NATIONAL INSTITUTE OF TECHNOLOGY, HAMIRPUR (HP) – 177 005

B.Tech. Mechanical Engineering, Fourth Year [7th Semester]

Sr. No.	Course No.	Subjectt	L	T	P	Hours	Credits
1.	[ME-471]	Elective – 1	3	0	0	3	3
2.	[ME-472]	Elective – 2	3	0	0	3	3
3.	[ME-473]	Elective – 3	3	0	0	3	3
4.	[ME-474]	Elective – 4	3	0	0	3	3
5.	[ME-475]	Elective – 5	3	0	0	3	3
6.	[ME-496]	Industrial Training Viva	0	0	0	0	2
7.	[ME-497]	Seminar	0	0	3	3	2
8.	[[ME-498]	Major Project – I	0	0	6	6	3
					Total =	**24**	**22**

List of Departmental Electives I, II, III, IV, V

GROUP – I [ME-471]

(a) Advanced Fluid Mechanics
(b) Heating Ventilation and Air Conditioning
(c) Power Plant Engineering
(d) Gas Turbine and Jet Propulsion
(e) Solar Energy Engineering
(f) Computational Methods in Fluid Dynamics and Heat Transfer
(g) Energy Conservation and Management

GROUP – II [ME-472]

(a) Non-Conventional and Alternative Source of Energy
(b) Environment and Energy Management
(c) Computer Aided Design
(d) Bearing and Lubrication
(e) Finite Element Method
(f) Finite Volume Method
(g) Industrial Tribology

GROUP – III [ME-473]

(a) Experimental Stress Analysis
(b) Applied Elasticity and Plasticity
(c) Noise Control

(d) Engineering Materials
(e) Total Quality Management
(f) Non-Conventional Machining
(g) Productivity Management

GROUP – IV [ME-474]

(a) Composite Materials
(b) Production Planning and Control
(c) Facility Layout Planning
(d) Maintenance Engineering and Management
(e) Inspection Quality Control and Reliability

GROUP – V [ME-475]

(a) Industrial Robotics
(b) Human Resource Management
(c) Management Information System
(d) Safety Engineering
(e) Quality Engineering
(f) Entrepreneurship
(g) Computer Graphics & Rapid Prototyping
(h) Product Design and Value Engineering

ADVANCED FLUID MECHANICS

ME – 471 (a)

L	T	P/D	Cr
3	0	0	3

1. **CONSERVATION EQUATION OF FLUID FLOW**: Conservation of mass, conservation of momentum – stress and strain in fluid flow and their relationship, conservation of energy, work done due to viscous stress.

2. **LAMINAR FLOW OF VISCOUS INCOMPRESSIBLE FLUIDS**: Flow between parallel flat plates, couette flow, plane Poiseuille flow, flow between two co-axial cylinders, flow between two concentric rotating cylinders, unsteady motion of flat plates.

3. **BOUNDARY LAYER THEORY**: Boundary layer equation, Blasius solution, shear stress and boundary layer thickness, boundary layer on a surface with pressure gradient, momentum integral theorem for boundary layer, separation and its prevention by boundary layer suction.

4. **TURBULENCE**: Concept of linearized stability of parallel viscous flow, transition to turbulent flow, Reynolds equation for turbulent flow, Reynolds stresses, Prandtl's mixing length theory, velocity profile, turbulent flow in pipes, turbulent boundary layer on flat ptate.

5. **INVISCID FLOW**: Elementary plane flow solutions, uniform stream, source or sink, vortex. Superposition of plane flow solutions, flow over wedge, circular cylinder and rankine oval.

RECOMMENDED BOOKS

1. Elements of Gas Dynamics — Liepmann & Roshko
2. Compressible Flow — Yahya
3. Viscous Fluid Flow — F.M. White
4. Advanced Engineering Fluid Mechanics — K. Muralidhar & G.Biswas

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HEATING, VENTILATION AND AIR CONDITIONING

ME – 471 (b)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Thermodynamics, Psychrometric Properties, Moist air properties, Psychrometric chart Psychrometric Processes.

2. **AIR-CONDITIONING SYSTEMS**: Air conditioning and distribution system, all air system, air-and-water system, all water system, heat pump system, heat recovery system, thermal storage.

3. **MOIST AIR PROPERTIES AND CONDITIONING PROCESSES**: Moist Air and standard atmosphere, adiabatic saturation, wet bulb temperature, psychrometric chart, space air conditioning.

4. **SPACE HEATING AND COOLING LOAD**: Design conditions, Transmission heat Losses, infiltration, heat losses from air ducts, auxiliary heat sources, heat balance method, fenestration, application of cooling load calculation procedures, supply air quantities.

5. **ENERGY CALCULATION**: The degree-day procedure, bin method, comprehensive simulation methods.

6. **SPACE AIR DISTRIBUTION**: Fluid Flow basic, Pumps, Piping system and design , Fan selection and installation, Ducts, Economics.

RECOMMENDED BOOKS

1. Thermal Environmental Engineering — T. Kuehn, J. Ramsey and J. Threlkeld, 3rd Ed.
2. ASHRAE Handbooks
3. HVAC Fundamentals — Samuel C. Sugarman
4. Thermal Environmental Engineering — Faye, Parker, and Jeffrey

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POWER PLANT ENGINEERING

ME -471 (c)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.

2. **HYDRO ELECTRIC POWER PLANTS**: Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.

3. **STEAM POWER PLANTS**: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection mechanical dust collector and electrostatic precipitator.

4. **COMBINED CYCLES**: Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbine power plants), re-powering systems with gas production from coal, using PFBC systems with organic fluids, parameters affecting thermodynamic efficiency of combined cycles, Problems.

5. **NUCLEAR POWER PLANTS**: Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled, Advantages and limitations, nuclear power station, waste disposal.

6. **POWER PLANT ECONOMICS**: Load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-out put curves, efficiency, heat rate, economic load sharing, Problems.

7. **NON-CONVENTIONAL POWER GENERATION**: Solar radiation estimation, solar energy collectors, low, medium & high temperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants.

8. **DIRECT ENERGY CONVERSION SYSTEMS**: Fuel cell, MHD power generation-principle, open & closed cycle systems, thermoelectric power generation, and thermionic power generation.

RECOMMENDED BOOKS

1. Power Plant Engineering — P.K. Nag
2. Power Plant Engineering — P.C. Sharma
3. Power Plant Engineering — M. Wakil
4. Modern Power Plant Engineering — Weisman & Eckart

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GAS TURBINES AND JET PROPULSION

ME – 471 (d)

L	T	P	Cr
3	0	0	3

1. **COMPRESSIBLE FLOW**: Wave propagation and sound velocity; Mach number and compressible flow regimes; basic equations for one-dimensional compressible flow, isentropic flow relations; area-velocity relation; normal shock waves, relation between upstream and downstream flow parameters.

2. **GAS TURBINE SYSTEMS AND CYCLES**: System of operation of gas turbines-constant volume and constant pressure gas turbines; thermodynamics of Brayton cycle; regeneration-intercooling, reheating and their combinations; closed cycle and semi-closed cycle gas turbines; gas v/s I.C engines and steam turbines.

3. **COMPRESSORS**: Classification-positive displacement and dynamic compressors, Operation of single stage reciprocating compressors; best value of index of compression; isothermal efficiency; effect of clearance and volumetric efficiency; multi-stage compression; air motors. Centrifugal compressors; static and total head values; velocity vector diagrams; slip factor; pressure coefficient and pre-whirl, Axial flow compressors; degree reaction and polytropic efficiency Performance characteristics; surging, choking and stalling.

4. **COMBUSTION SYSTEMS**: Types, combustion process, combustion intensity efficiency and pressure loss.

5. **AIR-BREATHING PROPULSION SYSTEMS**: Principle of jet propulsion; analysis and performance characteristics of turbojet, turboprop, ramjet and pulsejet; thrust power and propulsion efficiency.

6. **ROCKET PROPULSION**: Operating principle; solid and liquid propellants, performance analysis-calculations for specific impulse and propulsive efficiency.

RECOMMENDED BOOKS

1. Gas Turbine Theory — Cohen & Rogers
2. Principle of Jet Propulsion and Gas Turbine — Zucrow M J

REFERENCES BOOK

1. Heat Engineering Vasandani — V P & Kumar D S

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SOLAR ENERGY ENGINEERING

ME – 471 (e)

L	T	P	Cr
3	0	0	3

1. **SOLAR RADIATION**: Introduction, solar system-sun, earth and earth-sun angles, time, derived solar angles, estimation of solar radiation (direct and diffuse), measurement systems- Pyrheliometer and other devices.

2. **EFFECT OF SOLAR RADIATION**: Steady state heat transmission, solar radiation properties of surfaces, shading of surfaces, periodic heat transfer through walls and roofs.

3. **SOLAR COLLECTORS**: Flat plate and concentrating-comparative study, design and materials, efficiency, selective coatings, heliostats.

4. **HEATING APPLICATIONS OF SOLAR ENERGY**: Air and Water heating systems, thermal storages, solar bonds, solar pumps, solar lighting systems, solar cookers, solar drying of grains.

5. **COOLING APPLICATIONS OF SOLAR SYSTEMS**: Continuous and intermittent vapour absorption systems for cooling applications, absorbent refrigerant combination, and passive cooling systems.

6. **SOLAR ELECTRIC CONVERSION SYSTEMS**: Photovoltaic, solar cells, satellite solar power systems.

7. **EFFECTS ON ENVIRONMENT**: Economic scenario, ozone layer depletion, green house effect, global warming, Remedial measures by international bodies.

RECOMMENDED BOOKS

1. Solar Energy	S. P. Sukhatme
2. Solar Energy and Thermal Process	Duffie & Beckman

REFERENCE BOOKS

1. Applied Solar Energy	Maniel & Maniel
2. Solar Energy: Fundamentals and Applications	R. P. Garg &Jai Prakash
3. Principles of Solar Engineering	F. Kreith & J. F. Kreider

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COMPUTATIONAL METHODS IN FLUID DYNAMICS AND HEAT TRANSFER

ME- 471 (f)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Review of Governing equations, continuity, momentum and energy, classification of quasi-linear partial differential equations, general behavior of different classes of PDE, parabolic, hyperbolic and elliptic, review of solutions of simultaneous algebraic equations. Solution of initial value problem.

2. **BASIC OF FINITE DIFFERENCE METHODS**: Introduction to finite differences, discrimination, difference representation of partial differential equations, explicit and implicit methods, errors and analysis of stability.

3. **APPLICATION TO SELECTED MODEL EQUATIONS**: Numerical methods for solution of wave equation, heat equation, Lap lace equation; Burger equation.

4. **FINITE VOLUME METHOD**: Discrezation, control volume formulation, steady 1-D conduction, interface conductivity, nonlinearity, unsteady one-dimensional conduction, zero, Two and Three-dimensional conduction, over and under relaxation. Steady one- dimensional convection and diffusion.

5. **SOME CFD TECHNIQUES**: Lax-wendroff technique, Maccormack Technique, relaxation technique, aspects of numerical dissipation and dispersion, alternating-direction implicit technique, pressure correction technique, subsonic-supersonic isentropic nozzle flow, steady and unsteady state conduction in two-dimensional bodies, laminar boundary layer flows.

RECOMMENDED BOOKS

1. Computational Fluid Dynamics — A.D.Anderson Jr.
2. Computational Fluid Flow and Heat Transfer — D.A.Anderson Tannehil
3. Computational Fluid Flow and Heat Transfer — K.Muralidhar

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ENERGY CONSERVATION AND MANAGEMENT

ME – 471 (g)

L	T	P	Cr
3	0	0	3

1. **ENERGY MANAGEMENT**: Concept of energy management, energy demand and supply, economic analysis; Duties and responsibility of energy managers.

2. **ENERGY CONSERVATION**: Basic concepts, Energy conservation in household, transportation, agricultural, service and industrial sectors, Lighting, HVAC systems.

3. **ENERGY AUDIT**: Definition, need, and types of energy audit; Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements; Fuel & energy substitution; Energy audit instruments; Energy Conservation Act; Duties and responsibilities of energy managers and auditors.

4. **MATERIAL AND ENERGY BALANCE**: Facility as an energy system; Methods for preparing process flow; material and energy balance diagrams.

5. **ENERGY ACTION PLANNING**: Key elements; Force field analysis; Energy policy purpose, perspective, contents, formulation, ratification; Organizing the management: location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability; Motivation of employees: Information system-designing barriers, strategies; Marketing and communicating: Training and planning.

6. **ENERGY CONSERVATION IN PLANT SERVICE SYSTEMS**: Centrifugal pumps: Energy consumption & saving potentials; Design consideration minimizing over design; Case studies Fans & Blowers: Specification, safety margin, choice of fans-controls, design considerations. Air compressor & compressed air systems: Selection of compressed air layout, Design consideration. Refrigeration & Air conditioning: Heat load estimation, methods of minimizing heat loads, optimum selections of equipments; Case studies, Energy conservation in cooling towers & spray ponds; Case studies.

7. **THERMAL ENERGY MANAGEMENT**: Energy conservation in boilers, steam turbines and industrial heating systems; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pumps; Building Energy Management.

RECOMMENDED BOOKS

1. Energy Management Principles — C B Smith
2. Energy Auditing and Conservation; Methods, Measurements, Management & Case Study — Hamies
3. Energy Management and Conservation — D Patrick & S W Fardo
4. Heating and Cooling of Buildings: Design for Efficiency — J.Krieder & A.Rabi
5. Principles of Energy Conservation — Archie, W Culp
6. P. Energy Management — O'Callaghan

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NON-CONVENTIONAL/ ALTERNATE SOURCES OF ENERGY

ME – 472 (a)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Trends of energy consumption, sources of energy conventional and renewable, fossil fuel availability and limitations, need to develop new energy sources.

2. **SOLAR ENERGY**: Solar radiation characteristics and estimation, Solar Collectors, Flat Plate and concentrating types. Their comparative study, design and material selection, efficiency, Selective paints and surfaces. Heating of air and water for building and other uses, Thermal storages, Solar Ponds, Solar pumps, solar Power, Solar Cookers etc. Direct Conversion of Solar energy to electricity and its various uses, materials, limitations and costs.

3. **BIO-CONVERSION**: Generation of bio-gas, digesters and their design, selection of material, feed to digester, paralytic gasification, production of hydrogen, Algae production and their uses.

4. **WIND ENERGY**: Types of rotors, horizontal axis and vertical axis systems, system design and site selection.

5. **GEO-THERMAL ENERGY**: Sites, potentiality and limitation, study of different conversion systems.

6. **TIDAL ENERGY**: Sites, potentiality and possibility of harnessing from site, limitations.

7. **OCEAN THERMAL ENERGY**: Principle of utilization and its limitations, description of various systems.

8. **OTHER NON-CONVENTIONAL ENERGY SOURCES**: Fluidized bed combustions, heat from waste and other sources.

RECOMMENDED BOOKS

1. Solar Energy Utilization	G.D. Rai
2. Solar Heating and Cooling	Duffie & Beckman

REFERENCE BOOKS

1. Power Plant Technology	M.M. EL. Wakil
2. Power Plant Engineering	P.C. Sharma

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ENVIRONMENT & ENERGY MANAGEMENT

ME – 472 (b)

L	T	P/D	Cr
3	0	0	3

1. **FUNDAMENTALS OF AIR POLLUTION**: Methods for Air Pollution control, designing of air pollution control equipment, Collection efficiency, Advantages & Disadvantages of various control devices viz. Gravitational settling chambers, cyclone separators, fabric filters, electrostatic precipitators, scrubbers etc.

2. **FUNDAMENTALS OF WATER POLLUTION**: Primary, Secondary and Tertiary methods of treatment, design principles of various treatment processes, Choice of treatment processes.

3. **FUNDAMENTALS OF NOISE POLLUTION**: Impact of noise pollution, Machinery Noise, Reduction of noise and its control, Noise control in industry, Addition of Sound levels, Calculation of SPL, Measurement of noise.

4. **DEFINITION OF HAZARDOUS WASTES**: Classification, sources of hazardous waste generation, Hazardous waste treatment and disposal techniques.

5. **WORLD ENERGY SCENARIO**: Present and past, energy consumption pattern, development of electrical energy and its utilization, Non-commercial and commercial energy sources - supply and demand in different sectors, Renewable sources of energy, Energy resources of India, Energy development plans of India.

6. **CONVERSION TECHNOLOGIES OF FOSSIL AND FOSSIL FUELS**: Their primary and end use energy values, Hydro and pneumatic energy conversion, Storage and pondage principles, Direct energy conversion – Solar thermal and solar photovoltaic principles and their conversion technologies.

7. **EFFICIENCY CONSIDERATIONS IN GENERATION, TRANSMISSION AND UTILIZATION OF ENERGY**: Principles of long term demand forecasting, Energy auditing, Energy management - storage and conservation, Environment aspects of energy conversion and utilization, Impact of energy shortage of progress of civilizations.

RECOMMENDED BOOKS

1. Energy and the Environment — Detlev G. Kröger, Adrian Bejan
2. Energy and Environment — Richard Loulou, Jean-Philippe
3. Energy Policy Analysis and Modeling — Mohan Munasinghe
4. Air Pollution — Bela G. Liptak,
5. Energy & Environment: A Primer for Scientists and Engineers — E H Thorndike
6. Energy and the Environment — Fowler, J.M., 2nd Ed.
7. Noise Pollution and Control Strategy — Singal

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COMPUTER AIDED DESIGN

ME – 472 (c)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Design steps, role of computers in design and drafting, computer hardware, types of display - raster display, vector display, colour display, input devices, output devices.

2. **TRANSFORMATIONS**: World to device coordinate transformation, world coordinates, window and view port, and window to view port transformation, Normalized coordinates, zooming and panning.

3. **TWO DIMENSIONAL TRANSFORMATION**: Mathematical aspects of translation, scaling, shearing, rotation, Reflection, Composite (concatenation) transformation, concatenation properties of matrics, practical example - rotation about a pivot point, scaling relative to fixed point, scaling relative to arbitrary directions, shearing relative to a fixed point. Inverse Transformation: Inverse translation, scaling, rotation shearing matrix.

4. **THREE-DIMENSIONAL TRANSFORMATIONS**: Scaling, translation, rotation.

5. **THREE-DIMENSIONAL VIEWING OPERATIONS**: Projections- Multiview orthographic projections, Axonometric projections, Oblique projections, Perspective projections, Vanishing points, Special techniques for producing perspective views.

6. **CURVES**: Geometric curve description, Parametric and implicit formulations, Conics- Circles, Ellipses; Interpolation techniques for curve definition- Lagrange polynomial, Parametric cubic, Matrix approach, Cubic spline; Bezier curves.

7. **SOLID MODELLING SYSTEM**: Octree or Quadtree representations, boundary or perimeter modelling, primitive or constructive solid geometry or building block method.

RECOMMENDED BOOKS

1. Mathematical Elements for Computer Graphics D.F. Rogers & J. Alan Adam.
2. Microcomputer Graphics using Pascal Richard Halpern
3. Computer Graphics Hern & Baker
4. Introduction to CAD/CAM Oniver & Zimer
5. Computer graphics and Geometrical Modeling for Engineers Vera B.Anand

Special assignments and projects/models are to be submitted for evaluation in consultation with the course coordinator.

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BEARINGS AND LUBRICATION

ME – 472 (d)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Types of bearings, Bearing concepts and applications, Lubrication types, lubrication regimes, Lubrication Fundamentals.

2. **FUNDAMENTAL EQUATIONS**: Continuity momentum (N-S) equations/ Reynolds equation, Energy equation, Solution of N-S/Reynolds equations, Mechanisms of pressure development in fluid film bearings.

3. **HYDRODYNAMIC SLIDER BEARINGS**: Infinite width slider bearings, Rayleigh Step Bearing, Finite slider bearings, analysis of slider bearings, Application of slider bearings in Machine tools.

4. **HYDRODYNAMIC JOURNAL BEARINGS**: Infinitely long journal bearing, Finite journal bearing, Boundary conditions, analysis of journal bearings, phenomenon of cavitation.

5. **HYDROSTATIC AEROSTATIC BEARINGS**: Linear slider bearing, variation of friction with supply pressure, hybrid conical supports, Static and Dynamic response of Oil Bearing, Air film lubrication.

6. **ELASTOHYDRODYNAMIC LUBRICATION**: Basic concepts, lubrication between two contacting bodies, Hertzian and non-hertzian contact, phenomenon of starvation, applications of elastohydrodynamic lubrication.

7. **LUBRICANTS**: Types of lubricants, Selection of lubricants, Properties and tests on lubricants, Analysis of used oils/lubricants, Particle counter, Spectroscopic Oil Analysis, Ferrography

RECOMMENDED BOOKS

1. Fundamentals of Tribology — Basu, Sengupta, & Ahuja
2. Fundamentals of Tribology — Bharat Bhushan
3. Fundamentals of Fluid Film Lubrication — Hamrock, Schmid & Jacobson
4. Fundamentals of Machine Elements — Hamrock, Schmid & Jacobson
5. Basic Lubrication Theory — A Comeron
6. Applied Tribology — Khonsari

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FINITE ELEMENT METHODS

ME – 472 (e)

L	T	P	Cr
3	0	0	3

1. **FUNDAMENTAL CONCEPTS**: Introduction, Historical background, stresses and equilibrium, boundary conditions, strain-displacement relations, stress-strain relations, temperature effects, Rayleigh-Ritz Method, Galerkin's Method, Saint Venant's Principle, Matrix algebra, Gaussian Elimination.

2. **FINITE ELEMENT MESHES**: Choice of mesh, mesh data in numerical form, generation of mexh data, mesh modification.

3. **ONE -DIMENSIONAL PROBLEMS**: Introduction, Finite element Modeling, Co-ordinates and Shape Functions, Potential energy approach, The Galerkin Approach, Assembly of Global stiffness matrix and load vector, Finite element equations; Treatment of boundary conditions, quadratic shape functions, Temperature effects.

4. **TRUSSES**: Introduction, plane trusses, three dimensional trusses, assembly of global stiffness matrix for the banded and skyline solution.

5. **TWO- DIMENSIONAL PROBLEMS**: Introduction, finite element modeling, constant strain triangle (CST), Problem modeling and boundary conditions.

6. **AXISYMMETRIC SOLIDS SUBJECTED TO AXISYMMETRIC LOADING**: Introduction, Axisymmetric formulation, finite element modeling: Triangular elements, Problem modeling and boundary conditions.

7. **TWO -DIMENSIONAL ISOPARAMETRIC ELEMENTS AND NUMERICAL INTEGRATION**: Introduction, The fournode quadrilateral, Numerical Integration, Higher order element, Problem related to beams.

8. **BEAMS AND FRAMES**: Introduction, finite element formulation, load vector, boundary considerations, shear force and bending moment beams on elastic supports, plane frames, three dimensional frames.

9. **FINITE ELEMENT METHODS IN FLUID FLOW &. HEAT TRANSFER**: 1-D Steady heat conduction, 1-D heat conduction in thin fins, 2-D Steady heat conduction, 2-D Fins. 1-D & 2-D heat disfusion, incompressible inviscid flow (potential flow), acoustic flow, and viscous incompressible fluid flow.

RECOMMENDED BOOKS

1. Introduction to Finite Elements in Engineering — Tirupathi, R. ,Chandrupatle Ashoka D. Belegundu
2. An Introduction to Finite Element Method — J.N. Reddy
3. Finite Element Analysis -Theory and Programming — C.S. Krishnamurthy
4. The Finite Element Method in Engineering — S.S. Rao
5. Finite Element Methods for Engineers — Roger T.Fennee
6. Finite Element Analysis in Engg. Design — Rajoebaron

Special assignments and projects/models are to be submitted for evaluation in consultation with the course coordinator

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FINITE VOLUME METHOD

ME – 472 (f)

L	T	P	Cr
3	0	0	3

1. **DISCRETIZATION METHODS**: Review of other methods, control volume formulations, four basic rules.

2. **HEAT CONDUCTION**: Steady one- dimensional conduction: grid spacing, interface conductivity, non-linearity, source term linearization, boundary conditions, unsteady state one dimensional conduction; explicit, implicit and crank Nicolson scheme, two and three-dimensional conduction, over and under relaxation.

3. **CONVECTION AND DIFFUSION**: Steady one- dimensional convection and diffusion, upwind scheme a generalized formulation, discretization equation for two dimensions.

4. **FLOW FIELD**: Continuity and momentum equation, pressure correction equations, 6 simple algorithms.

5. **APPLICATIONS**: Developing flow in curved pipe, two-dimensional heat conduction on a non-uniform mesh, heat conduction in cylindrical geometry, an symmetric steady conduction in spherical coordinators.

RECOMMENDED BOOKS

1. Numerical Methods in Heat Transfer & Fluid Flow — S.V.Patankar
2. Computational Fluid Flow and Heat Transfer — Muralidhar & G. Biswas
3. Computational Fluid Dynamics Vol.1 & 2 — Fletcher
4. Computational Fluid Dynamics — Date, A. N.

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INDUSTRIAL TRIBOLOGY

ME – 472 (g)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Tribology, Contact of solids, nature of surfaces, surface topography, surface interactions and characterization, micro and nanotribology, surface roughness measurement techniques.

2. **FRICTION**: Types, laws, modern theories, dry sliding friction, temperature of sliding surface, Mechanism of rolling friction, friction instabilities.

3. **WEAR**: Classification, theories of adhesive, abrasive, surface fatigue and corrosives wear, erosive, cavitation and fretting wear, wear models, wear of miscellaneous machine components such as gears, plain bearings and rolling element bearings, ASTM standards for wear measurement, wear resistant materials, wear resistant components.

4. **VISCOSITY**: Basic definition, conversions, dynamic viscosity, Measurement, variation with temperature, ASTM Charts, Viscosity index, Grade of oil.

5. **LUBRICATION THEORIES**: Lubrication regimes, viscous flow and viscometry, Reynold's equation, hydrodynamic lubrication, hydrostatic lubrication, elastohydrodynamic lubrication, boundary lubrication, squeeze films, turbulent lubrication.

RECOMMENDED BOOKS

1. Basic Lubrication Theory — A Comeron
2. Friction Wear & Lubrication — Kenneth C.Ludema
3. Engineering Tribology — J.A.Williams
4. Fundamentals of Tribology — Basu, Sengupta & Ahuja
5. Engineering Tribology — Stachowiak & Bachelor
6. Fundamentals of Tribology — Bharat Bhushan
7. Applied Tribology — Khonsari

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EXPERIMENTAL STRESS ANALYSIS

ME – 473 (a)

L	T	P	Cr
3	0	0	3

1. **BASIC ELASTICITY**: Laws of stress transformation, principal stresses and principal planes, Cauchy's stress quadric. Strain analysis, strain equations of transformation, Principal strain, Cauchy's strain quadric, stress-strain relationship.

2. **TWO DIMENSIONAL PHOTO ELASTICITY**: Stress optic law, optics of polariscope, plane and circular polariscope, dark and light field arrangements, fringe multiplication, fringe sharp ending, compensation techniques, commonly photo-elastic materials.

3. **THREE DIMENSIONAL PHOTO ELASTICITY**: Neuman's stain optic relationship, stress freezing in models, materials for three-dimensional photo-elasticity, shear-difference method of stress separation.

4. **BI-REFRINGENT COATINGS**: Sensitivity reinforcing effects and thickness of bi-refringent coatings.

5. **ELECTRIC RESISTANCE STRAIN GAUGES**: Gauge construction and installation, temperature compensation, gauge sensitivity, gauge factor, corrections for transverse strain effects. Factors affecting gauge relation, Rosettes, Rosettes analysis, potentiometer and wheatstone bridge circuits for strain measurements.

6. **BRITTLE COATINGS**: Introduction, coatings, stresses and failure theories, different types of crack patterns, crack detection, Composition of brittle coatings, coating cure, influence of atmospheric conditions, and effect of biaxial stress field.

RECOMMENDED BOOKS

1. Experimental Stress Analysis — Dally & Ralley
2. Introduction to Photo Mechanics — Durellil & Hiley
3. Photo elasticity: Principles and Methods — Jesseop & Harris
4. Theory of Plasticity — J. Chakrabarty

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APPLIED ELASTICITY AND PLASTICITY

ME – 473 (b)

L	T	P	Cr
3	0	0	3

1. **BASIC ELASTICITY**: Three-dimensional stress and strain systems, Principal stresses, principal strains and principal planes, Mohr's circle for 3-dimensional stress and strain systems.

2. **TWO DIMENSIONAL ELASTICITY**: Stress functions, plane stress and plane strain methods.

3. **TORSION**: Torsion of circular and elliptical bars-Elastic analysis.

4. **INTRODUCTION TO PLASTICITY**: Idealized stress-strain systems, Approximate equation for stress strain curves (Remberg-Osgood, Ludwig's and Karunes equation), Bauschinger effect-yield locus, yield surface.

5. **YIELD CRITERIA AND FLOW RULES**: Tresca theory & Von-Mises yield criterion, their geometrical representation experimental evidence for the criteria.

6. **SLIP LINE FIELD THEORY**: Two dimensional plasticity, slip lines, basic equations, Hencky's first theorem, Geiringer's Velocity equation.Applications of slip line field theory to plane strain problems.

7. **LOAD BOUNDING**: The lower bound theorem, the upper bound theorem and their corollaries, Application of load bounding to plane strain problems.

RECOMMENDED BOOKS

1. Theory of Elasticity — Timeshenko & Goodier
2. Theory of Plasticity — Hoffman & Sachs
3. Engineering Plasticity — Johnson & Millor
4. Experimental stress analysis — Dally & Ralley
5. Analysis of Stress and Strain — Durelli & Phillips
6. Elasticity — Sokolnikoff
7. Engineering Plasticity — Calladina

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NOISE CONTROL

ME – 473 (c)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Fundamentals of vibration, vibration of membranes and plates, Acoustic wave equation, acoustic energy and sound Intensity, Propagation of sound.

2. **ACOUSTIC WAVES**: Elastic behavior of fluids, Plane wave equation, Velocity of sound in fluids, Energy density of Plane waves, Acoustic density, Decibel scales, Transmission phenomenon, spherical acoustic wave.

3. **RESONATORS AND FILTERS**: Helmholtz Resonator, Acoustic impedance, Reflection of waves in pipe, Expansion chamber type of filters.

4. **SPEECH, HEARING, AND NOISE**: Mechanism of hearing, Thresholds of ear, Loudness.

5. **ARCHITECTURAL ACOUSTICS**: Sound intensity in a Live room, Decay of sound, Measurement of Reverberation time, Sound absorption coefficients, Sound absorbing materials for noise reduction.

6. **NOISE ENGINEERING**: Machinery Noise, Reduction of Noise, Reduction of noise and its control, Design for less noise, Enclosures, Silencers, barriers etc. Noise control in industry, Addition of Sound levels, Calculation of SPL.

7. **NOISE MEASUREMENTS**: The range of quantities encountered in Sound, Decibel scale. Frequency / octave bands, Microphones, Sounds Level Meter, Frequency analyzers, fault detection from noise analysis, Diagnostic Maintenance, Measurement environment, Anechoic chamber.

RECOMMENDED BOOKS

1. Mechanical Vibrations — G.K.Grover,
2. Vibration Theory & Applications — W.T.Thomson
3. Vibration & Noise for Engineers — K.K.Pujara & R S Pujara
4. Fundamentals of Acoustics — Kinsler & Frey
5. Acoustics of Ducts and Mufflers — Munjal
6. Noise and Vibration Control Engineering — Beranek
7. Noise Pollution and Control Strategy — Singal
8. Mechanical Vibrations and Noise Engineering — Ambekar

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ENGINEERING MATERIALS

ME – 473 (d)

L	T	P/D	Cr
3	0	0	3

1. **FUNDAMENTALS OF MECHANICAL BEHAVIOR**: Engineering materials, Material properties: Tension, compression, torsion, hardness, Fatigue, creep etc.

2. **STRUCTURE OF METALS AND ALLOYS**: Elementary consideration of structures of metals, space lattices, crystal systems allotropy, grain boundaries.

3. **PHASE DIAGRAMS**: Solidification of metals, cooling curves, phase rule, solid solution, Eutectic and peritectic systems, Inter-metallic compounds. Interpretation of Equilibrium diagrams.

4. **FERROUS ALLOYS**: Iron carbon equilibrium diagram, Plain carbon steels, alloys steels, tool steels and heat resistant steels-classification composition and uses. Impurities in steel, hot shortness, and cold shortness, Manufacture, properties and uses of cast irons – Grey, malleable and nodular, ISI specifications.

5. **NON-FERROUS METALS AND ALLOYS**: Copper, aluminum, magnesium, nickel, zinc, and lead – base alloys, Equilibrium diagrams of some important alloys like bronze, brass, bearing materials, Agehardening of non-ferrous metals.

6. **HEAT TREATMENT OF STEEL**: Critical temperatures on heating and cooling, equilibrium structures – annealing normalizing, Martensitic transformation and tempering isothermal transformation diagrams, Quenching and hardening, Harden ability and harden ability tests, Interrupted quenching, surface hardening processes.

7. **MECHANICAL WORKING OF METALS**: Hot and cold working, Recovery, Recrystallisation, Soldering and brazing alloys.

8. **CORROSION AND OXIDATION**: Types of corrosion, oxidation Design against corrosion, protective coatings and environment control.

9. **EXTRACTION METALLURGY**: Brief outlines of oxygen steel making.

RECOMMENDED BOOKS

1. Engineering Metallurgy — A.G.Guy
2. Engineering Metallurgy — S.P.Nayak
3. Fundamentals of Engineering Metallurgy — F.W.J.Bailey
4. Physical Metallurgy — Avener
5. Metallurgy for Engineers — E.C. Rollason
6. Physical Metallurgy — V. Raghavan

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TOTAL QUALITY MANAGEMENT

ME – 473 (e)

L	T	P	Cr
3	0	0	3

1. **QUALITY MANAGEMENT**: Evolution of Philosophy of Quality, Quality Gurus-Crosby, Deming and Juran, Attributes of Quality, Quality Characteristics-Quality of Design, Quality of Performance and Quality of Conformance, Organization For Quality, Total Quality Management (TQM), TQM Models, 4 – C'S of TQM; Barriers to Implement TQM.

2. **ORGANISING FOR QUALITY**: Developing an Organization Al Structure for Quality. Quality Management System. Role of top Management ,Quality Council, Quality Policies ,Quality Improvement Teams, Role of Middle and Lower Management ,Quality Circles, Organization Structure for Quality Circles. Problem Solving Techniques .Zero Defects.

3. **QUALITY MEASUREMENT; TOOL AND TECHNIQUES**: Seven Basic (B7)Tools – Cause & Effect Diagram, Flow Diagrams, Trend Charts, Histogram, scatter Diagram, Control Chart, New Seven (S7)Tools – Affinity Diagram, Inter relationship Diagram, Tree Diagram, Matrix Diagram, Process decision Program chart (PDPC) and Matrix Data Analysis.

4. **QUALITY ASSURANCE & CONTROL**: Causes of Quality Failure ,Quality Assurance-Need and Various Elements In Quality Assurance Programme. Quality Control- On Line and Off Line, Statistical Concepts in Quality, Chance and Assignable causes. Types of control charts. Control chart for variables (X and R charts).Interpreting patterns of variations on X and R charts. Control chart for attributes: Attribute chart for defectives, P- chart, NP- chart. Attribute chart for number of defects per unit ,C-Chart and U-Chart.

5. **INNOVATIVE TECHNIQUES IN QM**: Quality Function Deployment (QFD)-Definition and Phases in QFD , Taguchi Approach to quality-system design, parameter design and Tolerance design, Six-Sigma -Definition & Implementation Steps, ISO-9000 and 14000, Role of Total Productive Management (TPM), Bench Making in quality management.

6. **QUALITY SYSTEMS**: Seven QC tools of quality control, Histogram, Scatter diagram, Standardisation

RECOMMENDED BOOKS

1. TQM Text with Cases — Amrik Sohal
2. Managing Quality — B. G. Pale
3. TQM Text with Cases — John S. Oaklend
4. TQM and ISO –14000 — Arora
5. TQM — Besterfield

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ME – 473 (f) **NON CONVENTIONAL MACHINIG**

L	T	P/D	Cr
3	0	2	3

1. **INTRODUCTION:** Types of advanced manufacturing processes; Evolution, need, and classification of advanced machining processes (AMPs).

2. **MECANICAL TYPE AMPs:** USM, AJM, WJM, AWJM processes: Process principle and elements; Tool design; Mechanism of material removal, parametric analysis; Shape and material applications; Operational characteristics; Limitations.

3. **ADVANCED FINE FINISHING PROCESS:** Abrasive Flow Machining; Magnetic Abrasive Finishing; Magneto Rheological Abrasive Finishing: Process principle, process equipment Analysis and modeling of finishing mechanism; Parametric analysis; Applications.

4. **CHEMICAL TYPE AMPs:** Process principle and details of Chemical Machining; Photo-Chemical Machining, and Bio-Chemical Machining processes.

5. **ELECTRO CHEMICAL TYPE AMPs:** ECM-Process principle, mechanism of material remo al; Kinematics and dynamics of ECM; Tooling design; Choice and analysis of process pariJ'11eters; Surface finish and accuracy.

6. **THERMAL TYPE AMPs:** EDM, LBM and EBM processes: Working principle; Power circuits; Mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy: Shape and materials applications, limitations.

7. **DERIVED and HYBRID AMPs:** Introduction of processes like rotary ultra sonic machining, electro stream drilling, shaped tube electro machining, wire electro discharge machining, electro chemical grinding, electro chemical honing, electro chemical deburring and electro-chemical spark machining.

Recommended Books:

1. Modern Machining Processes, Pandey,P.C Shan,H.S,Tata Mcgrahill
2. Manufacturing Science, Ghos, A. Malik,A.K Affiliated East-West Press 1985
3. Nontraditional Manufacturing Processes, Benedict, G.F., , Marcel Dekker 1987
4. Advance Method of Machining, McGeough, J.A, Ch'apman and Hall 1988
5. Nonconventional Machining, Mishra,. P.K., Narosa Publishing House 1997
6. Advanced Machining Processes, Jain, V.K., Allied Publishers 2002

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PRODUCTIVITY MANAGEMENT

ME – 473 (g)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Concern and Significance of Productivity, Management; Rationale of Productivity Measurement; Productivity's Perspectives, Relation of Productivity with Production, Productivity and Profitability, Productivity and Quality.

2. **PRODUCTIVITY MEASUREMENT MODELS**: Some Recent Attempts to Define Productivity; Review of Productivity Measurement Models, Production Function Models, Financial Ratios as Measures of Productivity, Production Based Models, Product Oriented Models, Surrogate Models, Economic Utility Models, Models Based on System Approach.

3. **PRODUCTIVITY MEASUREMENT; A CONCEPTUAL FRAME WORK**: Objectives of Productivity Measurement; Management by Objectives (MBO) and Productivity Measurement, System Approach to Productivity Measurement; "Performance Objectives- Productivity" (PO-P), Concept Model, Methodology and Applications.

4. **PRODUCTIVITY MEASUREMENT IN MANUFACTURING**: Productivity Measurement in a Small, Medium and Large Sized Organisations; Objectives, Weightages, Productivity Indices of KPA's, Sub System and the System; Productivity Measurement in a Medium Sized Organisation, Its Strength and Weaknesses, Marketing Characteristics, Production Characteristics, Productivity Indices-Calculations, Identification KPA's for Improvement.

5. **PO-P APPLICATION**: Need for Measuring Productivity in Service Sector; Difficulties in Measuring; Productivity of an R&D System, Ranking and Weightages of Sub Systems, KPA's and PO's; Methodology of Productivity Measurement of a Service Sector.

6. **IMPLEMENTATION STRATEGIES**: Productivity Management System; Productivity Policy; Productivity Organisation and Planning; Productivity Measurement and its Evaluation; Productivity Improvement Strategies; The Organisation Factor, Human Factor, Technology Factor, Productivity Improvement Programmes and Action Plans; Productivity Audit and Control.

RECOMMENDED BOOKS

1. Productivity Management - A System Approach — Prem Vrat, G.D.Sardalia & B.S. Sahay
2. Introduction to Work Study — ILO
3. Industrial Engineering and Production Management — M. Mahajan

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COMPOSITE MATERIALS

ME – 474 (a)

L	T	P	Cr
3	0	0	3

1. **CLASSIFICATION AND CHARACTERISTICS OF COMPOSITE MATERIALS**: Mechanical behavior of composite materials, Basic terminology of laminated fiber-reinforced composite materials, Definitions of laminae and laminate, Introduction on manufacture and quality control of laminated fiber-reinforced composite materials, current and potential advantages of fiber-reinforced composite materials, Advantages in strength and stiffness, current and potential usage of composite materials.

2. **STRESS-STRAIN RELATIONS FOR ANISOTROPIC MATERIALS**: Engineering constants for orthotropic materials, Restriction on elastic constant, Stress-strain relations for plane stress in an orthotropic materials, Stress-strain relations for a lamina of arbitrary orientation, Invariant properties of an orthotropic lamina, Strength of an orthotropic lamina, Experimental Determination of strength and stiffness, Failure theories for lamina.

3. **CLASSICAL LAMINATION THEORY**: Special cases of Laminate stiffness, lay-of-out laminates and their types, strength of Laminates, Laminate Strength Analysis Procedure, Thermal and Mechanical stress Analysis, Concept of interlaminar stresses and Delamination.

REFERENCES BOOKS

1. Mechanics of Composite Material — R. M. Jones
2. Composites Design, Think Composites — S. W. Tsai
3. Analysis and Performance of Fiber Composite — B. D. Agrawal & L.J. Brountman
4. Design and Manufacture of Composite Structures — Geoff Eckold
5. Introduction to Composite Material Stephen — W.Tsai & H. Thomas Hahn
6. Composite Materials and their use in Structures — J. R. Vinson & T.W. Chou
7. Composite Materials Handbook — M. M. Schwartz

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PRODUCTION PLANNING AND CONTROL

ME – 474 (b)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Types and Characteristics of Production Systems – (i) Continuous or Process Production (ii) Mass Flow Line Production. PPC Phases – Planning Phase, Action Phase, Control Phase, Implications for Production planning & Inventory Control.

2. **FORECASTING**: Definition and Concept, Purpose of Sales Forecasting, Basic elements of sales forecasting, Techniques of Forecasting – Time Series Analysis ; Delphi Method, Forecasting by moving average, Weighted Moving Average, Exponential Smoothening, Correlation Analysis and Linear Regression Analysis.

3. **INVENTORY CONTROL & MANAGEMENT**: Inventory Control, Types Of Inventory, objectives of Inventory Control, Economic Order Quantity (EOQ) Inventory Models, ABC Analysis – Need and Procedural Steps: Material Requirement Planning (MRP) – Function – Inputs to MRP, Bill of Material (BOM).

4. **PROCESS PLANNING**: Introduction and Concept, Information Required to Process Planning, Process Planning Procedure, Make or Buy decisions, Process Analysis, Process chart – Outline and Symbols, Automated Process Planning – Computer Assisted Process Planning (CAPP), Group Technology (GT).

5. **PRODUCTION SCHEDULING**: The Production Environment, Controlling Continuous Production, Sequencing and Line Balancing Methodologies, Master Production Schedule (MPS) – Managing the Master Production Schedule, Maintenance of MPS – Scheduling in Manufacturing Systems – Conventional & Flexible Systems.

6. **SUPPORTING PPC ACTIVITIES**: Enterprise Resource planning (ERP) – Objective and Advantages of ERP, Supply Chain Management (SCM) – Definitions, Need, SCM Models, Concept of Lean Manufacturing (LM) and Just in time (JIT) in Production Systems.

RECOMMENDED BOOKS

1. Production Planning b& Inventory Control — Seetharama L et. al
2. Production & Operation Management — N. Gaither Dryden
3. Material Management System — R.J.Brown
4. Decision Support for Inventory Management & Production Planning — Peterson & Surer

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FACILITY LAYOUT PLANNING

ME – 474 (c)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Growth of Formal Planning, Functional Subsystems of Organizations, Facility Layout and Planning; Strategic Management, Corporate Strategies & Functional Strategies; Industrial Plant Design Considerations; Factors Influencing Site Selections; Rural & Urban Location of Sites.

2. **FACILITY LOCATION**: Break Even Analysis; Single Facility Location Problem; Multi Facility Location Problems; Model for Ware House Location Problems.

3. **PLANT LAYOUT**: Classifications, Advantages, Disadvantages of Plant Layouts; Effects of Plant Layout on Industrial Production Management; Flow Systems, Effect of Automation on Layout; Symptoms of a Bad Layout; Evaluation of Layout and Criteria for Evaluating Alternative Layouts; Graphic & Schematic Analysis.

4. **COMMON PROBLEMS IN PLANT LAYOUT**: Material Handling Problem; Balancing of Line; Group Technology; Storage; Flexibility in Buildings, Service & Equipments.

5. **MATERIAL HANDLING**: Importance, Principles & Organization of Material Handling Analysis of Material Handling Problems; Classification of Matetrial Handling Equipments According to Their Construction & Nature of service; Space Planning & Area Allocation, Application of Robotics.

6. **EQUIPMENT MAINTENANCE & MANAGEMENT**: Importance; Types of Maintenance; Preventive Maintenance; Breakdown Maintenance; Corrective Maintenance; Condition Based Maintenance; Developments in Maintenance Engineering; Maintenance Planning; Evaluation of Maintenance Performance.

RECOMMENDED BOOKS:

1. Plant Layout and Design — Moore
2. Production and Operations Management — R. Panneerselvan
3. Materials Management & Material Handling — S.C. Sharma
4. Production Planning & Control — Samuel Eilon
5. Practice Plant Layout — Mulher
6. Plant Layout and Material Handling — Apple

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MAINTENANCE ENGINEERING & MANAGEMENT

ME – 474 (d)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Introduction to maintenance concepts: Corrective maintenance, Preventive maintenance, predictive maintenance, Total Productive maintenance, Maintenance economy & operation research (OR) techniques, Maintenance organization.

2. **CONDITION MONITORING & MAINTENANCE MANAGEMENT**: Introduction, Machine condition diagnosis Techniques, The economics of condition based maintenance, Formalized assessment of monitoring techniques, Condition based maintenance Policy, development in practice of Maintenance Management.

3. **RELIBILITY CENTRED MAINTENANCE**: Changing world of maintenance, maintenance and Reliability Centred Maintenance (RCM), Reliability Centred Maintenance (RCM), seven Basic questions, applying the Reliability Centred Maintenance process, Reliability Centered Maintenance (RCM) achieves.

4. **TOTAL PRODUCTIVE MAINTENANCE**: Basic concept of Total productive maintenance (TPM), Maximizing Equipment effectiveness, twelve steps of TPM development, Preparation for introducing TPM Development Activities, Master plan for TPM Promotion, Basic policies and objectives of TPM.

5. **SPARE PART MANAGEMTNT**: Strategies for spare parts management, ABC and XYZ analysis, just in time (JIT) lean manufacturing, Introduction to new approaches.

6. **ROLE OF COMPUTERS IN MAINTENANCE**:- Role of computer in Preventive maintenance program, computerized trouble shooting, computerized maintenance management system, Functions of CMMS, Implementation of computerized maintenance management systems.

7. **EQUIPMENT MANAGEMENT AND EVALUATION SYSTEM**: Approaches to equipment management, integrated approach of TPM, Participative approach of TPM, 5-Ps approach to equipment management.

8. **FAILURE STASTISTICS/ANALYSIS**: Failure Analysis of Mechanical Components and Troubleshooting, Failure Mode Effects and Critical Analysis, Weibull Analysis, Fault Tree Analysis, FRACAS.

RECOMMENDED BOOKS

1. Introduction to TPM — Nakajima
2. Maintenance Engineering Handbook — Higgins
3. Maintenance Planning and Control — Kelly
4. Industrial Engineering and Management — O. P. Khanna

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INSPECTION, QUALITY CONTROL AND RELIABILITY

ME- 474 (e)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Inspection, Definition, Objectives, Kinds of Inspection, Centralized Inspection, Decentralized Inspection, Functions of Inspection, Quality Control- Need and Functions, Difference between Inspection and Quality Control.

2. **ACCEPTANCE SAMPLING, AND O.C. CURVES**: Sampling Inspection –Need and Types, Inspection by attributes and variables, Various Sampling Plans-Single sampling Plan, Double Sampling Plan, Sequential Sampling Plan, Operating Characteristics Curve (O.C), Consumer Risk, Producer Risk and Average Outgoing Quality Level (AOQL).

3. **MEASUREMENT AND TESING**: Classification of Measuring Instruments, Measurement Terminology – Accuracy, Interchangeability, Tolerance, Fits, Allowances, Clearance and Interference. Errors – Sources & Safeguards, Methods of Destructive and Non – Destructive Testing (NDT).

4. **QUALITY PLANNING, IMPROVEMENT AND ASSURANCE**: Concept of Quality Planning, Quality Loop, Quality Gurus on Quality Improvement, Quality assurance, Responsibilities of Quality Assurance Department, Quality Assurance Activities, and Quality Audit.

5. **RELIABILITY**: Failure Characteristics, Failure Data Analysis – Mean time Between Failures- MTBF, Mean Time To Repair- MTTR, Reliability, Difference between Reliability and Quality, Systems Reliability – Parallel and Series System, Means for Improving Systems Reliability – redundancy – Derating – Operating and environmental Conditions.

RECOMMENDED BOOKS

1. Inspection quality Control and Reliability — S. C. Sharma
2. Industrial Engineering — O.P.Khanna
3. Quality Management — Howard Gitlow
4. Quality Planning & Analysis — Gryana M. Jr
5. Creating Quality Concepts, Systems & Tools — W.J. Kolarik
6. Quality Control Handbook — Juran
7. Reliability — Srinath

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INDUSTRIAL ROBOTICS

ME – 475 (a)

L	T	P/D	Cr
3	0	0	3

1. **FUNDAMENTAL OF ROBOTICS**: Introduction, automation and robotics, history of robotics, Advantages and disadvantages, investment on robot, economic analysis of robot, social impact, management and robotics, characteristics and application of the present robot, The characteristics and applications of robot of future industrial robot.

2. **THE STRUCTURE OF ROBOTIC SYSTEM**: Anatomy of robot, classification of robot, robot configurations, robotic systems, robot specifications, performance parameters, robot drive systems, wrist and motions, Robot end effectors, force analysis of gripper mechanisms, Gripper design considerations, selection consideration of grippers, robot control system and components.

3. **ROBOT MOTION ANALYSIS**: Introduction to manipulator kinematics, Homogeneous transformation and robot kinematics, Manipulator parameters, The D-H representation, Kinematics arm equations, inverse kinematics problems, Robot arm dynamics, dynamics equations, Trajectory planning.

4. **ROBOT SENSORS AND VISION**: Introduction, classification of sensors and their functions, Position, velocity, acceleration sensors, proximity and range sensors, Touch and slip sensors, force and Torque sensors, Vision: Introduction to machine vision, Image processing and analysis, Robotic applications.

5. **ROBOT PROGRAMMING**: Introduction, methods of programming, Motion interpolations, Robot programming languages, Language structure, Programming languages-features and applications, Introduction to artificial Intelligence and robotics.

6. **ENGINEERING APPLICATIONS FOR MANUFACUTRING**: Robot cell design and control, Robot as peripheral device, Material transfer, machine loading and unloading, processing operations applications, Assembly and applications.

7. **IMPLEMENTATION PRINCIPLES, SOCIAL ISSUES AND FUTURE OF ROBOTICS**: Plant survey to identify potential applications, planning and engineering. The installation, safety, training and maintenance issues, social and labor issues, robotic technology of the future and future applications.

RECOMMENDED BOOKS

1. Robotic Engineering - An Integrated Approach — Richard D. Klafter Thomas A. Chemielewski & Michal Negin
2. Industrial Robotics — Gordon M. Mair
3. Introduction to Robotics — Craig
4. Introduction to Robotics- Analyis, Systems Application — Nikku
5. Robotics & Automated Manufacturing — Richard C.Dort
6. Industrial Robotics — Mikell P.Groover, Nicholas G.Odery
7. Fundamentals of Robotics — Robert J. Schilling

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HUMAN RESOURCES MANAGEMENT

ME – 475 (b)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Nature, scope, development and operative functions of Human Resources Management, Importance, role and position of personnel function in the organization.

2. **THE PLANNING FUNCTION**: Manpower planning & career development planning, Job analysis including job descriptions and job specifications.

3. **THE PROCUREMENT FUNCTION**: The recruitment & selection, Induction & Placement, Employment Exchanges(Compulsory Notification of vacancies) Act 1959, The contract labour (Regulation & Abolition) Act 1970. The appraisal function-performance appraisal.

4. **THE DEVELOPMENT FUNCTION**: Training & Development in organization, Advancement/ Promotions & Transfers, Apprentice Act-1961.

5. **THE COMPENSATION FUNCTION**: Basic concepts in wage administration, Company Wage policy, Job Evaluation. Issues in wage & salary administration, Bonus and incentives, Payment of wages Act-1936, Minimum wage-act-1948.

6. **THE MAINTENANCE FUNCTION**: Fringe & Retirement/terminal Benefits, Administration of Welfare Amenities, Safety and Accident prevention, Factory Act 1948, Shops and Commercial Establishments Act, Employed P. F. Act 1952 and Scheme and Family Pension scheme, ESI Act 1948, Workmen's Gratuity Act 1972, Maternity Benefit Act 1961.

7. **THE INTEGRATION FUNCTION**: Administration of suggestion schemes, Employee Grievances and their Redressal, Administration of Discipline, Employee Morale & Motivation, Communication in organization, Absenteeism, Labour Turnover, Changing face of the Indian work force and their environment.

8. **INDUSTRIAL RELATIONS**: Management-Union Relations, Trade union movement collective bargaining, Employees participation in management, Group Dynamics; Nature of work groups, group cohesiveness, group performance, group norms.

RECOMMENDED BOOKS

1. Personnel Management — Edwin B. Flippo
2. Personnel Administration — Figors P. & Myers
3. Personnel and The Human Problems of Management — Strauss G. & Sayas L. R.
4. Personnel Principles and Policies — Yader D.

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MANAGEMENT INFORMATION SYSTEM

ME – 475 (c)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Organization and management, Management classification and Functions, Organizational structure, scalar point, span of control, Unity of command. Organizational systems, Open and Closed system, Application of systems concept to an organization, Information system, characteristics of MIS.

2. **INFORMATION SYSTEM AND CONTNROL**: Definition of information, Components of Information system, Evolution of Information systems Technology – The First generation, The Second generation, The Third generation, The fourth generation and Information systems today, Computer Hardware, A sample program, Data Representation, File processing and database processing. Case studies. Enterprise Information systems – Applications and goals. Information system control.

3. **DECISION MAKING**: Phases in Decision making process, Behavioral models of decision maker-classical Economic model, Administrative Model. Methods for decisions among alternatives, optimization techniques, pay off matrices, decision trees, Utility and Inference curves, statistical Technologies, Minicase studies.

4. **DECISION SUPPORT SYSTEMS**: Characteristic of DSS, classes of DSS, Expert system, cases, computer based decision support system, developing and implementing application system – life cycle approach, [prototyping approach, Quality assurance and evaluation of Information systems. Future development and Impact of Information Technology on organization and Society.

RECOMMENDED BOOKS

1. Management Information System — Jerome Kanter
2. Information Management for Decision Making — Nambudiri
3. Management Information System — Davis Olson
4. Management Information System — Kroenke & Hatch
5. Information System — Steven Alter

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SAFETY ENGINEERING

ME – 475 (d)

L	T	P/D	Cr
3	0	0	3

1. **MEANING & NEED FOR SAFETY**: Relationship of safety with plant design, equipment design and work environment, Industrial accidents, their nature, types and causes, Assessment of accident costs; prevention of accidentsm, Industrial hazards, Hazard identification techniques, Accident investigation, reporting and analysis.

2. **PLANNING FOR SAFETY**: Definition, purpose, nature, scope and procedure, Range of planning, variety of plans, Policy formulation and implementation of safety policies.

3. **ENVIRONMENT AND NEED FOR ENVIRONMENTAL CONTROL**: Environmental factors in industry, Effect of temperature, Illumination, humidity noise and vibrations on human body and mind, Measurement and mitigation of physical and mental "fatigue" Basics of environment design for improved efficiency and accuracy at work.

4. **VENTILATION, LIGHTING AND HEAT CONTROL**: 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, and local exhaust ventilation, Control of radiant heat, dilution ventilation, Purpose of lighting, benefits of good illumination, Phenomenon of 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.

5. **NOISE & VIBRATIONS**: Continuous and impulse noise, The effect of noise on man, Noise measurement and evaluation of noise, Noise isolation, Noise absorption techniques, Silencers vibrations: Effect, measurement and control measures.

6. **INDUSTRIAL WASTE AND ENVIRONMENT STANDARDS**: Types and sources of industrial waste, Impact of industrial waste on environment, treatment, disposal and control of industrial waste, Introduction to ISO 14000; Environment standards for representative industries.

RECOMMENDED BOOKS

1. Air Pollution Control — Rossamo
2. Ventilation — Joselin & Edward Arnold
3. Noise Reduction — Beranek
4. Modern Safety and Health Technology — D.C. Reamer
5. Industrial Accident Prevention — Heinrich, H.W.
6. The process of Hazard Control — Firenze, R.J.

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QUALITY ENGINEERING

ME – 475 (e)

L	T	P/D	Cr
3	0	0	3

1. **QUALITY AND QUALITY CONTROL**: Concept of Quality and Quality Control, total quality control, Quality System economics, System approach for quality management, Quality Policy, Product and Process reliability, Process capability, Quality cost optimization.

2. **QUALITY PLANNING**: Quality Planning, Quality information feed back, Taguchi's philosophy of Robust product and process design, Machine and process capability analysis and charts, Control Charts X, R, P and C, special process control charts; acceptance sampling, plans and tables for attributes and variables.

3. **QUALITY IMPROVEMENT TECHNIQUES**: Quality improvement techniques, variance concepts, fishbone diagrams, pareto charts, just-in-time philosophy; quality assurance systems, ISO 9000, philosophy, documentation, implementation and certification process, Management's commitment to quality, team work approach, training and motivation quality circles.

RECOMMENDED BOOKS

1.	Quality Planning & Analysis	Juran, Gryna
2.	Statistical Quality Control	E.L. Grant
3.	Total Quality Management	Besterfield,
4.	Total Quality Control	Feignbaum
5.	Fundamentals of Quality Control and Improvement, 2/e	Mitra
6.	Quality Control Handbook	Juran

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ENTREPRENUERSHIP

ME – 475 (f)

L	T	P/D	Cr
3	0	0	3

1. **THE ENTREPRENEURIAL DEVELOPMENT PERSPECTIVE**: Concept of Entrepreneurship Development Evolution of the concept of of Entrepreneur, Entrepreneur Vs. Intrapreneur, Entrepreneur Vs. Entrepreneurship, Attributes and characteristics of a successful Entrepreneur, Role of Entrepreneur in India economy and developing economics with refrence to self-Employment Development, Entrepreneurship Culture.

2. **CREATING ENTREPRENEUURIAL VENTURE**: Business Planning Process, Environmental Analysis – Search and Scanning, Indentifying problems and opportunities, Defining Business Idea, Basic Government Procedures to be complied with.

3. **PROJECT MANAGEMENT**: Technical, Financial, Marketing, Personnel and Management Feasibility, Estimating and Financing funds requirement – Schemes offered by various commercial banks and financial institutions like IDBI, ICICI, SIDBI, SFCs, and Venture Captial Funding.

4. **ENTREPRENEURSHIP DEVELOPMENT AND GOVERNMENT**: Role of Central Government and State Government in promoting Entrepreneurship – Introduction to various incentives, subsidies and grants – Export Oriented Units – Fiscal and Tax concessions available.

5. **ROLE OF FOLLOWING AGENCIES IN THE ENTREPRENEURSHIP DEVELOPMENT**: District Industries Centres (DIC), Small Industries Service Institute (SISI), Entrepreneurship Development Institute of India (EDII), National Institute of Entrepreneurship & Small Business Development (NIESBUD), National Entrepreneurship Development Board (NEDB).

6. **WHY DO ENTREPRENEURS FAIL**: The FOUR Entrepreneurial Pitfalls (Peter Drucker)

7. **WOMEN ENTREPRENEURS**: Reasons for Low/No Women Entrepreneurs, Role, Problems and Prospects.

8. **CASE STUDIES**: Case studies of Successful Entrepreneurial Ventures, Failed Entrepreneurial Ventures and Turnaround Ventures.

RECOMMENDED BOOKS

1. Entrepreneurship : New Venture Creation	David H. Holt
2. Entrepreneurship	Hisrich Peters
3. The Culture of Entrepreneurship	Brigitte Berger
4. Project management	K. Nagarajan
5. Dynamics of Entrepreneurship Development	Vasant Desai
6. Entrepreneurship Development	Dr. P.C. Shejwalker
7. Thought Leaders	Shrinivas Pandit
8. Entrepreneurship, 3rd Edition	Steven Brandt
9. Business Gurus Speak	S. N. Chary
10. The Entrepreneurial Connection	Gurmit Narula

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COMPUTER GRAPHICS AND RAPID PROTOTYPING

ME- 475 (g)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION AND OVERVIEW OF GRAPHICS SYSTEMS**: Computer-aided design, Presentation Graphics, Computer art, entertainment, education and training, visualization, image processing, graphical user interfaces, Video display devices, Raster scan systems, Random scan systems, Graphics monitors and workstation, Input devices, hard copy devices, graphics software.

2. **OUTPUT PRIMITIVES**: Point, and lines, line drawing algorithms, loading the frame buffer, line function, circle generating algorithm, ellipse generating algorithms, other curves, pixel addressing, filled area primitives.

3. **ATTRIBUTES OF OUTPUT PRIMITIVES**: Line attributes, curve attributes, area fill attributes.

4. **TWO-DIMENSIONAL GEOMETRIC TRANSFORMATIONS**: Two-dimensional translation, rotation, scaling, matrix representation and homogeneous co-ordinates, composite transformations, other transformations-reflection, shear transformation between co-ordinate systems.

5. **TWO DIMENSIONAL VIEWING**: The viewing pipeline, viewing co-ordinate reference frame, window to viewport coordinate transformations, clipping operations, point clipping, line clipping, polygon clipping.

6. **THREE DIMENSIONAL GEOMETRIC AND MODELING TRANSFORMATION**: Translation, rotation, scaling, reflection, shear, composite transformations, three-dimensional modeling and co-ordinate transformations.

7. **RAPID PROTOTYPING**: Details/methods of Rapid prototyping, Basic principles of RP, Different RP Techniques, Advantages of RP, CAD modeling, CAE Analysis

RECOMMENDED BOOKS

1. Computer Graphics — Hearn & Baker
2. Geometric Modeling — Vera B. Anand

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PRODUCT DESIGN & VALUE ENGINEERING

ME – 475 (h)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION**: Introduction to Product Design, Design by Evolution and Innovation, Essential factors of product design, Production consumption cycle, Flow and value addition in Production consumption cycle.

2. **FUNCTIONAL & AESTHETICS CONSIDERATION**: Basic design considerations, Role of Aesthetics in product design, Basic concept and elements of Visual design, Functional design practice.

3. **MANUFACTURING CONSIDERATION**: Producibility Requirements in the design of machine components, Forging design, Pressed component design, Design for machining, Ease of location and Clamping, Some additional aspects of production design, Design of powder metallurgical parts, Redesigning on basis of production consideration.

4. **VALUE ENGINEERING**: Concept of value, cost and price, customer and value, philosophy and objectives of value analysis, types of value, areas of application of value engineering, limitations of value analysis, difference between value engineering and cost reduction techniques; Tool of technology in value analysis, method & engineering, cause and effect diagram, SWOT analysis, break even analysis, systems approach; Job plan for value analysis approach: Information phase, Function Phase, Creation Phase, Evaluation Phase, Recommendation Phase, Implementation Phase, Audit Phase; Value Engineering Cell, value manual, composition of cell, Cost cutting, various cost cutting techniques; Case studies in value engineering and analysis from manufacturing and service industries.

RECOMMENDED BOOKS

1. Product Design and Development — Kail T. Ulrich & Steven D. Eppinger
2. Product Design and Engineering — A.K. Chitale & Gupta
3. Product Design and Process Engineering — Niebel & Draper
4. Design of Systems and Devices — Middendorf Marcel Dekker
5. Value Engineering SAVE — Mudge
6. Techniques of Value Analysis and Value Engineering — Miles Lawerence
7. Value Engineering in Manufacturing — ASME
8. Value Engineering Theory — Parker, D.E.

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