic servo system, Pneumatic circuits – Circuit design considerations, pressure losses in pipelines, basic pneumatic circuits, pneumatic vacuum system, Accumulator system analysis.

### **MODULE- III (13 hours)**

**Control Modeling for Fluid Elements:** Orifice Modeling for Fluid lines and Valve Ports as Fluid Resistance, Modeling Fluid Mass as Inertia, Modeling Gas Compressibility as Fluid Capacitance, Spring-mass-damper System and Its Analogy to a Control Valve Modeling, Control Modeling for

Fluid Systems – First Order System and its Characteristics, Open loop Control of Water Level in a Tank with Long Exit Line. Second Order Systems and Characteristics, Two-Tank System with Control Valve, Loaded Actuator Control by a Control Valve.

**Electrical controls for fluid power circuits :** Electrical components , control of cylinder using circuit switches , dual cylinder using circuit switches of regenerative circuits, counting timing and reciprocation of hydraulic cylinder, programmable logic controllers (PLC's)

**Fluid power maintenance:** Sealing devices, reservoir systems, Filters & strainers, Trouble shooting of fluid power circuits, Leakage analysis and modeling, safety considerations.

#### **TEXT BOOKS**

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall Inc.
2. Sullivan, “Fluid Power, theory and applications”, Prentice Hall Inc

#### **REFEREBCE BOOKS**

1. Pinches Michael J. and Ashby John G., “Power Hydraulics”, Prentice Hall Inc.
2. Ernst Walter, “Oil Hydraulic Power and Its Industrial Applications”, McGrawHill Book Co., 1960.

## **ME-435**

## **MECHANICAL VIBRATION**

**(3-0-0)**

### **MODULE – I(12 hours)**

**Fundamentals of Vibrations:** Introduction, Free vibration, Forced vibration, Simple harmonic motion, Basic relations, Representation of simple harmonic motion in complex form. Combination of two simple harmonic motions, Constituent harmonic motion along a straight line, Phenomenon of beats. Constituent motion along perpendicular lines, Fourier analysis, Fourier Integral. Modeling of vibratory system: inertia elements, stiffness elements, dissipation elements and model construction.

**Undamped Free Vibrations of Single Degree of Freedom Systems:** Introduction, governing equation and its Solution, Torsional Vibrations, Equivalent stiffness of spring combinations: Spring inclined to the direction of motion, parallel springs, series springs, Springs in series, Springs in parallel, Energy method.

**Damped Free Vibrations of Single Degree of Freedom Systems:** Free vibrations with viscous damping, Over-damped system, Critically-damped system, Under-damped system, Logarithmic decrement, Dry friction or Coulomb damping, Frequency of damped oscillations, Rate of decay of Oscillations.

### **MODULE – II (10 hours)**

**Forced Vibrations of Single Degree of Freedom Systems:** Introduction, Forced vibrations with constant harmonic excitation, Steady state solution with viscous damping, Forced vibrations with rotating and reciprocating unbalance, Forced vibrations due to excitation of the support, Absolute amplitude, Relative amplitude, Energy dissipated by damping, Forced vibrations with Coulomb and viscous damping, Forced vibrations with structural damping, Determination of equivalent viscous damping from frequency-response curve, System identification from Frequency response, Vibration isolation and transmissibility, Force transmissibility, Motion transmissibility, Typical isolators & mount types, Vibration measuring instruments, Displacement measuring instruments or vibrometers, Velocity measuring instruments or velocity pick-ups, Acceleration measuring instruments or accelerometers, Frequency measuring instruments.

### **MODULE – III (14 hours)**

**Two Degrees of Freedom Systems:** Introduction, Principal modes of vibration, Other cases of simple two degrees of freedom systems, Two masses fixed on tightly stretched string, Double pendulum, Torsional system, Combined rectilinear and angular modes, System with damping, Undamped forced

vibrations with harmonic excitation, Vibration absorbers, Undamped dynamic vibration absorbers, Centrifugal pendulum absorber, Dry friction damper, Untuned viscous damper, Vibration isolation.

**Multi Degree of Freedom Systems:** Multi-degree freedom system: Influence coefficients, generalized co-ordinates, matrix method, orthogonality principle, matrix iteration method. Vibration of Beams: Uniformly loaded, Carrying more than one concentrated load, Energy method, Dunkerley's method, Rayleigh's method. Torsional Vibration: Two rotor system, three rotor system, multi-rotor system, Geared system.

#### **TEXT BOOKS**

1. Meirovitch Leonard , Fundamentals of Vibrations, MC-GRAW Hill.
2. Thomson W. T., Theory of Vibration with Applications, 5th Ed., Prentice. Hall.

#### **REFERENCE BOOKS**

3. Rao, S. S. Mechanical Vibrations, 3rd Edition, Prentice-Hall.
4. Balachandran Balakumar, Magrab, Edward B. Fundamentals of vibration,

## **ME-445 WASTE HEAT RECOVERY & ENERGY UTILISATION (3-0-0)**

### **MODULE –I (10 hours)**

**Energy resources & Consumption:** Commercial and non-commercial forms of energy, Fossil Fuels, Renewable sources including Biofuels, their utilization & consumption pattern. Sources of waste heat and its potential applications, waste heat survey and measurements.

**Compound Cycles, Combined Plants & Cogeneration Systems:** Applications, advantages, saving potentials.

### **MODULE-II (10 hours)**

**Gas-to-Gas & Gas-to-Liquid heat recovery systems:**

**Regenerators and Recuperators:** Shell and Tube heat exchangers, Spiral tube heat exchangers.

**Thermic Fluid Heaters.**

**Waste heat Boilers:** Classification and Design considerations.

**Heat pipe exchangers:** Theory and applications.

**Furnaces:** Classification, general fuel economy measure in furnaces, excess air heat distribution, temperature control, draft control, waste heat recovery.

**Steam Systems:** Assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system.

**FBC Boilers:** Introduction, mechanism of fluidized bed combustion, advantages, types of FBC boilers, operational features, retrofitting FBC system to conventional boilers, waste heat recovery.

Air-conditioning and Refrigeration systems: waste heat recovery.

### **MODULE-III (10 hours)**

Thermo-electric system to recover waste heat, heat pump. Heat recovery from Incineration plants.

**Storage system:** Necessity, classification and uses.

#### **TEXT BOOK**

1. Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London, 1963.

#### **REFERENCE BOOKS**

1. Reay D.A., Heat Recovery Systems, E & F.N. Span, London, 1979.
2. Butler Charles H., Cogeneration, McGraw Hill Book Co., 1984
3. Fuel Economy in furnaces and Waste heat recovery-PCRA.

## **HS-403                      HUMAN RESOURCE MANAGEMENT                      (3-0-0)**

### **MODULE-I**

Concept, nature and scope of HRM, creating HR base, concept of job analysis, methods of job analysis, recruitment, sources and methods, selection and promotion

### **MODULE-II**

Training and development, monitoring and evaluation, performance appraisal methods, collective bargaining, worker's participation in management

### **MODULE-III**

Industrial relations, negative aspects of industrial relations, trade union, industrial disputes, grievance, and disciplinary actions.

### **TEXT BOOKS**

1. Aswathapa, Human resource Management, TMH

### **REFERENCE BOOKS**

1. Mathis and Jackson, Human Resource Management, Thomson

## **ME-465                      NON DESTRUCTIVE EVALUATION                      (3-0-0)**

### **MODULE-I (14 hours)**

**Non Destructive Evaluation:** Principle, developments of methods, standards and limitations. Possible material defects in Casting, Forging and Welding Metallurgical process, Visual inspection methods and liquid penetrant techniques, Magnetic Particle and eddy current methods: Basic principles, limitations and applications.

**Ultrasonic methods:** Transducers, Ultrasonic beam profile, loss energy in transmission, probe heads, probe selection, angle beam probes, contact type probes, immersion probes, twin element probe, focused transducers testing techniques, pulse echo-contact, immersion through transmission, resonance methods, performance evaluation of NDT transducers, calibration blocks.

### **MODULE-II (14 hours)**

**X ray radiography:** X-ray film processing, film types, Geometrical factors, Penetrimeters, Weld radiography, pipe radiography, reference radiography, Image intensifiers.

**Gamma ray radiography:** Half life, curie-Roentgen-Half value layer thickness, Gamma ray sources, Permissible exposure, Exposure calculation.

**Principles of Neutron Radiography:** Sources, Slow neutron beams, Neutron image detectors, flaw detection by Neutron radiography, limitation of Neutron radiography, comparison with X-ray radiography.

**Electromagnetic Acoustic transducers:** generation of various types of waves, Laser generated Ultrasonics, Thermo elastic generation of Ultrasonics, Ultrasonics in ablation regimes, Laser Ultrasonics at an angle calibration, Acoustic Emission flaw detection.

### **MODULE-III (8 hours)**

**Surface methods using Electron diffraction technique:** Low Energy Electron Diffraction (LEED), reflection high energy electron diffraction (RHEED)

**Surface methods using Neutron diffraction technique:** Neutron spectrometer, neutron diffraction in hydrogeneous matter, detection of antiferromagnetism.

## **TEXT BOOKS**

1. Kraut Kramer J. and Kraut Kramer H., Ultrasonic Testing of Materials, Narosa Publishing House, New Delhi.
2. Hull .B and John V.B., Non Destructive Testing, Mc Millan ELBS.
3. Bindal, Narosa V.N., Transducer for Ultrasonic Flaw Detection V.N. Bindal, Narosa Publishing House, , New Delhi.
4. Beldevraj, Thavasimuthu and Jayakumar, Narosa, Non Destructive Testing by Ultrasonic Methods, Publishing House, New Delhi.
5. Bacon, GE, X-ray and Neutron diffraction, Pergamon Press.

## **REFERENCE BOOKS**

1. Non Destructive Testing of Examination- Hand Book, Knud Edr.. Boving, G. Jaico Pub. House, New Delhi, 1995.
2. Tyufyakov N.D., and Shtan A.S., Principles of Neutron Radiography, Amerind Pub. Co. New Delhi, 1979.
3. Prutton M, Surface Physics, Clarendon Press, Oxford.
4. Beldevraj and Jayakumar, Non Destructive Testing of welds, Narosa Publishing, New Delhi.
5. Neutron Radiography – a Monograph, IGCAR Kalpakkam, Sep. 1999.
6. Treatise on Materials Science and Technology, Vol. 27, “Analytical technique for thin films”, Academic Press, Inc., New York, 1991.

## **ME-467 MICRO/NANO ELECTRO MECHANICAL SYSTEMS (3-0-0)**

### **MODULE – I (14hours)**

Introduction to MEMS/NEMS, MEMS/NEMS devices, MEMS/NEMS Material and their mechanical, electrical and optical properties, micro/nano fabrication methods and process integration, Basic MEMS/NEMS operating principles; mechanics, dynamics and electrostatics, Scaling laws.

### **MODULE – II (14 hours)**

Basic and advanced MEMS/NEMS operating principles for sensing and actuation, including piezoresistive, piezoelectric and thermo-mechanical, Design of MEMS/NEMS actuators and sensors, Microfluidics: Flow, heat and mass transfer at small scales; electrokinetics; power MEMS/NEMS and bioMEMS/NEMS applications.

### **MODULE-III (8hours)**

Nanotechnology concepts and principles, Bio-scientific and medical applications, Electronic control of MEM/NEMS devices and noise, Applications in automobile and aeronautical industry, Applications to fiber-optic communications and Photonics.

## **REFERENCE BOOKS**

1. Senturia S.D. Microsystems Design Kluwer Academic publisher 2000.
2. Senturia Stephen D., Kluwer, Microsystem Design, Boston, 2001.
3. Tai-Ran Hsu MEMS and Microsystems: Design and Manufacture, Tata McGraHill, 2001.
4. James Allen, Taylor & Francis Micro-electro-mechanical system design, 2005.
5. Nadim Maluf and Kirt Williams An introduction to Microelectromechanical systems engineering, Artechhouse, 2004.

**MODULE-I (10 Hours)**

Fundamentals of Computer Architecture-Introduction-Organization of computer, Central Processing Unit-Execution Cycle- Instruction categories- measure of CPU performance, Memory-Input/Output devices-BUS- addressing modes, System software-Assemblers-Loaders and Linkers-Compilers and Interpreters, Operating system-Introduction- Process management scheduling-Memory management-Threads. Problem Solving with Algorithms, analysis of algorithms-Asymptotic notations

**MODULE-II (12 Hours)**

RDBMS-data processing-the database technology-data models, ER-modelling concepts-notations-Extended ER features, Logical database design-Normalization, SQL-DDL statements-DML statements-DCL statements, SQL tuning techniques. Objects oriented concepts-object oriented programming, UML class Diagrams-relationships-Inheritance-Abstract classes-Polymorphism, and Object Oriented Design methodology.

**MODULE-III (08 Hours)**

System Development Methodologies-Software Development Models, Components of Web Application-Browsers and Web servers, World Wide Web, URL-HTML-HTTP protocol-Web Applications-Application Servers-Web Security.

1. Table Creation and Queries using SQL
2. A Simple project on Database Design
3. Design the Bio- Data From using HTML

All the assignments will be done in the Computer lab.

**TEXT BOOKS**

1. Abraham Silberschatz and Peter Bear Galvin, Operating system concepts, Addison welsley.
2. David A. Patterson, John L. Hennessy, Computer Organisation & Design , Elsevier.
3. R. Elmasri, S. Navatne : 4<sup>th</sup> Edition, Fundamental of Database Systems, Pearson Education.
4. Blaha, Rumbaugh, Object-oriented Modelling & Design with UML,; PHI

**REFERENCE**

1. Infosys course materials.

**MODULE-I [12 hours]**

Introduction to Management: Science, Theory and Practice; Importance and Scope of Management; Evolution of Management Thought; Management and Environment- Environmental Impact on the Management Process; Globalisation and Business Environment; Social Responsibilities and Obligations of Business Management.

Importance of Management in Engineering and Technology - Critical Factors in Managing Technology, Management of Technology and Global Competitiveness, Formulation of a Technology Strategy; Creating the Product-Technology-Business Connection, Technology Planning, Technology as an Instrument of Competition.

**MODULE-II [12 hours]**

The Process of Management; Planning – Essentials of Planning and Managing by Objectives, Strategies, Policies, Planning Perishes, and Decision Making; Organising – Principles of

Organization, Organization Structure, Effective Organizing and Organization Culture; Directing – Crisis Management and Corporate Governance; Staffing – Selection, Training, Development, Appraisal, Knowledge Management; Controlling – The System and Process of Controlling, Control Techniques and Information Technology.

### **MODULE-III [12 hours]**

Functions of Management – Marketing Function of Management, Modern Concept of Marketing, Functional Classification of Marketing, Marketing Mix, Fundamental Needs of Customers, Role of Distribution Channels and Advertising; Financial Functions of Management – Concept of Financial Management, Project Appraisal, Tools of Financial Decision Making, Introduction to Short-Term and Long-Term Sources of Financing.

#### **TEXT BOOKS**

1. Essentials of Management, Harold Koontz and Heinz Weihrich, Tata McGraw Hill, 8<sup>th</sup> Edition, 2010.
2. Business Organisation and Management, C. R. Basu, Tata McGraw Hill, 3<sup>rd</sup> Reprint, 2008.
3. Management of Technology, Tarek Khalil, Tata McGraw-Hill Edition, 2009.

#### **REFERENCE BOOKS**

1. Management – Theory and Practice, C. B. Gupta, 14<sup>th</sup> Edition, S. Chand & Sons, 2009.
2. Financial Management, I. M. Pandey, Vikas Publications, 9<sup>th</sup> Edition, 2009.

## **ME-402                      POWER PLANT ENGINEERING                      (3-0-0)**

### **MODULE – I (12 hours)**

**Introduction :** Different sources of energy; Types of power plants.

**Steam Power Plant :** Classification of steam power plants; Layout of a modern steam power plant, site selection, fuel handling: Coal handling systems coal handling. Burning of coal: Stoker firing; Pulverised fuel firing; Fluidised bed combustion (FBC), Ash handling equipments and systems; Dust collection; Removal of dust and dust collectors; Fly ash – its composition, disposal and applications. Chimney draught: Classification; Chimney height and diameters; condition for maximum discharge, Artificial draught; Forced, induced and balanced draught, steam jet draught.

### **MODULE – II (12 hours)**

**Steam Boilers :** Introduction; classification of boilers; fire tube boilers: Cochran boiler, Lancashire boiler; Water tube boilers; Babcock and Wilcox boiler, Stirling boiler; High pressure boilers: Benson and Velox boilers; Boiler mountings : Pressure gauge, Water level indicator, steam stop valve, Dead weight safety valve, Fusible plug etc; Accessories: Economiser, Air preheater, superheater; performance of boilers : Equivalent evaporation, Factor of evaporation, Boiler efficiency; Steam condensers: Classification; Jet condensers; Surface condensers; Vacuum measurement, vacuum efficiency; Condenser efficiency; Estimation of mass of cooling water; Spray ponds; Cooling towers, Dry cooling towers; Feed water treatment : Classification of impurities in water; Methods of feed water treatment, pH value of water.

### **MODULE – III (10 hours)**

**Nuclear Power Plant :** Introduction; Nuclear fuels; Nuclear fission; Reactor components; materials and classification; Pressurised water reactor (PWR); Boiling water reactor (BWR); CANDU reactor; gas cooled reactor; Liquid metal fast breeder reactor; Heavy water reactor.

#### **TEXT BOOKS**

1. Nag P.K., Power Plant Engineering, (TMH)
2. Wakil M.M.EI –, Power Plant Technology, (Mc Graw Hill)

#### **REFERENCE BOOK**

1. Rajput R.K., Power Plant Engineering, (L.P.)

## **ELECTIVE – IV**

<b>ME-412</b>	<b>MECHATRONICS</b>
<b>ME-422</b>	<b>ENTREPRENEURIAL DEVELOPMENT</b>
<b>ME-432</b>	<b>RENEWABLE ENERGY SOURCES</b>
<b>ME-423</b>	<b>MAINTENANCE ENGINEERING</b>
<b>ME-462</b>	<b>PROCESS HEAT TRANSFER</b>
<b>IT-417</b>	<b>MANAGEMENT INFORMATION SYSTEM</b>
<b>HS-404</b>	<b>MARKETING MANAGEMENT</b>
<b>ME-427</b>	<b>TECHNOLOGY FOR SURFACE COATING.</b>

**MODULE – I (16 hours)**

Introduction to mechatronics, Mechatronic products, Types of mechatronic products, Mechatronic system and its components, Mechatronic design approach, System interfacing, Instrumentation and control systems, Microprocessor-based controllers, System response.

Introduction to Sensors and Actuators: Fundamentals of time and frequency, Sensor and actuator characteristics. Sensors: Linear and Rotational sensors , Acceleration sensors, Force measurement, Torque and power measurement, Flow measurement, Temperature measurement, Distance measuring and proximity sensors, Light detection, Image and vision systems, Integrated micro-sensors. Actuators: Electrical actuators, Piezoelectric actuators, Hydraulic and Pneumatic actuation systems, MEMS: Micro-transducers, Analysis, design and fabrication methods.

**MODULE – II (10 hours)**

**Signal conditioning:** The operational amplifier, Protection, Filtering, Wheatstone bridge, Digital signal, Multiplexers, Data acquisition, Digital signal processing, Pulse modulation. Closed-loop Control System: Continuous and discrete processes, Control modes, Two-step mode, proportional mode, Derivative control, Integral control, PID controller, Digital controller, Control system performance, Controller tuning, Velocity control, Adaptive control.

**MODULE – III (10 hours)**

**Input / Output System:** Interfacing, Input / Output addressing, Interface requirements, Peripheral interface adaptors, Serial Communication interface, Examples of interfacing. Communication System: Digital communications, Centralized, Hierarchical and Distributed control, Networks, Protocols, Open system interconnection communication model, Communication interfaces.

**TEXT BOOKS:**

1. Bolton W., Mechatronics, 3rd Edition, Pearson Education Limited.
2. De Silva Clarence W, Mechatronics: An Integrated Approach, CRC Press

**REFERENCE BOOKS**

1. HMT, Mechatronics, TMH
2. Mahalik N.P, Mechatronics: Principles, Concepts And Applications, TMH

**ME-422    ENTREPRENEURAL DEVELOPMENT****(3-0-0)****MODULE – I (12 hours)**

Introduction to Entrepreneurship, Quality of an entrepreneur, charms of becoming an entrepreneur, Life story of few successful entrepreneurs of Indian and abroad.

Achievement motivation training, Business opportunity identification and guidance, source of new technology and product ideas – CSIR Labs, New, sector specific, technologies.

Business plan preparation, Exercise on preparation of initial business plan and presentation of business plan.

**MODULE-II (12 hours)**

Marketing Management-need and importance, Market survey-tools and techniques, Market assessment and promotion, Export/Import formalities. Concept of Micro, Small, Medium enterprises. Planning a small scale Industry.

### **MODULE-III (12 hours)**

Financial management, working capital assessment and management, Accounting principle and tax formalities, source of finance and incentives for technical entrepreneurs, seven crisis in Business, Source of non-financial support for MSME entrepreneurs from govt. and non-govt. organization.

Project Report-detailed project report, project viability analysis and understanding criteria for bankable projects.

#### **TEXT BOOKS**

1. Deshpande M.V., Entrepreneurship and Small Industries, Deep and Deep Pub. House.
2. Desai Vasant, Management of Small Scale Industry, Himalaya Pub. House.

#### **REFERENCE BOOKS**

1. EDI, Ahmedabad – Course material for Management of business Enterprises.
2. Atkinson J.W and Utwin G.H., Achievement motive and test anxiety conceived as motive to approach success and motive to avoid failure, Journal of abnormal and social psychology, 1960, 60.
3. McClelland, D.C. and Winter D.G. Motivating Economic achievement, , Newyork free press 1969

## **ME-432 RENEWABLE ENERGY SOURCES (3-0-0)**

### **MODULE -I (10 Hours)**

Fossil fuel; Sources, Supply; Extractor, demand and non-renewable feature; Environmental implications of fossil fuels; Air Pollution; Green house gas emission and land degradation; Fossil fuel supply and consumption in India.

### **MODULE – II (12 hours)**

Renewable energy technologies; Solar, Wind; Biomass, Hydro etc.; Technical and economic potential

### **MODULE – III (11 hours)**

Technology status : Global and India; Economic analysis; Renewable energy programme policies and measures. Environmental implication of renewable energy, case study on renewable energy project.

#### **TEXT BOOKS**

1. Renewable Energy Power for a sustainable future, Oxford University Press, 1996.
2. Cassidy E & Grossman P, Introduction to Energy Sources, Cambridge University Press, 1998.

## **ME-423 MAINTENANCE ENGINEERING (3-0-0)**

### **MODULE-I (14 hours)**

Fundamentals of Maintenance Engineering, Maintenance engineering its importance in material & energy conservation, Inventory control, Productivity, Safety, Pollution control etc.

Safety Regulations, Pollution problems, Human reliability, Total productivity maintenance (TPM), Environmental issues in maintenance, Types of maintenance strategies, Planned and unplanned maintenance, Breakdown, Preventive & Predictive maintenance their comparison, Advantage & disadvantages. Limitations, Computer aided maintenance, Maintenance scheduling, Spare part management, Organization of maintenance department.

### **MODULE – II (14 hours)**

Friction wear and lubrication, Friction & wear mechanisms, Prevention of wear, Types of lubrication mechanisms, Lubrication processes. Lubricants- types, General and special purpose, Additives, Testing of lubricants, Degradation of lubricants, Seal & packing. Condition based maintenance, Signature analysis, Oil analysis, Vibration, Noise and thermal signatures, On line & off line techniques, Instrumentation & equipment used in machine health monitoring. Instrumentation in maintenance, Signal processing, Data acquisition and analysis, Application of intelligent systems, Data base design.

### **MODULE – III (8 hours)**

Introduction to RAM failure mechanism, Failure data analysis, Failure distribution, Reliability of repairable and non-repairable systems, Improvement in reliability, Reliability testing, Reliability prediction, Utilization factor, System reliability by Monte Carlo Simulation Technique.

### **TEXT BOOKS**

1. Ebeling , An Introduction to Reliability and Maintenance Engineering, TMH
2. Srivastav S.K., Maintenance Engineering, S.Chand

### **REFERENCE BOOKS**

1. Higgins Lindly, Maintenance Engineering Hand Book, TMH
2. Hicks, Maintenance Engineering Hand Book, TMH
3. Niebel B.W., Engineering Maintenance Management, CRC Press.

## **ME-462**

## **PROCESS HEAT TRANSFER**

**(3-0-0)**

### **MODULE – I (14 hours )**

**Heat Exchangers :** Double pipe counter flow exchanger, Double pipe parallel Exchanger, Tubular Exchanger, Tubular heater and cooler, Tubular gas after cooler and Inter Cooler, Compact Heat Exchanger.

### **MODULE – II (12 hours )**

**Condensers :** Horizontal and vertical condenser, Desuperheater, Subcooler, surface condenser.

**Evaporation :** Raw water Evaporator, Power Plant makeup Evaporator, Process multiple effect evaporator, Heat transformer evaporation.

### **MODULE – III (10 hours )**

Vaporizing Exchangers; Vaporizer, Forced circulation, Thermosyphon reboiler, both horizontal and vertical type, Gas Cooler (Nitrogen-water) two phase flow co-relations.

### **TEXT BOOKS**

1. Das, Sarit K. Process Heat Transfer, Amazon Publication.

### **REFERENCE BOOKS**

1. Sadik and Kakag, Heat Exchangers, Kluwer Academic Publishers
2. Kays W.M., Compact heat Exchanger.
3. Kern D.Q., Process Heat Transfer, Mc-Graw hill Publications

## **IT-417            MANAGEMENT INFORMATION SYSTEM            (3-0-0)**

### **MODULE-I (12 Hours)**

Fundamentals of Information Systems, Systems approach to problem solving, Developing information system solutions. Information system components, Information quality, Data resource management, Database, Data models, Information Systems in marketing, manufacturing, HRM, Accounting and Finance.

### **MODULE-II (12 Hours)**

Information analysis and design tools : Decision tools, Decision Table, Structured Analysis, Dataflow Analysis, Tools for dataflow strategy, Developing dataflow diagrams, Leveling, Data dictionary, Structured flow chart, HIPO, Warnier/ORR diagram.

### **MODULE-III (12 Hours)**

Planning & implementation of Information Systems, Transaction Processing Systems, Executive information Systems, Decision Support Systems, Expert Systems, Knowledge Management. Computer crime, Security (Goals, risks, controls, security & recovery measures of IS, economics of information security) & ethical challenges.

### **TEXT BOOKS**

1. James A. O'Brien, George M. Marakas, Management Information Systems, Eighth Edition, 2008, McGraw-Hill Education (India), New Delhi.
2. Kenneth C. Laudon, Jane P. Laudon, Management Information Systems, Tenth Edition, Pearson Education Inc., New Delhi.

### **REFERENCE BOOKS**

1. Kenneth E. Kendall, Julie E. Kendall , System Analysis and design, PHI Learning Pvt. Ltd., New Delhi.
2. James A. Senn ,Analysis & Design of Information Systems, McGraw-Hill Education, New Delhi
3. Effy Oz, Management Information Systems, Sixth Edition, 2009, CENGAGE Learning India Pvt. Ltd., New Delhi.
4. Robert G. Murdick, Joel E. Ross, James R. Claggett, Information Systems for Modern Management, Third Edition, PHI Learning Pvt. Ltd., New Delhi.
5. Stephen Haag, Maeve Cummings, Amy Philips, Management Information Systems, Sixth Edition, 2007, McGraw-Hill Education (India), New Delhi.
6. Gordon B. Davis, Margarethe H. Olson, Management Information Systems, Second Edition, 1985, McGraw-Hill Education (India), New Delhi.
7. Mahadeo Jaiswal, Monika Mital, Management Information Systems, First Edition, 2004, Oxford University Press, New Delhi.

## **HS-404            MARKETING MANAGEMENT            (3-0-0)**

### **MODULE-I**

Marketing concept, marketing process, marketing environment, marketing mix, STP strategy-segmentation, targeting and positioning

### **MODULE-II**

Creating customer value, competitor analysis, marketing control process, marketing audit, consumer behavior, new product planning and development, Product life cycle

### **MODULE-III**

Branding, packaging, pricing, distribution channels, promotion mix, advertising, sales promotion and CRM

**TEXT BOOKS**

1. Kotler, Marketing Management, PHI
2. Rajan Saxena, Marketing Management, TMH

**REFERENCE BOOKS**

1. Stanton, Marketing management, TMH

**ME-427            TECHNOLOGY FOR SURFACE COATING            ( 3-0-0)****MODULE-I(12 hours)**

Purpose and scope of surface coatings: Surface coating processes and characterization of coatings:

**MODULE-II(16 hours)**

Flame spraying: Detonation spraying: Spray and fuse welding: Cladding: Electroplating: Electrophoretic deposition: Chemical vapour deposition: Metallizing etc.

**MODULE-III(8 hours)**

Factors affecting the choice of coating material and process: Testing of surface coatings.

**TEXT BOOKS**

1. Paul Swaraj, Surface coatings: Science and Technology, 1985, John Wiley & Sons
2. Lambourne R., Paint and surface coatings, theory and practice, Ellis Horwood Ltd. Publisher – 1987.

**REFERENCE BOOKS**

1. Dunkley F.G. and Collier C.W. The Testing of Paints, Vol – V, Paint Technology Manual, Chapman and Hall.
2. Hess Manfred, Paint film defects and their remedies, Chapman and Hall Ltd. London 1958.

## **ELECTIVE – V**

<b>ME-432</b>	<b>COMPOSITE MATERIALS</b>
<b>ME-452</b>	<b>SOLAR ENERGY ENGINEERING</b>
<b>ME-462</b>	<b>CRYOGENICS</b>
<b>ME-414</b>	<b>SAFETY ENGINEERING</b>
<b>ME-424</b>	<b>INJECTION MOLDING AND MOLD DESIGN</b>
<b>EC- 333</b>	<b>MICROPROCESSORS &amp; MICROCONTROLLERS</b>
<b>EC-452</b>	<b>SOFT COMPUTING</b>

**MODULE – I (10 hours)****Introduction, Basic Concepts, Materials, Processes and Characteristics:**

Introduction; Applications; Advantages and limitations; Geometric and Physical definitions; Material response under load; Classification of composite materials; Lamina and Laminate; Scale of analysis – micromechanics and macromechanics; Basic lamina properties; Constituent materials – Reinforcement and matrices; Manufacturing methods.

**Elastic behavior of composite lamina – Micromechanics**

Micromechanics methods – (1) Mechanics of materials methods, (2) Bounding methods, (3) Semiempirical methods; Longitudinal elastic properties and transverse elastic properties of lamina with continuous fibers; Inplane shear modulus.

**MODULE – II(14 Hours)****Elastic behavior of composite lamina – Macromechanics:**

Stress-strain relations for (i) general anisotropic material, (ii) special orthotropic material, (iii) transverse isotropic material, (iv) orthotropic material under plane stress, (isotropic material; Relation between mathematical and engineering constants; Relations and transformations in two dimensions such as (1) Stress-strain relation for a thin lamina, (2) Transformation of stress and strain, (3) Transformation of elastic parameters, (4) Transformation of stress-strain relations in terms of engineering constants, and (5) Transformation relation for engineering constants; Transformations in three dimensions such as (1) Transformation of stress and strain, and (2) Transformation of elastic parameters.

**MODULE – III(12 Hours)****Strength of unidirectional lamina – Micromechanics:**

Failure mechanisms and strength under longitudinal tension; Ineffective fiber length under long Broutman itudinal tension; Longitudinal compression; Transverse compression; Inplane shear; Out-of-plane loading.

**Strength of composite lamina – Macromechanics:**

Introduction; Failure theories; Maximum stress theory; Maximum strain theory; Tsai-Hill theory.

**Elastic behavior of multidirectional laminates:**

Basic assumptions; Strain-displacement relations; Stress-strain relations of a layer within a laminate; Force and moment resultants; Laminate stiffnesses; Laminate compliances; Symmetric laminates; Balanced laminates; Orthotropic laminates; Design considerations; Laminate engineering properties.

**TEXT BOOKS**

1. Daniel I. M. and Ishai O, Engineering Mechanics of Composite Materials, Oxford University Press, 2006.
2. Jones R.M., Mechanics of Composite Materials, 2<sup>nd</sup> edition, Taylor & Francis inc., 1999.

**REFERENCE BOOKS**

1. Agarwal B.D. and L.J., Analysis and Performance of Fiber Composites, Wiley-Interscience Publication,1980.
2. Chawla K.K., Composite Materials: Science and Engineering, 2<sup>nd</sup> Edition, Springer-Verlag,1998.
3. Hull D and Clyne T.W., An Introduction to Composite Materials, Cambridge University Press, 1997.
4. Sharma S C, Composite Materials, Narosa Publishing House, New Delhi, 2000.

**MODULE – I (10 hours)****Solar Radiation :**

The Sun; the solar constant; Variation of extraterrestrial radiation; Solar time; Direction of beam radiation; Tilt factor for beam radiation; Extraterrestrial radiation on horizontal surface.

**Available Solar Radiation :**

Estimation of average solar radiation; Distribution of Clear and cloudy days and hours radiation; beam and diffuse components of hourly radiation; Beam and diffuse components of daily radiation; Beam and diffuse components of monthly average radiation; Estimation of hourly radiation from daily data; Total radiation on fixed sloped surface; Average radiation on fixed sloped surface.

**MODULE – II (12 hours)****Flat-plate Collectors :**

Introduction; Description of a flat-plate collector; The basic flat-plate energy balance equation; collector overall heat loss coefficient; Top loss coefficient; Estimation of heat transfer coefficients; Sky temperature; Bottom loss coefficient; Side loss coefficient; Temperature distribution between tubes and the collector efficiency factor; Temperature distribution in flow direction; collector heat removal factor and flow factor; Effects of dust and shading. Flat-plate collector performance.

**Solar Air Heaters :**

Introduction; Performance analysis of air heaters; Two-pass solar air heater; overlapped glass plate air heater; Matrix air heater, Honey-comb porous bed air heater; Testing of solar air heater.

**MODULE – III (11 hours)****Concentrating Collectors :**

Introduction; Definitions; Aperture, concentration ratio, Acceptance angle; classification of concentrating collectors; concentrating collector configurations; Cylindrical parabolic collector; Tracking of cylindrical parabolic collector; Thermal performance of concentrating collectors; Compound parabolic collectors (CPC); Performance analysis; Absorbed solar radiation, Useful energy gain.

**Solar Energy Utilization:**

Solar water heating; Solar heating of buildings; Solar cooling of buildings; Solar thermal power generation; Solar chimney power plant; Solar pumping; Solar distillation; Solar drying, Solar cooking.

**TEXT BOOKS**

1. Sukhatme S.P., Solar Energy, TMH.
2. Rai G.D., Solar Energy Utilization, Khanna Publisher.

**REFERENCE BOOKS**

1. Duffie Duffie J.A.; Beekman W.A., Solar Engineering of Thermal Processes, John Wiley & Sons.
2. Magal B.S., Solar Power Engineering, TMH.

**ME-462**

**CRYOGENICS**

**(3-0-0)**

**MODULE –I [12 Hours]**

Introduction to Cryogenic Systems, Historical development, Low Temperature properties of Engineering Materials. Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties. Applications of Cryogenics: Applications in space, Food Processing, super Conductivity, Electrical Power, Biology. Medicine, Electronics and Cutting Tool Industry. Low temperature properties of engineering materials:

**MODULE –II [10 Hours]**

Liquefaction systems ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers.

Gas liquefaction systems: Introduction-Production of low temperatures- General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium – Critical components of Liquefaction systems.

**MODULE –III [14 Hours]**

Cryogenic Refrigeration systems: Ideal Refrigeration systems- Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media;, cryogenic fluid storage and transfer systems: Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations. Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems. Pressure flow-level and temperature measurements.–. Types of heat exchangers used in cryogenic systems. Cryo-pumping Applications.

**TEXT BOOK**

1. Klaus D.Timmerhaus and Thomas M.Flynn, " Cryogenic Process Engineering " Plenum Press, New York, 1989.

**REFERENCE BOOKS**

- 1 . Barron Randall, Cryogenics systems, Mc Graw Hill Book Co.
- 2 . .Scott R.B, Cryogenic Engineering, Van Nosfrand Co.
- 3 . Bell J.H., Cryogenic Engineering, Prentice Hall.
- 4 Bell R.W., Cryogenic Engineering, John Welley.
- 5 Walkers, Cryocoolers, Prentice Hill Publication.

**ME-414**

**SAFETY ENGINEERING**

**(3-0-0)**

**MODULE – I (12 hours)**

**Industrial Safety:** History of Safety Movement in India, UK, USA. “The Accident Problem”, Nature and Size, Need for safety, legal, humanitarian, economic and social considerations.

**Safety Management:** Role of Management in Industrial Safety, Safety Management Principles & Practices.

Principles of Accident Prevention: Incident, Accident injury, Dangerous occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistake etc.

**Planning for Safety:** Definition, purpose, nature scope and procedure, Range of planning variety of plans.

**Safety Education and Training for Safety:** Element of training cycle, assessment of needs. Techniques of training, design and development of training programmes. Training methods and strategies. Types of training. Evaluation and review of training programmes.

**Organizational behaviour and Safety, Human Behaviour:** Individual difference, behaviour as function of self and situation, perception of danger and acceptance of risks, knowledge, and responsibility vis-à-vis safety performance, theories of motivation and their application to safety, role of management, supervisors and safety deptt. in motivation.

**Economics of Safety Cost of Accidents:** Financial costs to individual and family, organization, society. Compilation procedure, utility and limitations of cost data. Budgeting for safety.

#### **MODULE – II (12 hours)**

**Safeguarding of Machines:** Principles of machine guarding, Ergonomics of machine guarding. Type of guards and their selection. Guarding of different types of machinery including further precautions for wood working, paper, rubber and printing machinery etc., built in safety devices, maintenance and repairs of guards, incidental safety devices and methods.

**Manual handling and Storage of Materials:** Kinetics of manual material handling, Maximum loads that could be carried. Lifting and carrying of objects of different shapes, size and weight. Safe use of accessories for manual handling. Storage of materials; Safety in stacking and un-stacking, floor loading conditions. Layout conditions for safety in storage, ergonomics of manual handling and storage.

**Mechanical Handling of Materials:** Lifting machinery, lifts and hoists: Safety aspects in design and construction, testing, use and care, signaling, inspection and maintenance, Safety in design and construction, operation, inspection and maintenance of industrial trucks, lifting tackles and loose gears, conveyors, safety features, safe locations, testing, inspection and maintenance of lifting tackles, safe working load for all mechanical material handling equipments, the competent persons in relation to safety legislations-duties and responsibilities.

**Working at Heights:** Incidence of accidents, Safety features associated with design, construction and use of stairways, ramps, working platforms, gangways, ladders of different types, scaffolds of different types including Boatswain's chair and safety harness, working on roofs. Other safety requirements while working at heights.

**Hand Tools and Portable Tools:** Main causes of tool accidents. Control of tool accident, Centralised and personal tool issue system. Purchase, storage and supply of tools. Inspection, maintenance and repairs of tools. Causes for tool failures. Tempering, safe ending and dressing of certain tools. Safe use of various types of hand tools used for metal cutting, wood cutting, miscellaneous cutting work, other hand tools such as torion tools, shock tools, non-sparking tools. Portable power tools and their selection, inspection, maintenance, repair and safe use.

**Safety at Workstation:** Work station design: Concept of workstation and its design. Improving safety and productivity through work station design. Technical and Engineering control measures. Ergonomic considerations. Role of preventive maintenance in safety and health. Importance of standards and codes of practice for plant and equipments.

#### **MODULE-III (12 hours)**

**Plant Design and Housekeeping:** Plant Layout and Design, Need for planning and follow-up. Safety and good housekeeping. Typical accidents due to poor housekeeping. Disposal of scrap and other trade wastes. Prevention of spillage. Marking of aisles space and other locations. Use of colour as an aid for good housekeeping. Housekeeping contests. Cleaning methods. Employee assignment. Inspections and check-lists. Benefits of good housekeeping.

**Industrial Lighting:** Purpose of Lighting. Benefits of good illumination. Phenomenon for lighting and safety. Lighting and the work. Sources and types of artificial lighting. Principles of good illumination. Recommended optimum standards of illumination. Design of lighting installation. Maintenance. Standards relating to lighting and colour.

**Ventilation and Heat Control:** Purpose of ventilation. Physiology of heat regulation. Thermal environment and its measurement. Thermal comfort. Indices of heat stress. Thermal limits for comfort, efficiency and freedom from health risk. Natural ventilation. Mechanical Ventilation. Air

conditioning. Process ventilation. Control of heat exposures, control at source, insulation, local exhaust ventilation, control of radiant heat, dilution ventilation, local relief.

**Electrical Hazards:** Hazards of electrical energy. Safe limits of amperages, voltages, Safe distance from lines. Capacity and protection of conductors. Joints and connections. Means of cutting protection. Earth fault protection. Earth insulation and continuity tests. Earthing standards. Protection against surges and voltage fluctuation. Hazards arising out of 'borrowed' neutrals. Other precautions. Types of protection for electrical equipment in hazardous atmosphere. Criteria in their selection. Installation, maintenance and use. Control of hazards due to static electricity.

**Noise and Vibration:** Continuous and impulse noise. The effect of noise on man. Measurement and evolution of noise. Noise isolation. Noise absorption techniques. Silencers. Practical aspects of control of noise. Case studies on impact of noise from compressors, generators and other sources.

**Fire & Explosion:** Factors responsible for fire, Chemistry of fire. Classification of fires. Common causes of Industrial fires. Determination of fire load. Fire resistance of building materials. Design of building plant, exits, etc. for fire safety. Prevention of fire. Portable extinguishers. Water systems. Carbon-di-oxide systems. Foam extinguisher system. Dry chemical extinguishing system. Industrial fire detection and alarms. Sprinkler systems. Special precautionary measures for control of fire and explosion in handling/procession flammable liquids, gases, vapors, mists and dusts etc. BLEVE (Boiling liquid expanding vapour explosion) Confined and unconfined vapour cloud explosion/Fighting fires involving pesticides. Fire emergency action plan/deflagration and detonation.

## REFERENCE BOOKS

1. Govan James, Safety Engineering.
2. Asfahl & Rieske, Industrial Safety & Health Management.
3. Dhillon B.S., Engineering Safety.
4. Encyclopaedia of occupational Health & Safety, Vol-I, edited by Jeanne Mager Stellman.
5. Davis Keith, Human Behaviour at Work (Organizational behavior).
6. Petersen Dean, PE, CSP & Roos Nestor, Industrial Accident Prevention (A safety management Approach), DBA-McGraw-Hill Book Company.

## ME-424 INJECTION MOULDING AND MOULD DESIGN (3-0-0)

### MODULE – I (15 hours)

#### Plastic materials:

Classification of plastic materials, their physical and mechanical properties, selection of plastics for various applications, advantages and limitations of using plastics.

Mould materials, basics of mould making & manufacturing. Types of moulds, mould making techniques, mould metallurgy, melting, pouring and solidification.

Constructional features of mould: constructional features of core and cavity plates, mold size and strength, cavity material, and fabrication, mold placement, constructional features and layout of runners and gates, sprue bushing, sprue pullers.

**Ejection:** ejection techniques, ejector grid, ejector plate assembly, ejection from fixed half. Feed System: runners and gates. Parting surface: Flat and non-flat parting surface, relief of parting surfaces, venting.

### MODULE - II (12 hours)

Design of moulds: Methodical mould design, design features, determination of economical number of cavities, side cores and side cavities, temperature control of injection moulds, calculation of mould opening force and ejection force.

Various considerations such as wall thickness, fillets and radii, ribs, under-cuts, drafts, holes, threads, inserts parting lines, etc. surface treatment mould design for avoiding warpage, Standards for Tolerances on moulded articles.

Mould for threaded components, runner less moulds.

### **MODULE - III (10 hours)**

Mould cooling: cooling integer-type mould plates, cooling insert-bolster assembly, water connections and seals.

Checking mould drawings: pin ejection mould, sleeve ejection mould, stripper plate mould, splits type mould, underfeed type mould, hot runner type mould, stepped parting surface mould design.

### **TEXT BOOKS**

1. Pye R.G.W., East-west publication.

## **EC- 333      MICROPROCESSORS & MICROCONTROLLERS      (3-0-0)**

### **MODULE-I (12 Hours)**

Microprocessor Architecture:- Introduction to Microprocessor and Microcomputer Architecture, Pins & Signals, Register Organization, Timing & Control MODULE, 8085 Instruction Timing & Execution. Instruction Set and Assembly Language Programming of 8085:- Instruction set of 8085, Memory & I/O Addressing, Assembly language programming using 8085 Instruction Set, use of Stack & Subroutines. Memory Interfacing:- Interfacing EPROM & RAM Memories Interrupts:-8085 Interrupts

### **MODULE-II (12 Hours)**

Microprocessor Based System Development Aids:- Programmable Peripheral Interface: 8255, Programmable DMA Controller: 8257, Programmable Interrupt Controller: 8259, Microcontroller (Architecture and Programming):- Introduction to 8051 Microcontrollers (Architecture, Pin description), 8051 Assembly Language Programming (JUMP, LOOP, CALL Instructions), I/O Port Programming, 8051 Addressing Modes, Arithmetic & Logic Instructions, Microcontroller Interrupts and Interfacing to 8255:- 8051 Interrupts, Interfacing to 8255

### **MODULE-III (12 Hours)**

Intel 8086 (16 bit processors):-8086 Architecture, Addressing Modes, Instruction Format, Pins & Signals, 8086 Basic System Concept, Interfacing with Memories, 8086 Interrupts.

Intel 80386 :- Introduction to 80386 Microprocessor, Architecture, Pins & Signals, Memory System, Registers, 80386 Memory Management, Paging Technique, Protected Mode Operation, brief introduction to 80387 Math Coprocessor. Pentium Processors (Only features):- Introduction to Pentium Processors, Memory System, Input/Output System, Branch Prediction Logic, Floating Point MODULE, Cache Structure, Superscalar Architecture. (only the features of Pentium Processor mentioned above are to be discussed)

### **TEXT BOOKS**

1. Ghosh & Sridhar, 0000 to 8085 -Introduction to Microprocessor for Scientists & Engineers, PHI publication
2. A.K. Roy & K.M. Bhurchandi, Advanced Microprocessor and Peripherals (Architecture, Programming & Interfacing), TMH Publication
3. Mazidi & Mazidi, The 8051 Microcontroller & Embedded Systems, Pearson / PHI publications

**MODULE-I**

Neural networks, Introduction, Neuron Models, Supervised and Unsupervised Learning Methods, Single Neuron/ Perceptron Networks, Training Methods, Applications to Linearly separable problems, Multi layered perceptrons, Back-propagation algorithm, Introduction to Fuzzy systems, Membership function, Fuzzy relational operation, fuzzy IF THEN rules, Defuzzification – Sugeno and Mamdani type systems, Adaptive Neuro-Fuzzy Systems, Training Methods.

**MODULE-II**

Genetic Algorithm: Basic Concepts, Search Space, Working Principle. Encoding: Binary, Octal, Hexadecimal, Permutation, Value and Tree. Decoding, Fitness Function, Selection: Roulette-wheel, Tournament, Rank and Steady-state. Elitism, Crossover: Single-Point, Two-Point, Multi-Point, Uniform, Matrix And Cross Over Rate, Mutation: Mutation, Mutation Rate.

Ant Colony Optimization: Ant Foraging Behavior, Combinatorial Optimization, Routing In Communication Network,

**MODULE-III**

Application: Control; Communication Engineering; System Identification And Pattern Classification, Function Optimization, Adaptive System Identification, Channel Equalization.

**TEXT BOOKS**

1. S. Haykin, Neural Networks, A Comprehensive Foundation, Pearson Education, India
2. Martin T. Hagan, Howard B. Demuth, Mark H. Beale; Neural Network Design; (ISBN: 0-9717321-0-8); Thomson 2002
3. Jang, Sun and Mizutani; Neuro-Fuzzy and Soft-Computing – A computational approach to learning and machine intelligence, Prentice Hall of India David E. Goldberg, Genetic Algorithms in search, Optimization and machine learning, 1989.

**REFERENCE BOOKS**

1. Satish Kumar, A Classroom approach, Neural Networks: Tata McGraw Hill, 2004, ISBN: 9780070482920

## 7<sup>th</sup> Semester Sessional

### **ME-471 METROLOGY AND CIM LAB (0-0-3)**

1. To measure the dimensions, surface finish, circularity, concentricity of a precision turned component using different Instruments and to make the drawing of it.
2. To measure different parameters of a screw thread and make the drawing of it to the scale.
3. To carry out calibration and accuracy checking of any machine tool
4. Measurement of Taper using Sine bar.
5. Strain measurement of a cantilever beam with the help of resistance wire Strain gauges and Indicator.
6. Generation of a Solid Model of a part using Software Simulate the part for stress and other parameters using Finite Element Software and modify the part to be within the Specified factor of safety.
7. To generate the 2-D drawing of the modified model and annotate it for manufacturing details.
8. To plan, program and produce one component using CNC Turning Tutor.
9. To plan, program and produce one component using CNC milling Tutor.
10. Experiment on Hydraulic Tutor.
11. Experiment on Pneumatic Tutor.
12. Experiment on Servo positioning control

### **ME-473 REFRIGERATION AND AIR CONDITIONING, (0-0-3) HEAT TRANSFER AND COMPUTATIONAL LABORATORY**

**No. of Experiment: 10 (At least 3 from each group)**

#### **REFRIGERATION & AIR CONDITIONING LABORATORY**

1. Determination of theoretical COP, Carnot COP and actual COP of Vapour compression refrigeration system.
2. Verification of different psychrometric processes using year round air conditioning system.
3. Determination of COP of an ice plant tutor.
4. Generation of psychrometric chart.
5. Determination of COP of vapour absorption test rig.

#### **COMPUTATIONAL LABORATORY:**

6. Numerical differentiation using MATLAB.
7. Numerical Integration using MATLAB.
8. Curve fitting using MATLAB.
9. Solving ODE using MATLAB.
10. Solving system of linear equations using MATLAB.

#### **HEAT TRANSFER LABORATORY**

11. Determination of thermal Conductivity of liquid.
12. Determination of inside & outside overall heat transfer coefficient, LMTD and effectiveness of shell & tube heat exchanger.
13. Determination of critical heat flux using critical heat flux apparatus.
14. Determination of thermal conductivity, thermal resistance of composite wall using composite wall apparatus.
15. Study of Heat pipe apparatus.
16. Study of drip and film forms condensation using condensation apparatus.