3rd Semester

3ME1 – Applied Mathematics III

Unit I
Laplace Transform – Definition and its properties, Transform of derivatives and integrals, Evaluation of integrals by LT, inverse and its properties, convolution theorem. LT of periodic functions and unit step function, Applications of Laplace transform to solve ordinary differential equations and partial differential equations (one dimensional wave and diffusion equations)   (8 Hours)

Unit II
Z- Transform – Definition and properties, inversion, relation with Laplace Transform. Applications of z-transform to solve difference equation with constant coefficient. (5 Hours)

Unit III
Fourier Transform – Definition, Fourier Integral Theorem, Fourier Sine and Cosine Integrals, Finite Fourier Sine and Cosine Transform, Parse Val's Identity, Convolution Theorem
(5 Hours)

Unit IV
Complex Variable – Analytic function Cauchy-Riemann Conditions, conjugate functions, singularities, Cauchy's Integral Theorem and Integral Formula (statement only). Taylor's and Laurent's Theorem (statement only) Residue Theorem, Contour Integration, Evaluation of real and complex integrals by Residue Theorem, Conformal mapping, Mapping by linear and inverse Transformation.   (10 Hours)

Unit V
Special Functions and Series solution. – Series solution of differential equation by Frobaniu's method, Bessel's Function, Legendre's Polynomials, Recurrence Relations, Rodrigue's Formula, Generating Functions, Orthogonal Properties of $J_n (x)$ and $P_n (x)$. (8Hours)

Unit VI
Fourier Series – Periodic Function and their Fourier series expansion, Fourier Series for even and odd function, Change of interval, half range expansions.
Partial Differential Equations – PDE of first order first degree i.e. Lagrange's form, linear homogeneous equations of higher order with constant coefficient. Method of separations of variables, applications to one-dimensional heat and diffusion equation. Two-dimensional Heat Equation (only steady state).   (9 Hours)

Text Books
1) Higher Engineering Mathematics – B S Grewal
2) Advanced Engineering Mathematics – Kreyszig

Reference Books
1) Mathematics for Engineers – Chandrika Prasad
2) Advanced Engineering Mathematics – Chandrika Prasad

3ME2 – Theory of Machines - I
Unit I
Basic concept of mechanism, link, kinematics pairs, kinematics chain, mechanism, machine, simple & compound chain, Degree of freedom, estimation of degree of freedom of mechanism by Grubber's criterion and other methods. Harding's notations, classification of four bar chain [class-I & Class-II], inversion of four-bar-chain, Kutchbach theory of multiple drives, energy paths. Various types of mechanism such as Geneva wheel, Pawl and ratchet mechanism, Exact straight line mechanism, Approx. straight line mechanism, steering mechanism, Transport mechanism.   [8 Hrs.]

Unit II
Quantitative kinematics analysis of mechanism: - Displacement, Velocity and Acceleration analysis of planer mechanism by graphical method as well as analytical method [complex number method/matrix method], Coriolis component of acceleration, Instantaneous center method, Kennedy's theorem.   [7 Hrs]

Unit III
Concepts of cam mechanism, comparison of cam mechanism with linkages. Types of cams and followers and applications. Synthesis of cam for different types of follower motion like constant velocity, parabolic, SHM, cycloid etc.
Analysis of follower motion for cams with specified contours like eccentric cam, tangent cam, and circular arc cam with concave and convex curvature. Pressure angle in cam, parameters affecting cam performance.   [8Hrs]

Unit IV
Concept of motion transmission by toothed wheels, comparison with cams and linkages, various tooth profiles, their advantages and limitations, gear tooth terminologies, concept of conjugate action, law of conjugate action, kinematics of in volute gear tooth pairs during the contact duration, highlighting locus of the point of contact, arc of contact, numbers of pairs of teeth in contact, path of approach and path of recess, interference, undercutting for in volute profile teeth. [7 Hrs]

Unit V
Kinematics of helical, bevel, spiral, worm gears, rack and pinion gears, kinematics analysis, and torque analysis of simple epicyclical and double epicyclical gear trains.   [7 Hrs]

Unit VI
Static force analysis: Free body diagram, condition of equilibrium. Analysis of all links of given linkage, cam, gear mechanism and their combinations without friction. Introduction to coupler curves, Robert's Law of cognate linkages.   Synthesis of four bar chain for gross motion, transmission angle optimization, Frudenstein equation and its application for function generation.   [8 Hrs.]

List Of Tutorials

1) Drawing sheets on Inversion of   i) Class I & Class II four bar chain   ii) Single slider crank chain   iii) Double slider crank chain
2) Problems on kinematic analysis   i) Graphical method   ii) Analytical method
3) Cam constructions
4) Cams with specified contour
5) Analysis of epicyclic gear train with torque analysis
6) Problems on static force analysis
   i) Linkages
   ii) Cam
   iii) Gear
7) Problems on synthesis
   i) Graphical method
   ii) Analytical method

Recommended Books
  1) Theory of mechanisms & machines by Shigley J. E.
  2) Theory of Mechanism and Machine by Ghosh & Malik
  3) Mechanism and Machine Theory by J.S. Rao & Dukki Patti
  4) Theory of Machine by Rattan
  Reference Books
 1) Theory of Machine by Thoman Bevan CBS publication
 2) Theory of Machines by Sandor & Erdman

3ME3 – Fluid Power I

Unit I
Introduction to Fluid Mechanics: Properties of fluids, Newton's law of viscosity and its application, Dimensional analysis, Dimensional homogeneity, Buckingham's π & Raleigh method. Pascal's law, Basic equation of fluid static, Fluid pressure & its measurement (Manometers & Bourdon's pressure gauge).   [7 Hrs.]

Unit II
Hydrostatics: Pressure variations in compressible & incompressible fluids, Forces on submerged plane surfaces and curved surfaces, Buoyancy, Stability of floating and submerged bodies, Oscillation of floating bodies.
Relative Equilibrium: Pressure distribution in a liquid subjected to acceleration, Pressure distribution in a liquid subjected to rotation. [7 Hrs.]

Unit III
Kinematics Of Fluid Flow: Types of flow, Stream line, Path line, Streak line, Stream tube, Continuity equation, One and Two dimensional flow, Velocity and Acceleration at a point, Potential lines, Flow net, Stream function, Velocity potential, Circulation, Vortex motion.
Dynamics Of Fluid Flow: One-dimensional method for flow analysis, Euler's equation of motion, Derivation of Bernoulli's equation for incompressible flow & its applications. [8 Hrs.]

Unit IV
Measurement Of Fluid Flow: Through ducts or pipes: Venturi meter, Orifice meter, Pitot tube. Through reservoirs: Orifice, Mouthpiece. Through open channels: Discharge over Notches (Triangular, Rectangular, Trapezoidal only) Rotameter, Vane Anemometer, Turbine meter. Error analysis in flow measurements.   [7 Hrs.]

Unit V
Viscous Flow: Introduction to laminar and turbulent flow, Reynolds number and its significance, Boundary layer concept, Wall shear and boundary layer thickness, Displacement thickness and Momentum thickness, Momentum integral equations for the boundary layer (Von Karman), Separation, Drag and Lift on immersed bodies. Flow of viscous fluids through parallel plates, Pipes, Kinetic energy correction factor, Momentum energy correction factor. [8 Hrs.]

Unit VI
Flow Through Pipes: Equations for pipe flow, Friction charts and their uses, Losses in pipes and fittings, Hydraulic gradient lines and total energy lines, Pipes in series and parallel. Siphon, Water hammer phenomenon, Economics of pipe systems.
Power Transmission Through Pipeline: Condition for maximum power transmission through a given pipeline (single pipe), Relationship of nozzle diameter to pipe diameter for maximum power transmission. [8 Hrs.]

Books Recommended:
1) Fluid Machines – Frank. M. White.
2) Fluid Mechanics & Fluid Power Engineering - D. S. Kumar -S. K. Kataria Pub.
3) Basic Fluid Mechanics - C.P. Kothandaram & R. Rudramoorthy - New Age Pub.
4) Fluid Mechanics for Engineers - P.N. Chatterjee – Macmillan India Ltd.
5) Fluid Mechanics – J.F.Douglas, J.M.Gasiorek & J.A. Swaffield - ELBS Pub.
6) Mechanics of Fluids – B. S.Massey – ELBS Pub.
7) Fluid Mechanics – A.K.Mohanty - Prentice Hall Pub.
8) Fluid Mechanics - A.K.Jain

Tutorials:
1) Applications based on fluid properties such as block sliding over an inclined plane, capillary phenomenon etc.
2) Study of force on gates.
3) Study of Manometers.
4) Study of stability of floating bodies and submerged bodies
5) Determination of coefficient of discharge of flow meters.
6) Verification of Bernoulli's equation.
7) Stoke's law.
8) Case study of pipe network.
9) Quasi-static flow.
10) Reynold's number and its significance.
11) Losses in pipes (Hagen Pois. equation).

3ME4 – Manufacturing Process I

Unit I
Introduction to Machining Parameters: Introduction to machining, Tool materials, nomenclature and tool geometry of single point cutting tool, tool materials properties, classification, HSS, carbide tool, coated tools, diamond coated tool, coolant materials.[7 Hrs.]

Unit II
Lathe: Introduction, type, construction of simple lathe, mechanism and attachments for various operations, machine specifications, basis for selection of cutting speed, feed and depth of cut, time estimation for turning operations such as facing, step turning, taper turning, threading, knurling. [8 Hrs.]

Unit III
Shaper: Introduction, type, specification, description of machines, hydraulic drives in shapers, cutting parameters. Mechanism of shaper: Quick return mechanism, Crank & slotted link mechanism, Table feed mechanism, attachments for shaper, work holding devices, shaper operations, time estimation for shaping operations.
Slotter: Introduction, specifications, description, type of drives for slotter, types of slotting machines - production slotter, puncher slotter, tool room slotter, slotter tools.
Planer: Introduction, specifications, description, type of planner, standard planner, open side planner, pit planner. Mechanism for planner: Driving mechanism, feeding mechanism, planner cutting tools, cutting parameters. [7 Hrs.]
Unit IV
Milling: Introduction, specifications, types, column & knee type milling machine, fixed bed type milling machines, production milling machines, special purpose milling machines such as thread milling machines, profile milling machine, Gear Milling/Hobbing machines. Mechanisms & Attachments for Milling. Cutting parameters, Types of milling operations, Types of milling cutters, Tool geometry & their specifications. Indexing- simple, compound and differential. [8 Hrs.]
Unit V
Grinding operations, grinding wheel, specifications & selection, cylindrical & centreless grinding operation, surface grinding, tool & cutter grinding, time estimation for grinding operations.
Super finishing process: Honing, Lapping, super finishing, polishing, buffing, metal spraying, galvanizing and electroplating. Process parameters and attainable grades of surface finish, surface roughness measurement. [8 Hrs]
Unit VI
Drilling: Introduction, tools for drilling, classification of drills, twist drills, drill size and specifications, carbide tipped drills, type of drilling machines-portable drilling machine, bench drilling machine, upright drilling machine, radial drilling machine, universal drilling machine, multispindle drilling machine. Drilling machines operations, time estimation for drilling.
Reaming: Introduction, description of reamers, type of reaming operations.
Boring: Introduction, types of boring machine, horizontal boring machine, vertical boring machine, jig boring machine, microboring, boring operations.
Broaching: Introduction, type of broaches, and nomenclature of broaches, type of broaching machines.   [7 Hrs.]

Recommended Books:

1) Manufacturing Technology (Metal Cutting & Machine Tools) – P N Rao
2) Manufacturing Science – Ghosh & Malik
3) Workshop Technology (Volume-II) - By Hajra Choudhary

Reference Books
1) Manufacturing Engineering & Technology – S Kalpakjian & SR Schmid
2) Technology of machine Tools – Krar & Oswald
3) Manufacturing Processes – M Begman
4) Processes & Materials of Manufacture – R Lindberg
5) Production Technology – HMT
6) Workshop Technology (Volume I & II) - By Bawa

Practical
1) Study of single point cutting tool
2) Tools for left hand & right hand turning
3) Tools for external & internal turning (Boring)
4) Study of cutting tool manual (any one)
5) Study of mechanisms in Lathe
6) Study of mechanism in drilling
7) Study of mechanism in shaper
8) Study of mechanism in milling
9) Practical on turning involving facing, step turning, taper turning, boring, boring
    with internal steps & taper, drilling (on lathe), internal & external threading
10) Practical on Shaper with exposure to auto feed
11) Practical on Milling machine-Gear Milling
12) Practical on use of drilling machines

Tutorials
1) Geometry and nomenclature of various tools
2) Time estimation for lathe, shaper and planer operations
3) Time estimation for milling, drilling and grinding operations
4) Study of cutting parameters and their effect on machining
5) Selection of process for machine components

3ME5 - Engineering Metallurgy

Unit I

Introduction to materials, classification of materials. Properties and applications of materials. Crystalline nature of metals, specially microscopic and macroscopic examinations of metals. Alloys and solid solutions, types and their formations, modified Gibbs's phase rule, Lever rule for phase mixtures and their application in system. (5 Hrs.)

Unit II

Study of equilibrium diagrams and invariant reactions. Iron-Iron carbide equilibrium diagram, critical temperatures. Microstructure of slowly cooled steels. Estimation of carbon from microstructures; structure property relationship.
Classification and applications of steels. Effect of alloying elements, specifications of some commonly used steels for Engineering applications (e.g. En. AISI, ASTM, IS etc.) with examples.   (8 Hrs.)

Unit III

Classification and application of plain carbon steels. Examples of alloy steel such as Hadfield Manganese Steel, ball Bearing Steels, Maraging Steels, Spring Steels, etc.
Tool Steels – Classification, composition, application and commercial heat treatment practice for HSS, Secondary hardening.
Stainless Steels - Classification, composition, application and general heat treatment practice for Stainless Steels.   (8 Hrs.)

Unit IV

Heat treatment and its importance. Annealing, Normalizing, Hardening, Quench Cracks, Hardenability test.
TTT diagram and its construction and related Heat Treatment Processes such as Austempering, Martempering, Patenting etc.
Retention of Austenite, Effects and elimination of retained austenite, Tempering.
Case / Surface hardening treatments such as Carburising, Nitriding, Cyaniding, Carbonitriding, Flame and Induction hardening.   (8 Hrs.)

Unit V

Cast Iron – Classification, White cast Iron, Gray Cast Iron, Nodular Cast Iron, Malleable Cast Iron, Chilled and alloy Cast Iron. (Production route, Composition, Microstructure and applications) Effects of various parameters on structure and properties of Cast Iron, Alloy cast Iron such as Ni-resist, Ni-hard.
Non-Ferrous Alloys – Study of non-ferrous alloys such as brasses (Cu-Zn diagram), Bronzes (Cu-Sn diagram), Aluminum Alloys (e.g. Al-Si & Al-Cu diagram), Bearing materials. (8 Hrs.)

Unit VI

Tension Test – Engineering and True Stress Strain Curve conversion relationship, evaluation of properties. Numericals based on tension and compression test Types of Engineering Stress Strain Curves. Compression Test
Hardness Test – Brinell, Vickers and Rockwell
Introduction to Charpy and Izod Impact Test
Introduction to Non-destructive testing. (8 Hrs.)

Reference Books

1) Introduction to Engineering Metallurgy – Dr. B K Agrawal
2) Introduction to Physical Metallurgy – Avner
3) Engineering Physical Metallurgy and Heat Treatment – Yu Lakhtin
4) Metallurgy for Engineers – E C Rollason

Practical

A set of 10 Experiments from following list

1) Study of Metallurgical Microscope
2) Preparation of Specimen for metallographic examinations.
3) Preparation of Mounted samples with the help of mounting press / cold setting resins.
4) Study and drawing of microstructures of Steels.
5) Study and drawing of microstructures of Cast Iron
6) Study and drawing of microstructures of Non Ferrous Metals.
7) Study of the effect of annealing and normalizing on properties of steels.
8) Determination of harden ability of steels by Jominy End Quench test.
9) Tensile test on Mild Steel and Aluminum test specimen.
10) Measurement of hardness of ferrous and non-ferrous materials with the help of
11) Brinell
12) Vickers
13) Rockwell Testing Machine
14) Study the heat treatment of high speed steels
15) Study the heat treatment of stainless steel.
16) Study of effect of alloying elements on properties of steels.
17) Study of macroscopic examinations
18) Study of mechanisms of quenching
19) Study of Pack carburising of steel samples

3ME6 - Computer Applications I

Unit I
Introduction to Algorithm. Expressing algorithm, narrative description, flowchart, an algorithm language. Data, data type and primitive operations. Variables and expressions. From algorithm to program. Decision structures, sub algorithms. (7-8 Hours)

Unit II
Composite Data Structures. Arrays and vector sorting algorithms, 1 – 2 Dimensions(7-8 Hours)

Unit III
Linear Data Structures, Linked List, Stacks, Queues, Recursion (7-8 Hours)

Unit IV
Non-linear Data Structures, Trees, General Trees and their searching techniques. (7-8 Hours)

Unit V
File handling – Record organization, Sequential, Index files and Random access files. (7-8 Hours)

Unit VI
Object Modeling – Basics of OOPS, with relation to modeling of objects. (7-8 Hours)

Recommended Books
Introduction to Computer Science: An Algorithmic Approach – J P Tremblay and R B Bunt
Algorithms and Data Structures – Horonitz and Sahany
Data Structures and Algorithm – A V Aho, J E Hopcioft, J D Ullman
Algorithms and Data Structures – Niklaus Wirth

Reference Books
1) Data Structures and Program Design – R L Kruse
2) Object Modeling – Rambaug
3) An Introduction to Data Structures with applications – Tremblay and Sonerson

4) Tutorials
Programming in C / C++ or any other suitable package based on above syllabus. Two programs from each Unit are expected.

Practicals
Algorithm and Program Development. Programs are expected in any suitable language preferably C or C++. At least one program is expected from each topic of following list.

1) Control Structures
2) Arrays
3) Sorting Techniques
4) Searching Techniques
5) File Handling
6) Non-Linear Data Structures
7) Linear Data Structures
8) Numeric Computation
9) Recursion
10) OOPS

3ME7 - Industrial Visit

Students should be taken for visit to Industries. Visits to minimum two different types of industries are expected. Students should submit a visit report in the format given below after the visit. Preferably they should make a presentation.
Report should consist of

1) Name of Industry
2) Nature of ownership
3) Year of establishment
4) List of finished products
5) Annual turnover of company
6) Number of employees
7) List of departments / sections
8) Classification of Industry
9) Based on turnover
10) Based on product / process
11) List of major machines / equipment
12) List of raw material used
13) Sequence of operation (with brief description of operations) of at least one product / process.

4th Semester

4ME1 – Applied Mathematics IV

Unit I
Matrices – Inverse of Matrix by adjoint method, rank of a matrix, consistency of system of equations, Inverse of matrix by portioning method, linear dependence, linear and orthogonal

transforms, characteristics equations, eigen values and eigen vectors, reduction to diagonal form, Statement and verification of Cayley-Hamilton Theorem (without proof), Sylvester's Theorem, solution of second order linear differential equation with constant coefficiant by matrix method. Special matrices – Rotation matrix, Sparse matrix, Vander monde matrix.

Unit II
Numerical Methods – Error analysis, solution of algebraic and transcendental equations by False position method, Newton-Raphson, Regula falsi. Newton-Raphson method for multiple roots. Solution of system of simultaneous linear equations, Gauss elimination method, Gauss Jordan method, Gauss Seidel method, Crouts method.

Unit III
Eigen values and eigen vectors by iteration methods, by Jacobi method, Givens method and Householder's method. Solution of ordinary differential equation by Taylor's series method, Runge-Kutta 4th order method, Euler's modified method, Milne's Predictor Corrector method.

Unit IV
Random variables, Distribution functions of continues and discrete random variables, Joint distributions, Mathematical Expectations, Moment, Moment generating function and Characteristic Function

Unit V
Special Probability Distribution – Geometric, Binomial Poisson's, Normal, Exponential, Uniform and Weibull Probability distributions.
Random Processes, Esemble average and temporal average, autocorrelation and cross correlation stationary random process, power spectrum of Stationary Processes and ergodic random process.

Unit VI
Calculus of variation – Functional, Extremals of Functionals, variational principle, Euler's Equation, Constrained extremals, Hamilton principle and Lagrange's equation in solid mechanics.

Text Books
1) Higher Engineering Mathematics – B S Grewal
2) Theory and Problems of Probability and Statistics – M R Spiegel
3) Introductory Methods of Numerical Analysis – S S Sastri

Reference Books
1) Advanced Engineering Mathematics – Kreyszig
2) Mathematics for Engineers – Chandrika Prasad
3) Advanced Engineering Mathematics – Chandrika Prasad
4) Applied Mathematics for Engineers and Physics – L A Pipes & Harvile
5) Calculus of Variation – Forrey

4ME2 – Machine Design I
Unit I
Concept of simple stresses and strains: Introduction, stress, strain, types of stresses, stress - strain diagram for brittle & ductile material, elastic limit, Hooks law, modulus of elasticity, modulus of rigidity, factor of safety, analysis of tapered rod, analysis of composite section, thermal stress and strain, thermal stresses with heat flow in cylinders and plates, Hertz's contact stresses.
Longitudinal strain & stress, lateral stresses and strains, Poisson's ratio, volumetric streeses and strain with uni-axial, bi-axial & tri-axial loading, bulk modulus, relation between Young's modulus and modulus of rigidity, Poisson's ratio and bulk modulus.

Principal stresses and strains:- Definition of principal planes & principal stresses, analytical method of determining stresses on oblique section when member is subjected to direct streesses in one plane in mutually perpendicular two planes, when member is subjected to shear stress and direct stresses in two mutually perpendicular planes, Mohr's circle for representation of stresses. Derivation of maximum and minimum principal stresses & maximum shear stresses when the member is subjected to different types of stresses simultaneously(i.e. combined stress) [8 Hrs.]

Unit II
Shear force and bending moment:- Types of beam (cantilever beam, simply supported beam, overhung beam etc.), Types of loads (Concentrated and UDL), shear force and bending moment diagrams for different types of beams subjected to different types of loads, sign conventions for bending moment and shear force, shear force and bending moment diagrams for beams subjected to couple, Relation between load, shear force and bending moment.
Stresses in beams:- Pure bending, theory of simple bending with assumptions & expressions for bending stress, derivation of bending equation, bending stresses in symmetrical sections, section modulus for various shapes of beam sections.
Shear stresses in beams:- Concept, derivation of shear stress distribution formula , shear stress distribution diagram for common symmetrical sections, maximum and average shear stress. [8 Hrs.]

Unit III
Deflection of beams: - Derivation of differential equation of elastic curve with the assumptions made in it. Deflection & slope of cantilever, simply supported, overhung beams subjected to concentrated load, UDL, Relation between slope, deflection & radius curvature Macaulay's method, area moment method to determine deflection of beam. [7 Hrs.]

Unit IV
Torsion of circular shafts: - Derivation of torsion equation with the assumptions made in it . Torsion shear stress induced in the shaft, when it is subjected to torque. Strength and rigidity criterion for design of shaft. Torque transmitted by solid & hollow circular shaft. Derivation of maximum, minimum principal stresses and maximum shear stress induced in shaft when it is subjected to bending moment, torque & axial load.
Column & Struts :- Failure of long & short column , slenderness ratio, assumptions made in Euler's column theory, end conditions for column. Expression for crippling load for various end conditions of column. Effective length of column, limitations of Euler's formula, Rankine formula, Johnson's parabolic formula. [8 Hrs.]

Unit V
Introduction to fracture mechanics : - Modes of fracture, stress intensity factors, crack propagation, Paris law, creep phenomenon, design for creep.
Strain energy & impact loading :- Definition of strain energy stored in a body when it is subjected to gradually applied load, suddenly applied loads & impact loads. Strain energy stored in bending & torsium. Castingliano's theorem. [7 Hrs.]

Unit VI
Factor of safety, Statistical methods in determining factor of safety. Theories of failure, modes of failure, compound stresses, eccentric axial loading, variable stresses in machine

parts, stress concentration & stress raisers, notch sensitivity, stress concentration factor, methods for reducing stress concentration. Goodmans criteria, Soderberg criteria, Gerber's criteria, fatigue design for finite and infinite life of the parts subjected to variable loads   [7 Hrs.]

Tutorials
1) Two problems on principle stresses
2) Two problems on Mohr's circle
3) Two problems on Thermal stresses with heat flow
4) Three problems on S.F. & B.M. diagrams
5) Two problems on Stresses in beam bending
6) Two problems on shear stresses
7) Two problems on Macaulay's methods
8) Two problems on area moment method
9) Two problems on shafts
10) Two problems on columns & struts
11) Two problems on compound loading
12) Two problems on fatigue & variable loads

Books Recommended
1) Strength of Materials – Timoshenko
2) Strength of Materials by – F. L. Singer
3) Machine Design – Shigley
4) Machine Design – Black & Adams
5) Design of Machine Elements by – B. D. Shiwalkar
6) Design Data for Machine Elements – B D Shiwalkar

4ME3 – Engineering Thermodynamics
Unit I
   Introduction To Thermodynamics: Basic concepts of Thermodynamics, Closed & Open Systems, Forms of energy, Properties of a system, State and Equilibrium, Processes and Cycles, Temperature and Zeroth Law of Thermodynamics. Introduction to First Law of Thermodynamics (Law of Conservation of Energy), Heat and Work, Mechanical forms of work, Non-Mechanical Forms of Work (Electrical, Magnetic etc.)
The Ideal Gas equation of state, Difference between Gas and Vapor, Compressibility Factor, Internal energy and specific heats of gases, Universal Gas Constants. [7 Hrs]

Unit II

First Law Of Thermodynamics: Closed Systems (Control mass systems), Work done, Change in Internal energy, Heat transferred during various thermodynamic processes, P-V diagrams. Open Systems (Control volume systems), Thermodynamic analysis of control volumes, Conservation of energy principle, Flow work and enthalpy, The Steady flow process applied to (i) Nozzles and Diffusers   (ii) Turbines and Compressors,(iii) Throttle Valves. Unsteady Flow process (simple systems like charging & discharging of tanks) .
[8 Hrs]

Unit III
Second Law Of Thermodynamics: Introduction (Law of degradation of energy), Thermal energy reservoirs, Kelvin-Plank & Clausius statements, Heat engines , Refrigerator and Heat pump, Perpetual motion machines, Reversible and Irreversible processes, Carnot cycle, Thermodynamic temperature scale.
Entropy: The Clausius inequality, Entropy, Principle of increase of entropy, Change in entropy for Closed and Steady flow open systems.
Second law analysis of engineering systems: Availability, Reversible work and Irreversibility.
[8 Hrs]

Unit IV
PROPERTIES OF STEAM : Critical state, Sensible heat, Latent heat, Super heat, Wet steam, Dryness fraction, Internal energy of steam, External work done during evaporation , T-S diagram, Mollier chart. Work and Heat transfer during various thermodynamics processes with steam as working fluid.Determination of dryness fraction using various calorimeters. [7 Hrs]

Unit V
Air Standard Cycles: Otto cycle, Diesel cycle, Stirling and Ericsson cycle, Brayton cycle .
Vapour Cycles: Simple and Modified Rankine cycle with reheat & regeneration. [7 Hrs]

Unit VI
Compressible Flow: Stagnation properties, speed of sound wave, Mach number, One dimensional isentropic flow, Stagnation properties, Isentropic flow through convergent-divergent nozzles, Normal shock.. [8 Hrs.]

Books Recommended
1) Thermodynamics- An Engineering approach - Yunus A. Cengel, Michael A. Boles
2) Thermodynamics - C.P. Arora - Tata Mc-Graw Hill publication.
3) Fundamentals of Classical Thermodynamics - Gorden J.Van Wylen, Richard E.Sonntag,
4) Engineering   Thermodynamics - P. K. Nag.
5) Basic Engineering Thermodynamics - Reiner Joel .

Tutorials
Problems On
1) Steady flow systems.
2) Charging & discharging of vessels.
3) Measurement of dryness fraction.
4) Clausius Inequality.
5) Chocking of nozzles.
6) Study of various Air Standard cycles.

4ME4 – Theory of Machines II
Unit I
 Concepts in machine element dynamics. Dynamic Stresses in machine elements, various approaches for dynamic analysis- D'Alembert principle, Hamilton principle and Lagrange equation. Application of these approaches for simple two or three degree of freedom systems. Rigid body motion in space. Euler's equation of motion, simple precession and gyroscopic couple. Gyroscopic effect on airplane, ship, vehicles and grinding mills. [8 Hrs.]

Unit II

Dynamic force analysis of planar linkages such as four bar chain and reciprocating mechanism by graphical method, virtual work method and analytical (complex number) method. Cam dynamic and jump-off phenomenon. [7 Hrs]

Unit III
Balancing in reciprocating mechanism. Turning moment Vs crank angle diagram for single-cylinder and multiple-cylinder engines, punching machines etc. Flywheel selection. [7Hrs]

Unit IV
Static & Dynamic balancing in rotating machines. Balancing machines and field balancing by vector diagram. Speed governors, centrifugal and inertia type, Watt, Portal, Proell, Hartnell governors, operating characteristics of governors. [8 Hrs.]

Unit V
Derivation of equation of motion for vibratory system. Free vibration of single-degree-of-freedom system with and without damping. Logarithmic decrement and damping estimation. Forced vibration of single-degree-of-freedom and vibration isolation, whirling of shaft and critical speed of rotors.   [8 Hrs.]

Unit VI
Equation of motion for two-degree-of-freedom system. Natural frequencies and mode shapes vibration absorber. Torsional oscillation of two-disc and three disc rotors. [7 Hrs.]

LIST OF EXPERIMENTS
1) Determination of jump-of speed of a typical cam- follower system
2) Dynamic balancing of rotating masses
3) Balancing of reciprocating mechanism
4) Critical speed of shafts
5) Gyroscope
6) Free vibration of single DOF and two DOF spring mass system
7) Natural frequency determination of cantilever beam
8) Damping determination through free vibration logarithmic decay of a simple damped system
9) Natural frequency determination of two and three rotor system
10) Torsional vibration of bifilar or trifilar pendulum
11) Transmissibility of single degree of freedom system
12) Dynamic vibration absorber
13) Dynamic force analysis of four bar mechanisms
14) Dynamic force analysis of slider crank mechanism
15) Flywheel selection and parameter design for a typical multicylinder engines
16) Performance characteristics of governors

Recommended Books
1) Theory of Machines and Mechanism - Shigley
2) Theory of Machines and Mechanism - Ghosh & Mallik
3) Theory of Mechanism - S. S. Rattan
4) Mechanism and Machine Theory - Rao & Dukipatti
5) Theory of Vibrations – W T Thomson
REFERENCE BOOKS:
1) Theory of Machine - Thomas Bevan

2) Theory of Machines - Sandor & Erdman
3) Mechanical vibrations - Grover

4ME5 – Fluid Power II

Unit I
Impact of Jet and Jet propulsion: Impact momentum principle, Dynamic action of jet on fixed & moving flat plates and curved vanes, Series of plates and vanes, Water wheels, Velocity triangles and their analysis. Introduction to jet propulsion of ships.
Principles & Classification of Hydraulic Machines: Principles of fluid machineries, Classification of hydraulic machines, Theory of turbo machines and their classification, Elements of hydro-electric power plant.

Impulse Turbines: Principle, Constructional features, Installation of pelton turbine, Velocity diagram and analysis, Working proportions, Design parameters, Performance characteristics, Governing and selection criteria. (8 Hrs)

Unit II
Reaction or Pressure turbine: Principles of operation, Degree of reaction, Comparison over Pelton turbine, Development of reaction turbines, Classification, Draft tubes, Cavitation in turbines.Francis turbine, Propellor turbine, Kaplan turbine: Types, Constructional features, Installations, Velocity diagram and analysis, Working proportions, Design parameters, Performance characteristics, Governing, Selection of hydraulic turbines, Bulb turbines. (8 Hrs)

Unit III
Hydrodynamic pumps: Classification and Applications.
Centrifugal Pumps: Principles of operation, Classification, Components of centrifugal Pump installation, Priming methods, Fundamental equation, Various heads, Velocity triangles and their analysis, Slip factor, Effect of outlet blade angle, Vane shapes, Losses & efficiencies of pumps, Multi staging of pumps, Design considerations, Working proportions, N.P.S.H , Cavitations in pumps, Installation and operation. Performance characteristics, Pump and system matching, Introduction to axial & mixed flow Pumps, Self priming pumps. (7 Hrs)

Unit IV
Positive displacement Pumps: Basic principle, Classification.
Reciprocating Piston / Plunger Pumps: Types, Main components, Slip, Work done, Indicator diagram, Cavitation, Air vessels, Hand pumps.
Rotary Displacement Pumps: Introduction to gear pumps, Sliding vane pumps, Screw pumps. (7 Hrs)

Unit V
Similitude: Types of similarities, Dimensionless number and their significance, Unit and specific quantities.
Model Testing: Application to hydraulic turbines and hydrodynamic pumps.
Miscellaneous And Water Lifting Devices: Air lift pumps, Hydraulic ram, Vertical turbine or Bore hole pumps, Submersible pumps, Jet pumps, Regenerative pumps.   (7 Hrs)

Unit VI
Essential Elements Of Hydraulic System: Flow actuators, Directional control valves, Pressure control valves, Flow control valves, Basic hydraulic circuits, Meter in & Meter out circuit. Use of single & double acting actuators, Hydraulic accumulator and intensifier.
Pneumatic Systems: Principle of pneumatics, Introduction to air compressors, Comparison with hydraulic power transmission, Air preparatory, Unit basic valves & industrial pneumatic circuits etc . (8 Hrs.)

Books Recommended
1) Fluid Mechanics with Engineering Applications - Daugherty & Franizin.
2) Hydraulic Machines- Theory & Design - V. P. Vasandani.
3) Fluid Mechanics - A. K. Jain.
4) Fluid Mechanics & Fluid Power Engineering - D. S. Kumar.
5) Fluid Mechanics & Machines -   R. K. Bansal.
6) Theory of Turbo-Machines - A. T. Sayers.
7) Industrial Hydraulics -   J. J. Pippenger.

8) Pneumatics - Gadre.
9) Hydraulic Machines - Jagdish Lal.
10) Hydraulics & Pneumatics - H. L. Stewart.

Tutorials
1) Selection of Turbines.
2) Design of Centrifugal Pumps.
3) Design of Francis Turbine.
4) Design of Reciprocating Pumps.
5) Governing of Turbines.
6) Study of Hydro-Kinetic Systems.

Practicals
(Minimum ten to be performed :   six experiments & four study)
1) To determine the Metacentric Height of given Floating Vessel.
2) To verify Bernoulli's theorem.
3) To find the value of coefficient of a given venturi meter fitted in a pipe.
4) To find the value of coefficient of discharge for a given orifice meter.
5) To find out critical velocity of flow by Reynold's experiment.
6) Performance characteristics of Pelton Wheel.
7) Performance characteristics of Francis Turbine.
8) Performance characteristics of Kaplan Turbine.
9) Performance characteristics of Reciprocating Pump.
10) Performance characteristics of Variable speed pumps.
11) Performance characteristics of Axial flow pump.
12) Study experiment on Fluidic devices.
13) Performance of Hydraulic Ram.
14) Practical on Pneumatic hydraulic circuit.

4ME6 – Manufacturing Process II
Unit I
Casting Process: Introduction. Pattern making: Types, materials used, Pattern making allowances, colour codes. Core making:- Types, core material & its properties.
Moulding: Types of sand moulds, moulding sand composition, moulding sand properties, moulding machines. (8 Hrs)

Unit II

Gating design – Elements of gating systems, pouring time, riser design (Analytical treatment)
Melting furnaces – Types, Electric furnace, Induction furnace, Cupola-construction & operation. Cleaning, inspection & casting defects.
Foundry mechanism: Special casting processes such as investment Casting, Centrifugal Casting, Shell Moulding, CO Moulding, Slush Casting, Die Casting. (9 Hrs)

Unit III

Mechanics of forming processes (including analytical treatment), Determination of rolling pressure & roll separation force, driving force & torque, power loss in bearing. Determination of forging forces & stresses, equipment (Hammer/Press) capacity required.
Rolling, Forging, Extrusion & Wire Drawing. (7 Hrs)

Unit IV

Powder Metallurgy: Powder manufacture and Conditioning, Production of Sintered Structural Components, Self lubricating bearing, Cemented Carbides, Ceramics, Sintered Carbide cutting tools.
Composite Materials: Classification, Different types of composite materials and its applications. (6 Hrs)

Unit V

Joining processes: Introduction to Welding, Soldering, Brazing Processes. Types of Welding, Arc Welding & Gas Welding Processes, Defects & Inspection of Welding Joints, Electrodes, Weldability of Metals, Welding equipments of Fixtures.   (8 Hrs.)

Unit VI

Processing of Plastics, Thermoplastic, Thermosetting plastics, general properties & applications of Thermosetting & Thermo Plastics.
General Plastic Processes: Extrusion, Injection Moulding, Compression Moulding, Transfer Moulding, Blow Moulding, Calendering, Wire Drawing, Embossing. (7 Hrs.)

List Of Practicals

1. Study of Cupola Furnace
2. Study of Moulding Techniques.
3. Study of Casting Processes.
4. Practice on wood pattern making.
5. Machining Work: At least two Mechanical assemblies using three or more parts involving machining on lathe, drill, shaper & milling machines.
** [It is expected that while planning practicals for manufacturing process-I; the job should be designed, such that the job machined in MP-I could also be used for assembly (either few or all of them) in MP-II with little machining (if required).]
6.   A Visit: A visit to a foundry shop for more understanding of the casting practices.

Recommended Books:
1) Manufacturing Technology (Foundry Forming & Welding) – P N Rao
2) Manufacturing Science – Ghosh & Malik
3) Workshop Technology (Volume-I) - By Hajra Choudhary
4) Manufacturing Engineering & Technology – S Kalpakjian & SR Schmid

Reference Books

1) Workshop Technology: Vol. I - III   - By WAJ Chapman
2) Manufacturing Processes – M Begman
3) Processes & Materials of Manufacture – R Lindberg
4) Workshop Technology (Volume I & II) - By Bawa
5) Workshop Technology Vol. I & II   - By B.S. Raghuvanshi

4ME7 – Mini-project

A group of students (not more than 9 students in a group) should **fabricate** a working model of any mechanical or electro-mechanical system. Computer / mathematical model or simulation is not acceptable. Students should submit (at least) one page abstract and a photograph of the model.

5ME1 INDUSTRIAL ECONOMICS AND ENTERPRENEURSHIP DEVELOPMENT

UNIT-I
Industrial Economics : Basic Concepts, Demand Analysis, Types of Demand, Determinants of Demand, Methods of Demand Forecasting, Supply, Law of Diminishing Marginal Utility, Elasticity of Demand.   [8 Hrs.]

UNIT-II

Factors of Production, Production Function, Firm and industry, Laws of Return, Cost Concepts, Fix Variable, Average , Marginal and Total cost, Break Even Analysis, Depreciation cost, Taxation System, Types of Taxes.   [7 Hrs.]

UNIT-III

Optimum Size of Unit, Optimum Firm, Industrial Combinations, Causes for the growth Combinations, Forms of Combinations in India, Various Competitive Situations, Perfect, Monopoly, Monopolistic, Oligopoly, Price Determination under these situations, Impact of Globlisation On Indian Economy.   [8 Hrs.]

UNIT-IV

Concept of Enterpreneurship, Definition, Competencies of Entrepreneurs, Entrepreneurial Functions, Achievement, Motivation, Types of Enterprises, Policies Governing to small scale Industries, Procedure to set up small scale Industries Unit, Advantages and Limitations of SSI.   [7 Hrs.]

UNIT-V

Market Survey and Factors Governing Product Selection, Project Report Preparation, Technical, Financial and Marketing Analysis of the Project, Factors Governing the Selection of site, Plant and Machinery, Financial and Ratio Analysis.   [7 Hrs.]

UNIT-VI

Role of Consultancy Organisations, Role of District Industries Centre, State Ind. Development Corporations, Banks and Financial institutions,latest SSI intensive schemes (to be confirmed from DIC time to time)

BOOKS:
1) Managerial economics: V.N.Gupta
2) Managerial Economics: G.S.Gupta
3) Indian Industrial Economy:K.V.Sivaya,V.B.M.Das.

5ME2   MACHINE DESIGN-II

UNIT I:
Definition of design,types of design , design process, need,defining the problem,feasibility,prilimnary design alternatives,final design selection, preliminary and final plant drawings.

Failure criterion & manufacturing considerations in design, basis of good design, failure of machine parts,deformations,wear,corrosion, manufacturing methods, machining tolerance, surface finish, cost design consideration in casting & forging.

Mechanical properties , application and designing as per ISI and their equivalence with other standards of engineering materials, selection of material ,temperature effect on properties of material such as cast iron ,plain carbon steel, plastics, polymers & composites & their application   [6 Hrs.]

UNIT II:

Design of cotter and knuckle joint.Shrink and press fit joints.

Riveted joints : Reveted joints for boilers, structural works (Uniform strength joint),and eccentric

loaded riveted joint.

Welded joint : design of single transverse ,double transverse, parallel fillet, combination fillet butt joint , Eccentrically loaded welded joints.

Bolted joint : Design of bolted fasteners, bolt of uniform strength, bolted joints under eccentric loading. Design of lever : Hand lever,foot lever ,and bell crank lever.[9 Hrs.]

UNIT III:

Design of power screw:

Derivation of expression for deflection and shear stress in helical spring, Design of Helical Spring, Design of Leaf Spring.   [8 Hrs.]

UNIT-IV

Kinematics of Friction Drives such as Brakes, Clutches Design of Friction Clutch, Single Plate, Multiple Plate, Cone, Centrifugal Clutch, Design of Brake , Shoe Brake, Band Brake,, Internal Expanding brake.   [7 Hrs.]

UNIT-V

Classification of Thick and Thin Cylindrical Pressure Vessel, Stresses in Thin and Thick Cylindrical Pressure Vessels when it is subjected to internal pressure, Expression for Circumferential and Longitudinal stresses, Design of pressure vessel, Heads and Cover Plate.   [7 Hrs.]

UNIT-VI

Design of transmission Shafts on the Basis of Strength , rigidity and critical speed. ASME Code for shaft Design, Design of Stepped shaft Axle splined Shaft, Keys.   [8 Hrs.]

BOOKS:
1) Mechanical Design of Machine   : Maleev hartman.
2) Machine Design   : P. H. Black.
3) Mechanical Engg. Design   : J. E. Shigley.
4) Design of Machine Element   : B. D. Shiwalkar
5) Design of Data for Machine Elements : B. D. Shiwalkar.

5 ME3   **MANUFACTURING PROCESS-III**

UNIT-I

Theory of metal cutting: Introduction, Orthogonal and Oblique cutting, Mechanics of metal cutting, Shear plane, Stress, Strain and Cutting Forces, Merchant Circle, Chip formation,

Cutting force calculations, Determination of Torque and Power required for turning, drilling, and milling, Influence of tool angle, Cutting Fluids, cutting speed, Feed and depth of cut on power requirement, Estimation of Tool life. [8 Hrs.]

UNIT-II

Gear Manufacturing : Gear casting, Gear Milling, Gear shaping, Gear Hobbing for Spur, Helical and Bevel Gear. Tooling and selection of Cutting Parameters, Process accuracy and quality of Gears, Gear stamping process, Gear drawing process, Rolling Process, Gear finishing, Gear shaving, Gear Lapping, Gear Honing. [7 Hrs.]

UNIT-III

Press working : Die cutting operation, Classification, Types of Presses, Press terminology, Introduction to shaping operations, Bending, forming and drawing.

Jigs and Fixtures : Introduction, Difference between Jigs and Fixtures, Uses, Principles of Jigs and Fixture Design, Materials, Principles of Location, Methods of Location, Clamping of Requirements, Types of Clamps, Jig Bushes, Drilling Jigs, Milling Fixtures, Classification of Fixtures. [8 Hrs.]

UNIT-IV

Capstan and Turret Lathe and special purpose Machines : Construction, Operation and selection of Machining Parameters, Machining Centers, Tool Heads and indexers.[7 Hrs.]

UNIT-V

Nonconventional Machining Processes : Characteristics, Operation, applications, Limitation and selection of process parameters of the following processes, Abrasive Jet Machining, Ultrasonic Machining, Water Jet Machining, EDM, ECM. [7 Hrs.]

UNIT-VI

Advance Welding Methods : Introduction to TIG, MIG, spot welding, Plasma Arc welding, Electron Beam, Electron Laser Beam welding. [8 Hrs.]

BOOKS:
1) Manufacturing Technology : Adithan, Gupta.
2) Modern Machining Processes : Pandey, Shah.
3) Production Engineering : Donaldson.

5 ME4   HEAT TRANSFER

UNIT-I

Introduction, Basic modes of Heat Transfer, Conduction, Convection and Radiation, Laws of Heat Transfer and Conservation of Energy requirement, General Heat conduction equation in Cartesian, Cylindrical and Spherical Co-ordinates, Thermal conductivity and diffusivity, One diamentional steady state conduction equation for the plane wall, Cylinder and Sphere, Thermal resistance of composite structures, Contact resistance, overall heat transfer coefficient, critical thickness of insulation. [8 Hrs.]

UNIT-II

Conduction with internal heat generation for plane wall, Cylinder and sphere, Extended Surfaces, Types of Fins, Fins of uniform cross section area, temperature distribution and their heat transfer rate, Fin efficiency and effectiveness, Error in temperature measurement, Steady state Heat transfer, Lumped Heat Capacity analysis, Heister charts, Biot number, Fourier number and their significance.   [7 Hrs.]

UNIT-III

Forced convection, physical signification of non dimensional parameters, Flow of high moderate and low prandtl number fluid over flat surface, Concept of velocity and thermal boundary layer thickness, Local and average Heat Transfer coefficient, empirical co-relation for external, internal flow, Laminar and turbulent flow through conduits. [7 Hrs.]

UNIT-IV

Free or Natural Convection, Grashof number, Rayleigh number, horizontal and vertical plate, empirical co-relations for Cylinders and sphere, Heat transfer with phase change, pull boiling curve and regimes of pull boiling, film and drop wise condensation, Laminar film condensation on vertical surface, Film condensation on horizontal tubes, effect of superheated and non condensable gasses on condensation heat transfer, Introduction to heat pipe.   [8 Hrs.]

UNIT-V

Radiation, nature of thermal radiation, black body radiation, radiation intensity , laws of radiation-Kirchoffs, Planks, Weins displacement, Stefen-Boltzmann and Lamberts Co-sine law, Emmisivity, absorbtivity, trnsmitivity, reflectivity, radiosity, emissive power, irrediation, Radiation network, radiation exchange between surfaces, idea of shape factor and reciprocity theorem, radiation between parallel plates, Cylinder and sphere,radiation shields,effect of radiation on temperature measurement. [8 Hrs.]

UNIT-VI

Heat exchanger : classification, overall heat transfer coefficient, Fouling factor ,LMTD method of heat exchange, Analysis for parallel, counter flow and cross flow arrangement, effectiveness NTU method, heat exchanger analysis by NTU method , design aspects of heat exchangers, introduction to compact heat exchanger, introduction to mass transfer .
[8 Hrs.]

PRACTICALS:
Minimum eight experiments should be performed.
1) Study of different methods of temperature measurements with special emphasis on thermocoules.
2) Study of different thermal properties of matter with special emphasis on thermal condactivity of various materials.
3) Determination of thermal conductivity of metal bar.
4) Determination of thermal conductivity of insulating material in the powder form.
5) Determination of thermal conductivity of liquids.
6) Determination of thermal conductivity by guarded plate heater methods.
7) Determination of temperature distribution and heat transfer plate from a fin under
   A) Free convection & B) Forced convection condition.
8) Determination of forced convection heat transfer coefficient for fluid flow through a
9) closed conduit.
10) Determination of forced convection heat transfer coefficient for air fluid flow over a
11) vertical surface.
12) Determination of critical heat flux in saturated pool boiling.
13) Determination of condensation heat transfer in film wise & drop wise modes.
14) Study of various types of heat exchangers.
15) Determination of emmissivity of non black surfaces.
16) Determination of Stefen-Boltzmann constant.
17) Study of heat pipes.

BOOKS
1) Introduction to heat transfer   : Incropera & Dewitt J. Wiley
2) Elements of heat transfer   : M.N.Ozisik
3) Heat transfer   : S.P.Sukhatme

5ME 5   MECHANICAL MESURMENT

UNIT-1
Purpose, Structure and elements of measuring system. Static characteristics of measurement system elements including systematic, statistical characteristics, Generalized model of system elements and calibration, measurements error, Error probability density function, Error reduction.   [8 Hrs]

UNIT- 2
Dynamic characteristics of measurements system, First and second order instruments, Transfer function G(S), Step, Ramp, and Frequency response,   dynamic Errors, Signals and Noise in measurement system (No Mathematical treatment) Including Deterministic and Random signals, Noise, Interference, Noise Sources and couplings, Reduction of Noise.   [8 Hrs]

UNIT-3
Classification, Principle, Sensing Elements, Signals Conditioning Elements, constriction, Range and working of instruments for measurements of linear & angular displacement and speed.   [7 Hrs]

UNIT- 4
Classification, Principle, Sensing elements, signal conditioning elements   construction,

Range and working of instruments for   measurement of strain, Weight, force, Torque,

Power, Pressure, Vacuum, Sound.   [8 Hrs]

UNIT- 5
Classification, Principle, Sensing elements, signal conditioning elements construction, Range and working of instruments for measurement of temperature, level, and flow.[7 Hrs]

UNIT–6
Signals processing: Analogue to digital conversion with emphasis on quantization and encoding. Structure and elements of microcomputer system. Introduction to data Acquisition and communication system.   [7 Hrs]

PRACTICALS:
1) Static characteristics of at least three different instruments
2) Static calibration   of at least one instrument
3) Dynamic characteristics of at least one first order instruments
4) Dynamic characteristics of at least one Second order instrument (optional)
5) Static response of minimum three two sensors
6) Data Acquisition
7) Measuring parameters by minimum three instruments
   (Experiments should be based on at least eight different measurements)

BOOKS:
1) Principles of measurements system, John   P. Bentely, Pearson Education Asia
2) Buckwith Buck
3) Nakra Choudhary

4) Doeblin

5 ME 6   PRODUCTION TECHNOLOGY

UNIT – 1
Interpretation of production drawing Classification of operations –basic, qualififying process, critical product, critical secondary, auxiliary, supporting operations, break even analysis .
[7 Hrs]

UNIT – 2
Tolerance analysis of limit & fits. Design of limit gauges, types of fits, shaft basis system, hole basis system selective assembly,   allowances, IS specification process planning sheet preparation of tolerance chart (problems   on tolerance chart not expected in theory examination).   [8 Hrs]

UNIT – 3
Metrology: Standard of measurements simple gauging instruments for linear   and angular measurements, comparators – Mechanical, Electrical And Pneumatic, measurement of straightness and flatness. Measurements of thread, measurements of gear tooth. [8Hrs]

UNIT – 4
Quality Control: Definition, function, objective characteristics. Quality, Quality   of   design quality of conformance, process control charts and process capability. Statistical quality control.   [7 Hrs]

UNIT – 5
Acceptance sampling techniques O.C. curves, sampling plans,   inspection   types   and objectives.   [7 Hrs]

UNIT –6
Introduction to ISO 9000, BIS 14000 series, TQM concepts, Quality   assurance quality audit, Quality circle.   [8 Hrs]
Practical:
1) Measurement of linear dimensions
2) Measurement of angular dimension using sine bar, clino meter.
3) Measurement of screw thread by floating carriage micrometer
4) Measurement of flatness and straightness
5) Study and measurement of parameters using tool Makers Microscope
6) Calibration of Micrometer / dial gauge
7) Use of optical flat.

Quality control
1) Case studies on process control
2) Design of sampling plans
3) Study of ISO 9000/BIS14000 series
4) Study of TQM

Process planning & Tolerance chart

1) Preparation of process planning sheet and Tolerance chart (Two case studies on two different jobs.)
2) Design of limit gauges.
3) Problems on tolerance Analysis (limit & Fits)

Tutorials

1) Study of various linear Measurement instruments
2) Study of various Angular measurements instruments
3) Study of various types of comparators
4) Design of limit gauges
5) Problem on control charts
6) Design of sampling plans
7) Preparation of process planning sheet and tolerance chart (one for circular job and one for square a rectangular jobs)

Recommended Books
1) Metrology by R.K. Jain
2) Metrology by I.C. Gupta
3) Statistical Quality control – Grant
4) Production Engg. By P.C. "Sharma
5) Statistical quality control by Mahajan.

5ME 7   **SEMINAR**

Students should collect information from library on any advanced relevant technical topic. Student should prepare a report on the topic studied. Student should make at least one presentations on the matter studied. Students should be encouraged to go through Handbook, Journals , Reference Books etc.

SEMESTER – SIX

6ME - I   ENERGY CONVERSION - I

Unit - I
Principal of Steam Generation , Classification of Steam Generators, Fire Tube, and Water Tube Steam Generators, High Pressure Steam, Boiler Mountings and Accessories .
                                                                [8Hrs]

Unit - II

Draught and Its Classification , Chmney Height , Chimmey Diamter, Efficiency. Condition for Maximum Discharge Performance of Steam Generators : Evaporation Capacity Equipment Evaporation Boiler Efficiency . [7 Hrs]

Unit - III

Fluidized Bed Boiler : Buddling Fluidized Bed Boilers, Circulating Fluidized Bed Boilers (Elementary Treatment Expected) Fuel for Steam Generators ,Graduation & Analysis of Coal,Cola Handling Systems, Ash Collection and Handling System , Flue Gas Analysis Feed Water Supply System. [7Hrs]

Unit - IV

Steam Nozzles: Adiabatic Expansion in Nozzles, Maximum Discharge Critical Pressure Ratio and effects of Friction, Calculation of Throat and Exit Areas, Supersa Flow , Wilson Line . Steam Turbines Principals of Working of Steam Turbines, Classification of Steam Turbines, Comparison of Impulse and Reaction Turbines, Compounding of Steam Turbines . [8 Hrs]

Unit - V

Energy Losses in Steam Turbines, Flow of Steam Through Turbine Blades, Ideal and Actual Reheat Factors, Velocity Diagrams, Graphical and Analytical Methods, Work, Done, Thrust and Power, Dimensions and Proportioning of the Blades, Steam Turbine Efficiencies, Condition for maximum efficiencies, Reheat and Regenerative Cycles, Governing of steam Turbines. [8Hrs]

Unit - VI

Introduction to Steam Engine.

Steam Condensers: Types of Condensers ,Classification of Condensers Quality of cooling water required ,Design calculations for surface condenser, Daltons Law of Pressures, Sources of Air leakage's and Air Removal, Air Ejectors. Cooling Towers: Wet Cooling Towers, Dry Cooling Towers, Cooing Ponds. [7 Hrs]

Books :
1) Thermal Engineering by P.L. Ballaney
2) Thermal Engineering by Mathur & Mehtra
3) Thermal Engineering by Vasaudani & Kumar
4) Power Plant Engineering by V.M. Domkundwar

6ME-2   AUTOMATIC CONTROL

Unit - I

    Mathematical Modeling of Physical System and Concept of Transfer Function system Representation Through Block Diagram and Signal Flow GraPH. Transfer friction through Block Diagram Simplification and Masons Gain Formula.   [8Hrs]

Unit - II

    Control System Components such as hydraulic actuators, Servomechanism D.C. and liquid level control ,Automobile Power Steering Control, Speed Control, Position control of Robotic Manipulator Etc.   [8Hrs]

Unit - III

    Time Domain Response Analysis under transient input steady stare error analysis and error constants, PID controller and its application Routh criterion of stability.
    [7 Hrs]

Unit - IV

    Frequency Domain analysis Root - Locus techniques, Bode plot, gain Margin and phase margine , transportation lag, System Identification from Bode plot.   [8Hrs]

Unit - V

    Polar Plot, Nyquist Plot and Stability criterion, Introduction to control system design log load compensation ,Feed Back, Compensation and Pole -Zero placement.
    [7Hrs]

Unit - VI

    State Variable approach and state equations, Transfer function from state models state transition matrix and solution of state equations controllability and observability test through test model.   [7Hrs]

BOOKS :

    1)   Modern Control Engineering by   Ogata[PHI]

    2)   Control system Engineering by   Nise [Willey]

    3)   Control system by Nagrath & Gopal   [TMH]

    4) Modern Control System by Dorf [Addision Wesley]

    5) Digital Control and State Variable Methods by Gopal [TMH]

6ME-3 OPERATION RESEARCH

Unit - I

Introduction to Or & Basic or Models, Definition Characteristics and limitations of OR linear programming solutions of LPP by graphical methods and simplex method. Sensitivity analysis & formulation of Dual of LPP.   [8Hrs]

Unit - II

Assignment Model, Travelling Salesman Problem by branch and bound method transshipment model, Transportation Model.   [7Hrs]

Unit - III

Dynamic programming   structure and characteristics   of   Dynamic programming application of Dynamic programming to resource allocation, Inventory control & linear programming.   [7Hrs]

Unit - IV

Project Management : Drawing of Network, CPM & PERT, probability of completion of project, cost analysis, Allocation and updating of Networks.[7Hrs]

Unit - V

Replacement Models : Concept of equivalence , Interest Rate, Present   worth ,economic Evolutions of Alternatives ,Group replacement models. Inventory control models, Analysis of single product deterministic models.   [8 Hrs]

Unit - VI

Waiting line situations, Queuing Theory and   models (No derivations expected simulations, concept and its applications in waiting line situations, inventory and networks.
                    [7 Hrs]

BOOKS ;

1) Operation Research   Heera & Gupta
2) Operation Research   JK Sharma
3) Operation Research   Askhedkar & Kulkarni
4) Operation Research   Vohra ND
5) Operation Research   Liberman

6ME4   INDUSTRIAL ELECTRONICS

UNIT-I
  Electrical actuation systems: Mechanical switches, Solid state switches, Solenoids, DC Motors, AC Motors, Stepper Motors, AC & DC Servomotors, Speed torque characteristics and Selection of Motors.   [8 Hrs.]

UNIT-II
  Digital Logic: Number system, Logic Gates, Boolean Algebra, Karnaugh Maps, Application of Logic Gates, Sequential Logic.   [7 Hrs.]

UNIT-III
  Microprocessors: Microcomputer structure, Microcontrollers, Applications and Programming.
Assembly Languages, Instruction Sets, Assembly language programmes. [8 Hrs.]

UNIT-IV
  I/O System: Interfacing , I/O Ports, Interface Requirement, Peripheral Interface Adapters, serial communication Interface.
  PLC : Structure, I/O Processing, Programming, Mnemonics, Timers, Internal Relays and Counters, Shift Registers, Master and jump Control, Data handling, Analogue I/O, Selection of PLC. [8 Hrs.]

UNIT-V
  Digital Communication : Centralised, Hierarchical and Distributed control, Networks Protocols, Communication Interfaces.
  Fault Detection Techniques: Watchdog Timer, Parity and error Coding checks, Common hardware Faults, Emulation and Simulation.   [8 Hrs.]

UNIT-VI
  Introduction to Design of Mechatronics, System and Case studies. (Question is not expected on this topic in Theory examination.)   [6 Hrs.]

PRACTICAL:
Minimum Six experiments to be conducted on
   1) Characteristics of Electric Motors.
   2) PLC Applications
   3) Micro controller applications.
   4) Design of Mechatronics System.

BOOKS:
   1) Mechatronics(Electronic Control Systems in Mechanical Engineering) by W. Bolton, Addison Wesley.
   2) Fundamentals of Electric Drives by Gopal K. Dube Narosal Publishing house
   3) A First Course on Electric Drives by S. K. Pillai, New Age International Publishers

6ME5   COMPUTER APPLICATION-II

UNIT-I
An application to DBMS: Data and Database, Database Systems: Concepts and Meaning, Disadvantages of File Systems, Advantages of database Approach, Disadvantages of using DBMS, Database Languages, Database Administrator and User, System Structure.   [8 Hrs.]

UNIT-II
Entity Relationship Model: Entities and Entity Sets, Relationship and Relationship Sets, Mapping Constraints, Keys, Entity Relationship Diagram, Reducing E-R Diagrams to Table, Generalisation, Aggregation Design of an E-R Database Schema.   [8 Hrs.]

UNIT-III
Relation Database & SQL : Structure of relational database, relational algebra, Basic structure of SQL, Set operations, Aggregate Functions, Nested sub Queries, derives relations, Modification of Database, Joined Relations, Data definition Language Embedded SQL.   [8 Hrs.]

UNIT-IV
Integrity Constraints and Relational Database Design: Domain Constraints, Referential integrity, Functional Dependencies, Assertions, Triggers, Pitfalls in relational Database, Normalisation Using Functional Dependencies, Using Multi-Valued Dependencies, Domain Key Normal Form.   [7 Hrs.]

UNIT-V
Indexing and Hashing: Basic Concepts, Indexing, B+Tree Index Files, B-Tree Index Files, Static Hashing, Comparison of Indexing and Hashing, Index Definition in SQL, Multiple_key Access, Introduction to Transaction Concurrency Control, Recovery Systems, Query Interpretation and Query Optimisation.   [7 Hrs.]

UNIT-VI
Computer Network: Networking, Topologies, Protocols, Network Model, Internet and E-Commerce B-B.   [7 Hrs.]

PRACTICALS:
1) Program for Selection of Machine.
2) Program for Tool selection
3) Program for Material Management
4) Inventory Management
5) Optimisation.
6) Office Automation
7) Thermodynamics Problem.
8) Heat Transfer Problem.
9) Production Planning.

BOOKS:
1) An Introduction to Database System by C. J. Date.
2) Database System Concepts by A Silberschatz H. F. Konh, A. Sudarshan.
3) Computer Network by Stalin.
4) Computer Network by Tannmban.

6ME6   MACHINE DRAWING

UNIT-I
Drawing Standards for following- Drawing Sheets, Name Blocks, Lines, Sections, Dimensioning, Dimensioning of Tolerances, standard Components, Standard features, Machining Symbols, Welding Symbols, Heat Treatment, manufacturing Instructions, Allowances, Materials.   [8 Hrs.]

UNIT-II
Orthographic Projection of Elements : Orthographic Projections, Sectional Views, Missing Views, Profiles, Cross Sections, References, Alignments, Dimensioning.   [6 Hrs.]

UNIT-III
Study Qualitative Selection of type / Size(Excluding Design Calculations) and Standard Practices for Following Elements- threads, Bolts, Nuts, Washers, Rivets, Welds, Keys and Keyways, splines, Couplings.   [6 Hrs.]

UNIT-IV
Assembly and Dismantling Principles : Fits and Tolerances (Standards, Types Application and Selection) , Tolerance Charting, Surfaces Finishing Requirement for Assembly, Geometry suitable for Assembly, Assembly / Dismantling Tools, Bearing Assemblies, Assemblies by Fastening.   [8 Hrs.]

UNIT-V
Study of some Standard Assemblies.
Assembly Drawings: Principles, Techniques and standards for Preparing Component Drawings, Subassembly Drawing, Full Assembly Drawing, Exploded Views.   [9 Hrs.]

UNIT-VI
Production Drawing : Name Plates, Part List, Revisions Etc., Essential Parts/ Formats Required for Production Drawings, Process Sheet.   [8 Hrs.]

PRACTICAL:
1. Pencil Drawing for some Standard Components.(Two Sheets).
2. Pencil Drawing for two Standard Assemblies with Components.(Two Sheets).
3. Computer print out of a small Assembly with Components.
4. Pencil Drawing / Computer print out of a Large Assembly with Components Drawings, subassembly drawings and assembly drawings using all standard formats.
5. Computer Print out of Production Drawing and process Sheets for One Component having maximum five Operations.

Pencil Drawing should be in full imperial sheet folded to quarter Imperial size, Computer printouts should be on a dot matrix printer in A3 size. All drawings should be submitted in one folder.

BOOKS:
1) PSG Data Book
2) CMTI Data Book
3) Relevant IS Codes

6ME7   INDUSTRIAL CASE STUDY

Industrial case study should be based on the study of some specific case / issue/ problem related to any industrial / business establishment. Data should be Collected from Industry with the objective of studying some specific case / issue / problem. The Collected data should be analysed using one or more theories studied in the curriculum. The Result should be worked out and conclusion should be drawn. A group of maximum nine students should be formed for one case study.

A report should be submitted. The report should consist of the problem / issue identified. Methodology of data collection, data collected, method of analysis, analysis, result, and conclusion.

Minimum two presentation should be made.

7ME1   PRODUCTION TECHNOLOGY-II

PAPER   : 80 MARKS   COLLEGE ASSESSMENT   : 20 MARKS
Lectures per week   : 3 Hrs   Tutorials per week   : 1 Hr.

UNIT I
Work Study : Productivity –Concept and objectives of productivity, Types of productivity, factors affecting productivity. Tools and techniques to improve productivity, Measurement of productivity.
Work study and methods study : Definitions, objectives, steps in method study, process charts, string diagram, motion study, micro motion study, SIMO Chart[9 Hrs.]

UNIT II
Work measurement : Objectives, definition, stop watch study, work sampling , PMTs, MTM & Work factor method
Ergonomics : Objectives, Human factors in Engg., Man machine system, Display design, design controls. Principles of motion economy, work place design.[9 Hrs.]

UNIT III
Plant layout : Objectives, Principle, Types of plant layout,Material handling, Objectives Principles and selection of material handling equipments, Unit load concept, material flow pattern.[6 Hrs.]

UNIT IV
Forecasting : Need for forecasting, classification of forecasting methods, like judgmental technique, time series analysis, least square method, moving average method, exponential smoothing method.[7 Hrs.]

UNIT V
Production planning and control :Definition, objectives of PPC, functions of PPC, types of production, Value analysis and value Engineering:, Introduction, steps involved in value analysis. Applications in Manufacturing.[7 Hrs.]

UNIT VI
Maintenance: Objectives, Types of maintenance, preventive,
        predictive, break down maintenance
        Reliability and maintainability analysis
        Failure data analysis, reliability, MTBT, MTTR, Batch tub curve,
        series parallel and stand by system.[7 Hrs.]

Recommended books
   1) Work study by ILO
   2) Motion and Time study by Barnes
   3) Ergonomics – Murell
   4) PPC - Jain & Agrawal
   5) Industrial Engg. and Project management by Mart and Telsang

6) Reliability Engg. By Balguruswami
7) Plant layout and Material Handling by James Apple.

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7ME2   ELECTIVE – I : **INDUSTRIAL ROBOTICS**

Paper	: 80 Marks	College Assessment	: 20 Marks
Lectures per week	: 3 Hrs.	Tutorials per week	: 1 Hr.

UNIT I
Automation and Robotics, Robot anatomy, configuration of robots, joint notation schemes, work volume, introduction to manipulator kinematics, position representation, forward and reverse transformations of a 2- DoF arm, a 3-DoF arm in two dimension, a 4-DoF arm in three dimension, homogeneous transformations in robot kinematics, D-H notations, solving kinematics equations , introduction to robot arm dynamics. (7 Hrs)
UNIT II
Basic control system models, slew motion, joint-interpolated motion and straight line motion, controllers like on/off, proportional, integral, proportional plus integral, proportional plus derivative, proportional plus integral plus derivative. (7Hrs)
UNIT III
Robot actuation and feedback components, position and velocity sensors, actuators and power transmission devices, mechanical grippers, vacuum cups, magnetic grippers, adhesive grippers, pneumatic, electric, hydraulic and mechanical methods of power and control signals to end effectors. (8 Hrs)

UNIT IV
General considerations in robot material handling, material transfer applications, pick and place operations, palletizing and related operations, machine loading and unloading, die casting, plastic molding, forging, machining operations, stamping press operations usingrobots. (8 Hrs)
 UNIT V
Use of robot in spot welding, continuous arc welding, spray coatings, Robots in Assembly Operations.   (7 Hrs)

UNIT VI
Robot cell layouts, multiple robots and machine interface, other considerations in work cell design, work cell control, interlocks, error detection and recovery, workcell controller, robot cycle time analysis. (8Hrs)

Text Books
1) " INDUSTRIAL ROBOTICS", (MHP)M.P. Groover, M. Weiss, R.N. Nagel, N.G. Odrey

2)   " Robotics" by Koren

7ME2 ELECTIVE – I : PROJETCT EVALUATION & MANAGEMENT

Paper : 80 Marks   College Assessment : 20 Marks
Lectures per week : 3 Hrs.   Tutorials per week : 1 Hr.

UNIT- I
Need analysis, market survey, characteristics of market, sample survey, demand forecasting, secondary data, accuracy, confidence level, uncertainty.   [7 Hrs.]

UNIT-II
Technical feasibility : Process selection, Level of automation, plant capacity, acquiring technology, Appropriate technology plant location, Equipment selection & procurement, Govt. policies.   [7 Hrs.]

UNIT-III
Economic feasibility: Cost of Project, working capital analysis, fixed cost, means of finance, estimation of sales & production price analysis, Break even point, Projected cash flow statements, projected balance sheet, projected profit & loss statement, projected cash flow, rate of return, Discounted payback period, cost benefit analysis, return after taxes.   [9 Hrs.]

UNIT-IV
Project Planning & Control: CPM, PERT, Optimum project duration, resource allocation, updating   [7 Hrs.]

UNIT-V
Project report: Preparation of project report, risk analysis, sensitivity analysis, methods of raising capital   [7 Hrs.]

UNIT – VI
Project review :
Initial review, performance analysis , ratio analysis, sickness, project revival, environ- mental & social aspects.   [8 Hrs.]

Recommended books :

1) Projects, Prasanna chandra, Tata mc graw Hill publishing company Ltd.

2) CPM & PERT, Shrinath, East West publisher
3) Projects, P.K. Joy, Macmillon
4) Engineering Economy H. G Thuesen, W J Fabricky, G,J, Thuersen, Printce Hall of India Pvt. Ltd.

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7ME2   **ELECTIVE – I** : **TOOL DESIGN**

Paper   : 80 Marks   College Assessment : 20 Marks
Lectures per week   : 3 Hrs.   Tutorials per week   : 1 Hr.

UNIT - I   Theory of metal Cutting
Introduction, Mechanics of chip formation , Cutting tool materials, Single point cutting tool, Designation of cutting tools, ASA system, Importance of Tool angles, Orthogonal rake system, Classification of cutting tools, Types of chips, determination of shear angle, velocity relationship , force relations, Merchant's Theory, Cutting power, Energy consideration in metal cutting, Tool wear, Tool life, Tool life criteria, variable affecting tool life, Machine ability   (8 Hours)

UNIT - II
Design of single Point Cutting Tool
Form tools- Introduction, Types, design of form tools.
Drills- Introduction, Types, Geometry, Design of drill.
Milling cutters - Introduction, Types, Geometry, and Design of milling cutters.
Reamers, Taps & Broaches - constructional features only   (7 Hours)

UNIT - III
Press tool Design
Introduction, Press operations - Blanking, piercing, Notching, Perforating, Trimming, Shaving, Slitting , Lancing, Nibbling , Bending, Drawing , Squeezing .

Press working equipment - Classification, Rating of a press, Press tool equipments , arrangement of guide posts . Press selection, press working terminology , Working of a cutting die , Types of dies - Simple dies, inverted die, compound dies, combination dies, progressive dies, Transfer dies, multiple dies Principle of metal cutting, strip layout, clearance, angular clearance, clearance after considering elastic recovery, cutting forces, method of reducing cutting forces, Die block, Die block thickness, Die opening, Fastening of die block, back up plate, Punch, Methods of holding punches, Strippers. Stoppers, Stock stop, Stock guide, Knock outs, Pilots. Blanking & Piercing die design - Single & progressive dies.

UNIT - IV
Bending Forming & Drawing dies
Bending methods - Bending Terminology, V- Bending, Air bending, bottoming dies, Wiping dies, spring back & its prevention, channel dies.
Design Principles - Bend radius, Bend allowance, Spanking, width of die opening, Bending pressure.
Forming Dies- Introduction, Types - solid form dies, pad type form dies, curling dies, Embossing dies, coining dies , Bulging dies, Assembly dies.
Drawing Dies - Introduction, Differance between blending, forming & drawing, Metal flow during drawing, Design, Design consideration - Radius of draw die, Punch radius, Draw clearance, Drawing speed, Calculating blank size, Number of draws, Drawing pressure, Blank holding pressure. (6 Hours)

UNIT - V
Forging Die Design & mould Design
Forging Die Design : Introduction, Classification of forging dies, Single impression dies, Multiple Impression dies. Forging disign factors - Draft, fillet & corner radias, parting line, shrinkage & die wear, mismatch,finish allowances, webs & ribs
Preliminary forging operation - fullering, edging, bending, drawing, flattering, blacking finishing, cutoff. Die design for machine forging - determination of stock size in closed & open die forging. Tools for flash trimming & hole piercing, materials & manufacture of forging dies .

Mould Design: of Simple Blow Moulds for Articles such as bottles, cans
Design of simple two plate injection moulds , Mould Materials (8 Hours)

UNIT - VI

Design of jigs & fixture :- Introduction, locating & clamping - principle of location, principle of pin location, locating devices, radial or angular location, V - location, bush location. design principle for location purpose, principle for clampimng purposes, clamping devices, design principles common to jigs & fixtures.

Drilling Jigs :- Design principles, drill bushes, design principles for drill bushings, Types of drilling jigs - Template jig, plate type jig, open type jig, swinging leaf jig, Box type jig, channel type jig . Jig feet.

Milling Fixtures :- Essential features of a milling fixtures, milling machine vice, Design principles for milling fixtures, Indexing jig & fixtures, Automatic clamping devices. (7 Hours)

TEXT BOOKS

    1) Production Engineering   By P.C. Sharma   S. Chand Publication
    2) Tool Design   By Donaldson   TMH

7ME2   ELECTIVE – I : SYNTHESIS OF MECHANISMS

Paper	: 80 Marks	College Assessment	: 20 Marks
Lectures per week	: 3 Hrs.	Tutorials per week	: 1 Hr.

UNIT-I

Introduction to kinematics,types of mechanism, kinematics synthesis, science of relative motion, tasks of kinematic synthesis with practical applications, Degree of freedom, class-I, class-II chain, Harding's notation, Grashof criterion, Grubler's criterion.   [7 Hrs]

UNIT-II

Introduction to position generation problem, concept of pole, two &three position generation synthesis, pole triangle, Relationship between moving & fixed pivots, Four position generation, opposite pole quadrilateral, center point &circle point curve, Burmester's point. Matrix method for position generation problem, rotation matrix, displacement matrix. [8 Hrs.]

UNIT-III

Introduction to function generation problem, co-ordination of input-output link motion, relative pole technique, inversion technique, overlay technique, graphical synthesis of quick return mechanisms for optimum transmission angle.

Types of errors, accuracy points, cheby sher's spacing, frudenstein's equation.   [7 Hrs]

UNIT-IV

Introduction to path generation problem, synthesis for path generation with and without prescribed timing using graphical method. Coupler curves, cognate linkages, Robert's law of cognate linkages.

Complex number method for path generation problem 3 precision points.   [8 Hrs]

UNIT-V

Synthesis for infinitesimally separated position, concept of polode and centrod, Euler's savery equation, inflection circle, Bobbilier and Hartman's construction.   [7 Hrs]

UNIT-VI

Optimal synthesis of planer mechanisms, powell's search method, least square method, penalty function.

Introduction to spatial mechanisms, D-H notations, introduction to kinematic analysis of robot arm. [8 Hrs]

Text Books:
1) Applied linkage synthesis   by TaO D.C.
2) Advanced mechanism design by G.N. Sandor. A.G. Erdman
3) Kinematics and mechanism design by C.H.Sue & C.W.Radchiffe.

7ME2   **ELECTIVE – I : AUTOMOBILE ENGINEERING**

Paper   : 80 Marks   College Assessment : 20 Marks
Lectures per week   : 3 Hrs.   Tutorials per week   : 1 Hr.

Unit – I
Introduction, Automobile history and development,

Chassis, articulated and rigid vehicles and vehicles layout. Prime movers
Engine construction – Structural components and materials
Fuel supply system, cooling and lubrication systems, Filters, water pumps, radiators, Thermostats,

antifreezing Compounds.   [8 Hrs]

UNIT - II
Clutch – Necessity, requirements of a clutch system. Types of Clutches, centrifugal clutch, single & multi plate clutch, fluid Clutch.

Gear box **- *Necessity of transmission, principle, types of transmission, Sliding mesh, constant mesh, synchromesh, Transfer gear box, Gear Selector mechanism, lubrication and control. Torque Converter, Automatic Transmission*.   [8 Hrs]**

UNIT - III
Transmission system: Propeller shaft, Universal joint, constant velocity joint, Hotchkiss drive, torque tube drive.

Differential - Need and types, Rear Axles and Front Axles
Brakes   - Need, types Mechanical, hydraulic, Pneumatic brakes, Electrical Brakes, Engine Exhaust brakes, Drum and Disc brakes,Comparison.
Details of components, Brake adjustment.   [8 Hrs]

UNIT – IV
Steering systems, principle of steering, center point steering, Steering linkages, steering geometry and wheel alignment, power Steering, special steering systems. Tyres, tyres specification, factors affecting tyre performance, Special tyres, wheel balancing, suspension systems - Function of Spring and shock absorber, conventional and Independent suspension System, Telescopic shock absorber, linked suspension systems.   [8 Hrs]

UNIT - V
Electrical systems – construction. Operation and maintenance of Batteries, Alternator working Principles and Operation of regulators, starter motor, Battery Ignition and magneto ignition systems ignition timing. Electronics ignition, Lighting, Horn, Side indicator wiper. Automobile air-conditioning, Panel board instruments.
Maintenance, Trouble shooting and service, procedures, Overhauling, Engine tune up, Tools and equipment for repair and Overhaul. Testing equipments   [8 Hrs]

UNIT - VI
Recent Advances in automobiles such as ABS, Electronic Power Steering, Steer by wire, Traction control, Active suspension,Collision avoidance, Inteligent lighting, Navigational aids andIntelligent vehicle highway system.   [5 Hrs]

Text Books
       1) Automotive Machanics   -- Joseph Heitner
       2) Motor Vehicle Technology   -- J.A. Dolan
       3) Automotive Engines   -- W.H. Crouse
       4) Motor Vehicle   -- K.Newton and W.Seeds, T.K.Gawet

5) Western Hand book

7ME2 ELECTIVE – I : MATERIAL HANDELING SYSTEM

Paper	: 80 Marks	College Assessment	: 20 Marks
Lectures per week	: 3 Hrs.	Tutorials per week	: 1 Hr.

UNIT-I
Types of intraplant transporting facility, principal groups of material handling equipments, choice of material handling equipment, hoisting equipment, screw type, hydraulic and pneumatic conveyors, general characteristics of hoisting machines, surface and overhead equipments, general characteristics of surface and overhead equipments and their applications. Introduction to control of hoisting equipments.

(8 Hrs)

UNIT II
Flexible hoisting appliances like ropes and chains, welded load chains, roller chains, selection of chains, hemp rope and steel wire rope, selection of ropes, fastening of chains and ropes, different types of load suspension appliances, fixed and movable pulleys, different types of pulley systems, multiple pulley systems. Chain and ropesheaves and sprockets. (10 Hrs)

UNIT III
Load handling attachments, standard forged hook, hook weights, hook bearings, cross piece and casing of hook, crane grab for unit and piece loads, carrier beams and clamps, load platforms and side dump buckets, electric lifting magnets, grabbing attachments for loose materials, crane attachments for handling liquid materials. (7 Hrs)

UNIT IV
Arresting gear, ratchet type arresting gear, roller ratchet, shoe brakes and its different types like electromagnetic, double shoe type, thruster operated, controlled brakes, shoe brakes, thermal calculations of shoe brakes and life of linings, safety handles, load operated constant force and variable force brakes, general theory of band brakes, its types and construction. (10 Hrs)

UNIT V
Different drives of hoisting gears like individual and common motor drive for several mechanisms, travelling gear, travelling mechanisms for moving trolleys and cranes on runway rails, mechanisms for trackless, rubber-tyred and crawler cranes.motor propelled trolley hoists and trolleys, rails and travelling wheels, slewing, jib and luffmg gears. Operation of hoisting gear during transient motion, selecting the motor rating and determining braking torque for hoisting mechanisms, drive efficiency calculations, selecting the motor rating and determining braking torque for travelling mechanisms, slewing mechanisms, jib and luffmg mechanisms. (Elementary treatment is expected)   (8 Hrs)

UNIT VI
Cranes with rotary pillar, cranes with a fixed post, jib cranes with trolley, cranes with luffmg boom, cantilever cranes, cage elevators, safety devices of elevators, belt and chain conveyors and their power calculations, vibrating and oscillating conveyors, pneumatic and hydraulic conveyors, screw conveyors, hoppers, gates and feeders. Introduction to AGV's as new material handling device, use of robot for material handling. (7 Hrs)

Text Book
1) Materials Handling Equipment- N. Rudenko , Envee Publishers, New Dehli
2) Materials Handling Equipment- M.P. Alexandrov. Mir publications ,Maskow

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7ME2   **ELECTIVE – I: ADVANCED I. C. ENGINES**

Paper   : 80 Marks   College Assessment : 20 Marks
Lectures per week   : 3 Hrs   Tutorials per week   : 1 Hr,

UNIT-I
Engines types and their operation, Introduction and Historical Perspective,
Engine classifications, Engine operating cycles, Engine components
Engine friction, lubrication and cooling, lubrication systems.

Frictional losses, blow by losses, pumping loss, Factors affecting mechanical friction

(8 hrs)

UNIT – II

AUTOMOTIVE FUELS
S.I. Engine fuels characteristics, C.I. Engine fuels characteristics
Rating of engine fuels, I.C. engine fuels - petrol, diesel, CNG, LPG, Alcohols, Vegetable oils
fuel supply system, S.I.Engine, Carburetors, modern carburetor, SPFI, MPFI, direct injection,
C.I.Engine: Fuel injection pump, reciprocating rotary, fuel injector, High presser D.I. systems,
fuel distribution systems.   (7hrs.)

UNIT – III
S. I. Engine
Charge motion within the cylinder swirl, squish, combustion stages, flame propagation ,cyclic
variations in combustion, ignition fundamentals, conventional ignition system, abnormal
combustion, knock and surface ignition, knock fundamentals, turbocharging, supercharging and
scavenging in engines.   (7 hrs.)

UNIT – IV
C. I. Engines
Combustion in direct and indirect injection, fuel spray behaviour, combustion in C. I. Engines, ignition delay, auto ignition. Factors affecting delay.
Effects of fuel properties. Abnormal combustion, supercharging and turbocharging in engines.   (7 hrs.)

UNIT – V
Stratified charge engine, free piston engine, adiabatic engines.
Pollutant formation & Control Nature and extent of problem, Nitrogen oxides
Kinetics of NO formation, formation of NO_2, NO formation in S. I. Engines,
NOx formation in C. I. Engine
Carbon monoxide and unburned hydrocarbon emissions in S.I. and C.I. engines,
EGR Particulate emissions, measurement technique,Catalytic converters, particulate traps.
(8 hrs.)

UNIT - VI
Engine Design and Operating Parameters,
Important engine characterstics, Geometrical properties of Reciprocating engines, Brake,
Torque & Power, Indicated work per cycle, Mechanical efficiency, Road load power, Mean
effective pressure, Specific fuel consumption and efficiency, Air/Fuel and Fuel/Air ratios,
Volumetric efficiency, Engine specific weight and specific volume, Correction factors for

power and efficiency, Specific emission and emission index, Relatioship between performance parameters

<u>Measurement and Testing</u>

Measurement of friction power indicated power, Brake power, Fuel consumption, Air consumption, Performance parameters and characteristics:

Engine Power, Engine efficiencies, Engine performance characteristics, Variables affecting

performance characteristics   (8 hrs)

Text Book
1) Internal Combustion Engine Fundamentals - John B. Heywood
2) Internal Combustion Engines and Air pollution - Edward F. Obert

Reference Books

1) Internal Combustion Engines - V. Ganesan
2) Internal Combustion Engines - V. M. Domkundwar
3) Internal Combustion Engines - M. C. Mathur, R.D. Sharma.

7ME3   ELECTIVE – II : INDUSTRIAL FLUID POWER

Paper : 80 Marks   College Assessment : 20 Marks
Lectures per week : 3 Hrs.   Tutorials per week : 1 Hr.
Practicals per week : 2 Hrs.

UNIT-I

Fluid power systems: Components, advantages, applications in the field of M/c tools, material handling, hydraulic presses, mobile & stationary machines, clamping & indexing devices etc. Transmission of power at static & dynamic states.

Types of Hydraulic fluid petroleum based, synthetic & water based. Properties of fluids. Selection of fluids, additives, effect of temperature & pressure on hydraulic fluids. Seals, sealing materials, selection of seals. Filters, strainers, sources of contamination of fluid & its control.
JIC symbols/ISO Symbols for hydraulic & pneumatic circuits.   [8 Hrs]

UNIT-II
PUMPS: Types, classification, principle of working & constructional details of vane pump, gear pumps, radial & axial plunger pumps, power and efficiency calculations, char, Curves, selection of pumps for hydraulic power transmission.
ACCUMULATORS & INTENSIFIERS: Types & functions of accumulators, intensifiers, applications, selection & design procedure.   [7 Hrs]

UNIT-III
CONTROL OF FLUID POWER: Necessity of pressure control directional control, flow control valves, Principle of pressure control valves, direct operated, pilot operated, relief valves, pressure reducing valve, sequence valve & methods of actuation of valves.
FLOW CONTROL VALVES: Principle of operation, pressure compensated, temp. compensated flow control valves, meter in & meter out flow control circuits, bleed off circuits.
DIRECTION CONTROL VALVES: Check valves, types of D.C. valves:- Two way two position, four way three position, four way two position valves, open center, close center, tandem center valves, method of actuation of valves, manually operated, solenoid operated, pilot operated etc.   [8 Hrs]

UNIT-IV
ACTUATORS: Linear & Rotary actuators, Hydraulic motors-Types, vane, gear piston, radial piston. Methods of control of acceleration types of cylinder & mountings, calculations of piston velocity, thrust under static & dynamic applications. Design consideration for cylinders.
Hoses & Pipes: Types, materials, pressure drop in hoses/pipes.
Hydraulic piping connections.   [7 Hrs]

UNIT-V
DESIGN OF HYDRAULIC CIRCUITS:
- Meter in meter out circuits
- Pressure control for cylinders
- Flow divider circuits

Circuit illustrating use of pressure reducing valves, sequencing valve, counter balance valves, unloading valves with the use of electrical controls, accumulaters etc. Maintenance, trouble shooting & safety precautions of Hy. Circuits.   [7 Hrs]

UNIT-VI

Pneumatics: Introduction to pneumatic power sources, e.g. reciprocating & rotary compressors, roots-blower etc. Comparison of pneumatics with Hydraulic power transmission. Air preparation units, filters, regulators & lubricators. Actuators, linear, single & double acting, rotary actuators, air motors, pressure regulating valves, Directional control valves two way, three way & four way valves, solenoid operated, push button; & lever control valves. Flow control valves. Check valves methods of actuation, mech, pneumatic & electrical etc.

Pneumatic circuits for industrial applications & automation. Eg. Feeding, clamping, indexing, picking & placing etc.[8 Hrs]

Text Books:
1) Introduction to Fluid Power By Sahashtrabudhe, Nirali Prakashan Pune
2) Industrial Hydraulics By J.J. Pipenger, mcgraw Hill Co.
3) Pneumatics circuits By D.S. Mujumdar

Reference Books:
1) Pinches, "Industrial Fluid Power:, Prentice Hall
2) Vickers manuals on Industrial Hydraulics
3) H.L. Stewart, "Hydraulics & Pneumatics", Industrial Press
4) Yeaple, " Fluid Power Design Handbook".

Practicals :- Minimum eight practicals to be conducted /studied
1) Study of JIC/ISO symbols for Hydraulics and Pneumatics
2) Study of hydraulic pumps
3) Study of various valves used in hydraulic circuits
4) Study of accumulators and Intensifiers
5) Study of different flow control methods
6) Study of various industrial hydraulic circuits (three to four applications)
7) Study of various industrial hydraulic circuits (another three to four applications)
8) Study of FRL unit and valves used in pneumatics
9) Study of industrial pneumatic circuits (three to four app.)
10) Study of hydraulic fluids and fluid seals used in hydraulic systems

7ME3   ELECTIVE – I I: MANAGEMENT INFORMATION SYSTEM

PAPER   : 80 MARKS   *COLLEGE ASSESSMENT : 20 MARKS*
Lectures per week   : 3 Hrs.   Tutorials per week   : 1 Hr.
Practicals per week   : 2 Hrs.

UNIT-I
Introduction to MIS;
System & Its components, System Concepts, system control, Types of systems, Date & Information, Nature and scope, Character Function & Applications, system life cycle design.

UNIT-II
System Analysis: System planning, Information Gathering, Structure Analysis tools, Feasibility Study, cost/benefit analysis.

UNIT-III
System Design: Stages of system Design, Input/Output & form design, Database Design, Design Documentation.

UNIT-IV
SYSTEM IMPLEMENTATION & EVALUATION :
System testing, Implementation Detailed evaluation, System maintenance.

UNIT-V
DECISION SUPPORT SYSTEM :
Concepts & Philosophy of DSS, Deterministic System, Artificial Intelligence(AI), knowledge Based Expert system(KBES).

UNIT-VI
MIS TOOLS & PACKAGES/AREAS OF MIS
        ERP(Enterprise Resource Planning)
        SCM(Supply Chain arrangement)
        CRM(Customer Relation argt.)
        Concept of data ware housing and data mining.

PRACTICALS :
    Inventory control, MRP, Office Automation by using:MS-Access, Visual Basic, Oracle or any other database Languages.

REFERENCE BOOKS
        1) MIS by WS Jawadekar
        2) MIS by D. P. Goyal
        3) System Analysis and Design by Elias M. Awad
        4) System Analysis and Design – by Don Yeales.

7ME3   ELECTIVE – II : REFRIGERATION & AIR CONDITIONING

Paper   : 80 Marks   College Assessment : 20 Marks
Lectures per week   : 3 Hrs.   Tutorials per week   : 1 Hr.
Practicals per week   : 2 Hrs.

UNIT-I
REFRIGERATION:
Introduction, Definition, Applications.
STUDY OF SIMPLE VAPOUR COMPRESSION REFERIGERATION SYSTEM:
Analysis of simple vapour compression refrigeration system, effect of subcooling, superheating, polytropic compression & pressure drops on the performance of the system.
STUDY OF VAPOUR ABSORPTION REFRIGERATION SYSTEM:
Introduction Ammonla-Water, Lithium bromide-water systems, three fluid refrigerators.
REFEGERANTS:
Nomenclature of refrigerants, refrigerant properties, mixture refrigerants, global warming potential & Ozone depletion potential, Montreal & Kyoto protocol, alternate refrigerants. [8 Hrs.]
UNIT-II
MULTISTAGE VAPOUR COMPRESSION REFRIGERATION SYSTEMS:
Multiple compressor & multiple evaporator systems, cascade refrigeration systems. Study of equipments such as compressors, evaporators, expansion devices & controls defrosting methods (types & principle only). Testing & charging of refrigeration systems.[8 Hrs.]
UNIT-III
OTHER REFRIGERATION TECHNIQUES:
Air cycle refrigeration, Applications in air refrigeration systems, Vortex tube, and thermoelectric refrigeration.
CRYOGENICS:
Introduction, Application of cryogenics, Joule- Thomson coefficient, inversion curve, methods of liquefaction of air.   [7 Hrs]
UNIT-IV
PSYCHROMETRY:

Introduction, psychometric properties of air, psychometric chart, psychometric processes bypass factor, apparatus dew point temperature.
HUMAN COMFORT:
Mechanism of body heat losses, factors affecting human comfort, effective temperature, comfort chart. [7 Hrs.]

UNIT-V
ADVANCED PSYCHROMETRY:
Application of psychrometry to various air-conditioning systems. RSHF, GSHF, ESHF, air washers, air coolers.
HEAT LOAD CALCULATIONS:
Data collection for load calculation, various components of heat load estimate, method of cooling load calculation. [8 Hrs.]
UNIT-VI
AIR TRANSMISSION & DISTRIBUTION:
Principle of air distribution, types of grills & diffusers & their selection criteria, air alteration, types of air filters, distribution of air through ducts, pressure losses in ducts, methods of duct design, duct friction chart, air conditioning controls. [7 Hrs.]

PRACTICALS:

[Minimum seven experiments to be performed / demonstrated / studied]

1) Demonstration of use of various tools and equipments used by a refrigeration mechanic.
2) Study of various types of compressors.
3) Study of various condensers, evaporators, expansion devices used in refrigeration systems.
4) Study of demonstration of various controls used in refrigeration and air-conditioning.
5) Study of demonstration of miscellanecus refrigeration devices such as vortex tube. Thermoelectric Cooler, Cascade Refrigeration Unit etc.
6) Study & demonstration of window air conditioner / packaged A/c / automotive/ A/c system.
7) To perform experiments on vapour compression test rig to determine COP of the system.
8) To perform experiments on Air-conditioning test rig.
9) To perform experiments on desert cooler to evaluate its performance.
10) Demonstration of charging a vapour compression refrigeration system.
11) Report on visit to air-conditioning or cold storage plant or ice liqualification plant.
12) Study of a central A/c plant
13) Study of Demonstration of domestic freeze.
14) Exercises on computer assisted cooling load calculation.
15) Exercises on computer assisted duct design.

TEXT BOOKS:

1) A text book of Refrigeration & Air-conditioning by R.S. Khurmi & J.K. Gupta
2) S. Chand Pub.
3) Refrigeration & Air-conditioning by Dr. P.L. Ballany – Khana Pub.
4) Refrigeration & Air-conditioning by Dr.C.P. Arora-TMH Pub.
5) Refrigeration & Air-conditioning by Dr. Manohar Pressed new Age Int. Pub
6) Refrigeration & Air-conditioning by S.V. Domkundwar- Dhanpat Rai & Sons Pub.

REFERENCE BOOKS:

1) Refrigeration & Air-conditioning by Stocker & Jones – McGrawi-Hill Publication
2) Principle of Refrigeration & Air-conditioning by Roy J.Dossat-Pearson Edu.
3) Refrigeration & Air-conditioning by Jordon & Priestar – PHt Publication.
4) Thermal Environmental Engg. by James Throlkeld
5) Modern refrigeration Practice by Guy R King
6) Modern Air-conditioning Practice by Harris- McGrawi-Hill Publication
7) ASHRAE hand books - McGrawi-Hill Publication
8) Carrier's air-conditioning design data book - McGrawi-Hill Publication
9) Air conditioning Principles & System. Energy approach by E.G. Pita- Pearson.
10) Audels Series on Air-conditioning, Home Refrigeration & Air-conditioning and commercial Refrigeration – D.B. Taraporewala & Sons.
11) Principles of Refrigeration by Marsh Olive – CES Publication.
12) Principle of Air-conditioning by Paul Lang – CES Publication.
13) Basic Refrigeration& Air-conditioning by P.N. Ananthnarayanan – TMH Publication.

7ME3   ELECTIVE – II : FINITE ELEMENT METHOD

Paper   : 80 Marks   College Assessment : 20 Marks
Lectures per week   : 3 Hrs.   Tutorials per week   : 1 Hr.
Practicals per week   : 2 Hrs.

UNIT I
Fundamentals of stress & strain, stress & strain components, stress strain relationship, Elastic constants, plane stress, plane strain., differential equation of equilibrium, compatibility equations, boundary conditions, Saint Venant's principle, Airy's stress function. [7 Hrs]

UNIT II
Fundamental concepts of FEM -' Historical background, Scope of FEM in Engg.Applications, Principle of minimum potential energy. Concept of Virtual work. Raleigh-Ritz method. FEM analysis procedure. Mathematical understanding required for FEM, Matrix algebra & operations, eigen values & eigen vectors. Methods for solution of simultaneous equations. like Gauss elimination. Matrix decomposition method.
Concept of discritization of body into elements. degrees of freedom, bandwidth, Basic types of 2-D & 3-D elements, displacement models, convergence requirements, shape function. Commercial FE Software's. [7Hrs]

UNIT III

Finite element modeling & analysis using Bar & Beam element -stiffness matrix, assembly, boundary conditions, load vector, temperature effects.
Two dimensional plane 'b11ss -Local & Global coordinate system, element stiffness matrix, assembly, boundary conditions, load vector, force & stress calculations [8 Hrs]

UNIT IV
Two dimensional problems using CST & LST -formulation of CST & LST elements, elemental stiffness matrix, assembly, boundary conditions, load vector. stress calculation. Temperature effect .
Axi-symmetric solids subjected to axi-symmetric loading -axi-symmetric formulation using CST ring, element, stiffness matrix, boundary conditions, load vector, calculation of stresses. [8 Hrs]

UNIT V
Introduction to Isopearametric & Higher order elements. Introduction to Numerical Integration.
Introduction to dynamic analysis, formulation of mass matrix for one-dimensional bar element, free vibration analysis using one-dimensional bar element.
Torsion of prismatic bars using triangular elements. [7Hrs]

Steady state one dimensional & two dimensional heat conduction problems using I-D and triangular element respectively. Programming aspects of FEM -Algorithms for, reading Finite Element modeling data, formation of elemental stiffness matrix, formation of elemental load vector. assembly of individual elemental spiffiness matrix into global' stiffness' matrix, assembly of individual elemental load vector into global load vector, application of boundary .conditions, solution of equations, determination of stresses and strains. Pre & Post processing in FEA [8 Hrs]

Suggested books

1) Introduction to Finite Elements in Engineering -T.R. Chandrupatla & AD. Belegundu .

2) Theory of Elasticity -S.P. Timoshenko
3) Concept and applications of Finite element Analysis -RD. Cook
4) The Finite Element Method -A basic introduction for engineers -D. W. Griffiths, D.A Nethercot – Granada Publishing

List of Practical :

Students should use the commercial software or programmes from the text-books or self developed programs, to verify the results obtained by manual calculations. The input data and output results of the problem solved using the computer programs should be included in the Journal.

1) Any two problem using bar element
2) Any two problems using truss element
3) Any two problems using CST element
4) Any one problem using axisyrmnetric element
5) Any one problem of free vibration analysis using bar element
6) Any one problem of Torsion of Prismatic bars.
7) Any one problem on Steady State Heat conduction.

List of Tutorial:

TWO TUTORIALS ON EACH UNIT

7ME3   ELECTIVE – I I: **STRESS ANALYSIS**

PAPER   : 80 MARKS   *COLLEGE ASSESSMENT : 20 MARKS*
Lectures per week   : 3 Hrs.   Tutorials per week   : 1 Hr.
Practicals per week   : 2 Hr

UNIT I

Two Dimensional Problems in. Cartesian Coordinate system -Fundamentals of stress & strain, stress-strain relationship, Elastic constant, plane stress, plane strain., differential equation of equilibrium Boundary conditions, Saint Venant's principle, compatibility equation, Airys stress function. Stress analysis of cantilever subjected to concentrated load at its end and simply supported beam subjected to uniformly distributed load. [8 Hrs.]

UNIT ll

Two dimensional problem in polar coordinate systems -General equations of equilibrium in polar coordinate compatibility equation, stress distribution about symmetric. axis, stress analysis of cylinder subjected to ~ internal & external pressure, Pure bending of curved beams, effect of hole on the stress distribution in plates, Stress analysis of rotating circular disk. [7Hrs]

UNIT III

Two Dimensional Photoelasticity - Introduction to basic optics related to photoelasticity, stress optic law, plane & circular polariscope arrangements, effect of stressed model in plane & circular polariscope, Isoclinic & Isochromatics, stress trajectories, calibration of photoelastic material (determination of fringe constant). various photoelastic materials and their properties, Casting of photoelastic models, Tardy's compensation technique, Separation techniques like, shear difference, oblique incidence & electrical analogy. [8Hrs]

UNIT IV

Introduction to 3-D photoelasticity -Phenomenon of Stress freezing, Method of stress freezing, slicing techniques, determination of material fringe constant at critical temperature. Scaling Model- Prototype relations. Birefringerent coating method - Reflection polariscope. Introduction to fringe sharpening & fringe multiplication. [7 Hrs]

UNIT V

Strain gage technique for stress & strain analysis -Introduction to electrical resistance strain gages, gage . factor, bridge circuit, bridge balance, output voltage of Wheatstone bridge, balancing of bridge, temperature compensation, various bridge configurations, bonding of strain gages to the specimen, determination of principle strains & stresses using strain rosettes. Environmental effects on performance of strain gages, Strain gages response to dynamic strains, Effect of lead wires.Introduction to Strain measurement on rotating components, Static & Dynamic Strain Measurement introduction to semiconductor gages, high temperature strain gages & self-temperature compensated gages. Introduction to Commercial strain indicators. [8 Hrs]

UNIT VI

Grid technique of strain analysis, Brittle coating method for stress & strain analysis, Moire fringe method for stress & strain analysis. [7Hrs]

Suggested books

1) Theory of Elasticity -S.P. Timoshenko
2) Experimental Stress Analysis -Dally & Riley
3) Experimental Stress Analysis -T.K. Ray
4) Experimental Stress Analysis -L.S. Srinath

List of Practical :

1) Casting of Photoelastic Sheet
2) Preparation of Circular Disk or any model from photoelastic sheet
3) Determination of fringe constant using circular disk.
4) Determination of stresses using atleast three photoelastic models
5) Seperation of Principle Stresses using any method of stress separation
6) Stress freezing of photoelastic model
7) Fixing of strain gages to the specimen
8) Stress & strain measurement in cantilever beam using strain gages.
9) Study & demonstration of Reflection Polariscope
10) Study & demonstration of Fringe sharpner & multiplier

List of Tutorial:

Two tutorials on each unit

7ME4   ENERGY CONVERSION-II

Paper	: 80 Marks	College Assessment	: 20 Marks
Lectures per week	: 3 Hrs.	Tutorials per week	: 1 Hr.
Practicals per week	: 2 Hrs.		

UNIT-I
Positive displacement Compressors:-Reciprocating compressors: - Parts, Operations, Work done during isothermal, polytropic &adiabatic compression process, Pv diagram, isothermal efficiency, Effect of clearance, volumetric efficiency, Mechanical efficiency, Multistage compressor, condition for minimum work input, capacity control, Actual indicator diagram. [8 Hrs]

UNIT-II
Rotary compressors:–Rotary &vanes blower and screw compressor: -
Principle, operation, parts, indicator diagram, workdone, Rodts efficiency, vanes efficiency. (No analytical treatment expected)
Centrifugal compressor:-Principle, operation, parts, velocity diagram, static& total head quantities, work done by impeller,isentropic efficiency of compressor. slip factor,pressure coefficient,power input factor.
Axial flow compressor:-Principle, operation, parts. velocity diagram, workdone, Degree of reaction stage efficiency compressor characteristics, surging&chocking. Poly tropic efficiency.   [8 Hrs]

UNIT III
I.C.Engines:Air standard &fuel air cycles,parts of I.C.Engines, working of I.C. Engines,Two stroke & four stroke I.C.Engines SI & CI engines, Introduction to combustion in SI & CI engine, carburetion & fuel injection. (Analytical treatment not expected)[8 Hrs]

UNIT IV
I.C.EngineTesting:-Measurement of power: indicated,friction &brake power,measurement of speed, fuel & air consumption,calculation of indicated &brake thermal efficiency,volumetric efficiency,mechanical efficiency,percentage of excess air,Heat balance sheet,performance characteristics &factors influencing the performance of I.C.Engines.
                                     [8 Hrs]

UNIT V
Gas Turbines:-Ideal cycles isentropic and small stage efficiency, application of gas turbine pressure losses, effect of intercooling, reheat & regeneration,fuel-air ratio,combustion efficiency performance calculation, open cycle &closed cycle gas turbine plants co-generations &combined power cycles.   [8 Hrs]

UNIT VI
JET PROPULSION:-principles &working of turbojet,tuboprop,Ramjet &pulse jet simple turbojet cycle,Thrust power,propulsive power.Thermal efficiency propulsive efficiency. overall efficiency   [5 Hrs]

TEXT BOOKS
1) Thermal Engineering: BY P.L.Ballaney
2) Thermal Engineering: BY R.Yadav,
3) Heat power engg.: BY Kumar & Vasandani,
4) IC Engine by : V. Ganeshan
5) Gas turbine & Jet Propulsion: Khajuria & Dubey

REFERENCE
1) Gas Turbine Theory—By Cohen & Rogers.
2) Internal Combustion Engines –By E.O. Obert

Practicals:

Minimum eight practicals to be conducted
1) Trial on steam turbine plant
2) Technical report on visit to thermal power plant.
3) Trial on reciprocating compressor
4) Trial on rotary compressor.
5) Study of internal combustion engines
6) Study of fuel injection and ignition systems
7) Performance testing of a single cylinder I.C. Engine.
8) Study of engine cooling and lubrication systems
9) Trial on multicylinder Petrol Engine with energy balance sheet.
10) Heat balance on Multicylinder Diesel Engine
11) Morse test on multicylinder I.C. engine
12) Study of gas turbines
13) Study of Carburettors such as zenith, carter, soles, S.U. etc.
14) Study of cogeneration GT Plant and jet propulsion systems

7ME5   **MACHINE DESIGN- III**

UNIT-I
Coupling: Types of shaft coupling, design of flange coupling, flexible bush coupling.
Flywheel: Coefficient of fluctuation of energy and Coefficient of fluctuation of speed, energy store in flywheel, stresses in flywheel, design of flywheel.   [7 Hrs.]

UNIT II:
Surface finish, friction wears, lubrication, oil seals, design of journal bearings for radial and thrust loads, selection of ball and roller bearing for radial and thrust loads. Failures of antifriction bearing, design of hydrostatic pocket type thrust bearing such as circular step thrust bearing, bearing housing.
                    [7 Hrs.]

UNIT III:
Flat belt drive: Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley.

V belt drive: Types of V-belt, analysis of V-belt tension, design of V belt pulley,
Roller change drive: Velocity ratio and length of chain, design of chain, dimensions of tooth profile, sprocket.   [8 Hrs.]

UNIT IV:
Review of Kinematics of gears & terminology, interference, tooth profiles, formative number of teeth etc. Bukingham equation, design of spur gear drive, helical gear drive.

                                                                    [8 Hrs.]

UNIT V:
Worm gear drive: Types and proportion of worm and worm gear, force analysis, beam strength of worm gear teeth, dynamic tooth load, wear load, thermal rating of worm gear, design of worm and worm gear.

Bevel gear drive : Types of bevel gear, proportions of bevel gear, force analysis of bevel gear drive design of bevel gear drive.
                    [8 Hrs.]

UNIT VI:

Introduction to haulage system, design of wire rope, sheave and drums
Electric motor rating, types of motor like AC, DC, their Characteristics, controls, selection motors.
                    [7 Hrs.]

List of Practicals :
Numerical problem (at least 10 problems should be included in the Journal)
    1) Design of fly wheel
    2) Design of coupling

3) Design of Journal Bearing
4) Design of Selection Antifriction bearing
5) Design of Belt drive
6) Design of chain drive
7) Design of wire rope
8) Design of Gear drive

Each student shall submit two-assembly design report along with the drawing for assembly/sub assemembly for any mechanical system consisting of not less than four members included in the syllabus

TEXT BOOKS:
1) Mechanical Design of Machine   Maleev, Hartman
2) Machine Design   P.H. Black
3) Mechanical Engg. Design   Shigley
4) Design Data book   B.D. Shiwalkar
5) Design of Machine Elements   V. B. Bhandari
6) Design of Machine Elements (Theory & Problems) B.D. Shiwalkar

Reference Books

1) Hard book of Machine Design   -   Shiglay & Mischke
2) Mechanical Engineering Hard book (Vol 1 & 2) -   Kent
3) Design Data Book Coimbatore
4) PSG. Tech. Machine Tool Design Data Book   -CMTI

Syllabus for Seventh Semester B. E. (Mechanical Engineering)

7ME6   **PROJECT SEMINAR**

Practical per week : 03 Hrs.   College Assessment : 50 Marks

       It is expected to select project topic as per the guidelines of the project to be undertaken in the 8th semester. Also it is expected to carry out the Literature survey for their project work and finalize the methodology and schedule of the project . Each student of the concerned project batch shall work on approved project topic under the Project guide and shall present a seminar using audio-visual aids of about 15 minute duration on their project methodology and schedule of completion. Seminar delivery will be followed by question – answer session. The students shall also be required to submit in advance a detailed type written report on his work.

       A committee of staff members called "seminar Committee" shall be constituted for the purpose of evaluating the seminar.;

8ME1   *INDUSTRIAL MANAGEMENT*

Paper	: 80 Marks	College Assessment	: 20 Marks
Lectures per week	: 3 Hrs	Tutorials per week	: 1 Hr,

UNIT I
Principles of management
Concepts of management, development of scientific management. , Principles of Frederick Taylor & Henry Fayol, functions such as planning, organizing, staffing, leading, motivating, communicating, controlling, decision making, span of control.   (8 Hours)

UNIT II
Personnel Management
Meaning, functions of personnel management, manpower planning, collective bargaining, wages &

salary administration, labor welfare, training, trade unions, Industrial Factories Act, Industrial Boils

Act, Trade union act. (7 Hours)

UNIT III
Plant Management: Plant location, plant layout, types of maintenance such as break down, predictive & preventive maintenance, stores management, industrial safety, causes & cost of accidents, safety programs, production planning & control, job, batch & process type of production.
         (8 Hours)

UNIT IV
Marketing Management: Definition & scope, selling & modem concepts of marketing, market research, new product development, product life cycle, product launching, sales promotion, pricing, channels of distribution, Advertising, market segmentation, marketing mix.   (7 Hours)

UNIT V
Material Management: Importance of Materials Management, Classification, Codification, Forecasting, and Necessity of Inventory.   (8 Hours)

UNIT VI
Financial management: Sources of finance financing organizations, types of capital, elements of costs & allocations of indirect expenses, cost control, break even analysis, budgets & budgetary control, equipment replacement policy, make or buy analysis, balance sheet, ratio analysis, profit & loss statement.

        (7 Hours)

TEXT BOOKS:
I) Principles of Management: Koontz & O Denial
2) Industrial Organization & Engineering Economics: T. R. Banga & S. c. Sharma
3) Financial Management – Kuchal

REFERENCES:
1) Principles of marketing management; Philip Kotler & William Stauton

8ME2   ELECTIVE – III MACHINE TOOL DESIGN

Paper   : 80 Marks   *College Assessment : 20 Marks*
Lectures   per week   : 3 Hrs   Tutorials per week   : 1 Hr,

UNIT   I

Introduction to Machine tool drives & Mechanism
Working & auxiliary motions in machine tools, Parameters defining the working motions of a machine tool; Machine tool drives, Hydraulic Transmission & its elements, Mecll.'U1ical Transmission & its elements, General requirements of machine tool design, layout of machine tool.   (7 Hours)

UNIT ll
Regulation of speed & feed rates -
Aim of speed & feed regulation, Stepped regulation of speed -Various laws of stepped regulation, Selection of range ratio, Standard values of Geometric progression Ratio & guidelines for selecting proper value, break up of speed steps; Structure diagrams & their analysis, Speed clla11.
Design of feed box, machine tool drives using multiple speed moters, Special cases of gear box design -speed box with overlapping speed steps, speed box with a combined structure, speed box Wit11 broken geometric progression,
General recommendation for developing the Gearing diagram, determining the Number of teeths of gears, Classification of speed & feed boxes.
Electromechanical system of Regulation, Friction, Pressure and Ball Variation, Epicyclic Drive   (8Hours)
UNIT III

Design of Machine Tool Structure -
Functions of machine tool structures & their requirements, Design criteria for machine tool structU1.es, Materials of machine tool structures, Static &Dynamic stiffness, Profiles of machine tool structures, Factors affecting stiffness of machine tool structures & methods of improving it; Basic design procedure of machine tool structures -design for strength, design for stiffness.
Design of Beds, Column, housings, Bases & Tables, Cross Rails, Arms, Saddles, Carriages, Rams.   (7 Hours)
UNIT IV
Design of Guide ways & Power Screws -
Functions & types of guide ways, Design of Sideways - Shapes, materials, methods of adjusting clearances. Design Criteria & Calculations for sideways, Design for wear resistance, Design for stiffness. Guide ways operating under liquid friction conditions - Hydrodynamic & Hydrostatic sideways, Design of Aerostatic sideways, Design of Antifriction Guide ways, Combination guide ways, protecting devices for sideways.
Design of Power Screws -Sliding friction power screws, Rolling friction Power Screws. (8 Hours)

Design of Spindles & Spindle Supports
Functions of spindle unit & requirements, Materials of spindles, design calculations of spindles – Deflection of spindle axis due to bending, deflection of spindle axis due to compliance of spindle supports, optimum spacing between spindle supports deflection due to compliance of the Tapered Joint permissible deflection & design for stiffness. Antifriction bearings -Preloading of antifriction bearing. Sliding bearings - Sleeve bearings, hydrodynamic journal bearing, and air -lubricated bearings.   (7 Hours)

UNIT VI
Testing & Control of Machine Tools
a) Testing: Objects and procedure for Acceptance Test, Instrumentation for
    acceptance, Accuracy of machine tools, accuracy of work pieces.
b) Control systems: Electrical control, push button control, directional control relays,
    electrical brakes, automation in feed mechanism
c) Hydraulic control: positional control, power pack for lubrication system in hydraulic
    drive.
d) Control system for gear sliding and feed mechanism(open loop or close loop) for
    NC/CNC machine using stepper motor or DC motor.
                                                                (8 Hours)

TEXTBOOKS
 I) Machine Tool Design -N. K. Mehata TMH
2) Principles of Machine Tools -Sen , Bhattacharya New central book agency
3) Machine Tool Design -Basu, Pal Oxford IBH

TUTORIALS :

    I) Design of working of speed gear and feed gearbox.
    2) Design and working drawing of 4 M/C Tool mechanism.

8ME2   ELECTIVE – III RENEWABLE ENERGY SYSTEMS

Paper   : 80 Marks   College Assessment : 20 Marks
Lectures per week   : 3 Hrs   Tutorials per week   : 1 Hr,

UNIT I Solar Energy: Introduction, solar constant, spectral distribution of solar radiation, beam & deffuse radiation, measurement of solar radiation and measuring instruments. Solar radiation geometry, solar angles, estimation of average solar radiation, radiation as tilted surface, tilt factors   [8 hrs.]

UNIT II: Solar flat plate collectors: Types of collectors, liquid flat plate collectors, solar air heaters, transmissivity of glass cove(system, collector efficiency, analysis of flat plate collector, fin efficiency,
collector efficiency factor and heat removal factor, selective surfaces, evacuated   collectors, novel designs of collector.   [7 hrs.]

UNIT III: Concentrating collectors: line focusing, point focusing and non focusing type, central receiver concept of power generations compound parabolic collector, comparison of flat & concentrating collectors.

Applications of solar energy to water heating, space heating, space cooling, drying refrigeration, distillation, pumping. Solar furnaces, solar cookers, solar thermal electric conversion, solar photo- voltaics.

Solar energy storage, sensible, latent and thermochemical storage, solar pond [8 hrs.]

UNIT IV: Biogas: - Introduction, bio gas generation, fixed dome & floating drum biogas plants their constructional details, raw material for biogas production, factors affecting generation of biogas and methods of maintaining biogas, production, digester design considerations, fuel properties of biogas and utilisation of biogas Bio Mass :- Introduction, methods of obtaining energy from biomass, Incineration, thermal gasification, classification of gasifiers & constructional details chemistry of gasification fuel properties, applications of gasifiers.   [7 hrs.]

UNIT V *Wind and Ocean energy:* -Power in wind, forces on blades, wind energy: Basic principle of wind energy conversion site selection consideration wind data and energy estimation, basic components of WECS Classification of WEC systems, savonius and darrieus rotars applications of wind energy.
Ocean energy: Introduction: - ocean thermal electric conversion open and closed cycle of OTEC, hybrid cycle, energy from tides basic principles of tidal power & components of tidal power plants, single & double basin arrangement estimation of tidal power and energy. Energy from ocean waves -energy availability, wave energy conversion devices. [8hrs.]

UNIT VI : Geothermal and MHD power generation :

Geothermal energy: Introduction, classification of geothermal systems vapour dominated, liquid dominated system, total flow concept, petrothermal systems, magma resources, applications of geothermal operational & environmental problems.

Magneto Hydro Dynamic power generation: Introduction principles of MHD power generation, MHD open and closed systems, power output from MHD generators, design problems of MHD generation, gas conductivity, seeding [7 hrs.]

Text books
1) Energy Technology -Parulekar & Rao
2) Non Conventional Energy Sources -G D Rai

Reference book
1) Solar Energy -S.P. Sukhatme
2) Solar Energy -Duffie & Beckman
3) Solar energy engg.- Jui sheng Hsieh

8ME2   **ELECTIVE – III**   **VIBRATIONS**
Paper   *: 80 Marks*   *College Assesment : 20 Marks*
Lectures per week   : 3 Hrs   Tutorials per week   : 1 Hr,

UNIT I
 Free body diagram, free & forced vibration, undamped and damped single degree of freedom systems subjected to harmonic and other periodic excitations. Impulse response, convolution integral and response to arbitary excitation. Vibration isolation and transmissibility. Solution using laplace transform, Runga kutta method, structured damping.   (7 Hrs)

UNIT II
Energy method applied to multi degree freedom system. Lagranges equation. Generalized mass formulation of mass , damping and stiffness matrix and its numerical solutions . Vibration absorber, torsional vibration of two and three disc system. Geared rotor system, Influence Coefficients and flexibility matrix of bending vibration of beam and multi-disc rotor. Mode shapes and orthogonality principle.   (7 Hrs.)

UNIT III
Numerical techniques for M.d.o.f. systems. Matrix iteration method. Holzer's method for torsional vibration. Dunkeleys method for critical speed determination of multi disc rotor. Rayleigh quotient sweeping matrix method for determination of all the natural frequencies and modi shapes. Rayleigh rit method. Modal matrix and expansion theorem. Free and forced response by modal analysis.   (8 Hrs.)

UNIT IV
Vibration of continuous system. Axial vibration of rod, bending vibration of beam and torsional vibration of shaft. Hamiltons principle and derivation of equation of motion, Rayleigh quotient. Modal co-ordinates and modal forces. Free and forced response through modal analysis.
                              (8 Hrs.)

UNIT V

Finite element method in vibration of continuous system. Variational functional formulation for axial element and Raylrigh-Ritz method. Shape function for rod and beam elements. Derivation of mass and stiffness matrix. Natural frequencies and mode shape computation for simple rod and beam problem.   (7Hrs.)

UNIT VI

Vibration pickup, seismometers, accelerometer, proximity probe spectrum analyzer, FET &

DFT(DiscreteFT), torsional, Vibration measurement, Digital vibration measurement, philosophy of

vibration condition monitoring.   (8 Hrs.)

Text books

1) Theory of vibration   : W.T. Thomson
2) Elements of vibration analysis : L. Meirovitch
3) Mechanical vibration : J.S. Rao & K. Gupta

Reference Books

1) Advanced theory of vibration – J.S. Rao
2) Vibration condition Monitoring of Machines - J.S. Rao
3) Random vibration – gandall & Mark.

Syllabus for Eighth Semester B. E. (Mechanical Engineering)

8ME2   ELECTIVE – III   MECHATRONICS

Paper   : 80 Marks   *College Assessment : 20 Marks*
Lectures per week   : 3 Hrs   Tutorials per week   : 1 Hr,

UNIT l

Need and scope of the subject, recent trend of designing machine units along with electronic circuits for operation and supervision of mechanisms. Techniques of interfacing mechanical devices with computer hardware and development of software for driving them.   [7 Hrs.]

UNIT II

Basic principles and specific applications of armature and field and control of D.C. Motors, Variable

voltage and variable frequency control of 3 phase and single phase Induction motors, speed control

of synchronous motors, Different types of stepper motors, hold on torques and position control of

stepper motors.   [8 Hrs.]

UNIT III

Common and commercial I.Cs used for amplification, timing and digital indication.

Different types of actuators, working of synchro -transmitter and receiver set , pair of P/I, Pressure to

current and l/P type for pneumatic position control, Electrical and hydraulic servomotors.

Design of AC and DC solenoid plungers and pressure and force amplification devices.

[8 Hrs.]

UNIT IV

Adon cards for sampling and actuation, 4-20 mA ports, AD-DA conversion, Peripheral interface organization, general layout of data bus and data transfer through serial and parallel modes of communication, schemes of computer networking and hierarchy in supervisory control.
[7 Hrs.]

UNIT V

Working of integrated systems by using combined block diagrams. Study of systems used in Ink Jet

Printers, Photo copying, Washing Machines, IC Engine fuel injection system etc

[8 Hrs.]

UNIT VI

General philosophy of Artificial Neural Network simulations, Fuzzy logic for operation and control

of mechatronic systems.   [7 Hrs.]

8ME2   ELECTIVE – III   POWER PLANT ENGINEERING

Paper   : 80 Marks   College Assessment : 20 Marks
Lectures per week   : 3 Hrs   Tutorials per week   : 1 Hr,
UNIT –I
NUCLEAR POWER GENERATION
Introduction to Nuclear Engineering, Binding Energy, Energy release, Nuclear reactions & its

initiation, Fission, Component of nuclear reactors & its material, Numerical based on energy release.

Nuclear Reactors: - Types of reactors, PWR, BWR, CANDU, Gas cooled, liquid metal cooled, Breeder reactor, problems of operation, location of nuclear station, present & proposed nuclear plant in India.
Nuclear Waste Disposal**: -** Effects of nuclear waste on environment, its disposal to soil, water, air, sea etc. Comparison with other power plants.   (8 Hrs)

UNIT –II
 HYDROELECTRIC POWER PLANT.
Hydrology:- Rainfall, Runoff, Hydro graph, flow duration curve, mass curve.

Hydroelectric power plant: - Site selection, classification of hydroelectric power plant, general arrangement, details of different components, prime movers, governing, models & model testing, advantages, comparison with other power plant.   (7 Hrs)

UNIT -III *STEAM POWER PLANT*
Introduction, Coal -its properties, handling & storage, fuel firing methods, ash & dust handling, boiler accessories, high pressure boiler, draught system, steam turbine, condenser, cooling towers, water treatment, steam pipes, power plant layouts, pollution from steam power plant.
                        (8 Hrs)

UNIT-IV
Gas Turbine Power Plant: -Introduction, classification, various components, different arrangement, governing, methods to improve efficiency, comparison with other power plant.
Diesel Electric Power Plant: - Introduction, Outline, type of engines, different components, performance, plant layout, comparison with other power plant.
Introduction to unconventional power sources -Solar, wind, Tidal, geothermal, MHD. (8 Hrs)

UNIT-V
Peak Load plants, waste heat recovery system
 Various energy storage -systems like pumped hydro, compressed au., flywheel, battery storage, thermal sensible & latent heat storage, chemical energy storage.
Automation & Instrumentation -Measurement of water purity, 02, C02 measurement, gas analysis, smokes & dust measurement, moisture measurement, and nuclear measurement.
(7 Hrs)

Fluctuating Load: - Load curves, various terms & definition, effect of fluctuating load.
Economic Analysis: - Tariffs, load division, and cost of electric energy.
Combined operation: - Need, division, combination of different plant & their coordination, advantages.   (7 Hrs)

TEXT BOOK
   1) Power Plant Engineering -Domkundwar.

REFFERENCEBOOKS
        1) Power Plant Engineering -Vopal & Slortzki
        2) Power Plant Engineering –P. K. Nag
        3) Power Plant Engineering -R. K. Rajput
        4) Power Plant Engineering –M.M. Wakil

8ME2:   ELECTIVE-III   CRYOGENICS

UNIT I
Introduction to Cryogenic Systems:
Definition, Cryogenic temperature scale, History of Cryogenics, Properties of materials at low temperature, Properties of Cryogenic Fluids.   (7Hrs)

UNIT II
Air and Gas Liquefication Systems :
Thermodynamically ideal system, Production of low temperatures.
Liquefication systems for gases other than neon, hydrogen and helium, liquefication systems for neon hydrogen and helium.
Cryogenic Refrigeration Systems.   (8Hrs)

UNIT III
Gas separation and Gas Purification systems:
The thermodynamically ideal separation system Properties of mixtures, Principles of gas separation, air separation systems, Hydrogen, Argon, Helium air separation systems, Gas purification methods.   (8Hrs)

UNIT IV
Vacuum Techniques: .;
System' for production of high vacuum such as mechanical, diffusion, ion and cryopumps.
Cryogenics measurement systems: Temperature pressure, flow rate, liquid level measurement, Introduction to Cryocoolers.   (7Hrs)

UNIT V
Cryogenic fluid storage systems: .
Introduction, Basic storage vessels, inner vessel, outer vessel design, piping, access manways, safety device.
Cryogenic insulations :
Vacuum insulation, gas filled powders and fibrous materials, solid foam, selection and comparison of

insulations. Cryogenic fluid transfer systems. Transfer through uninsulated lines, vacuum insulated

lines, porous insulated lines etc.   (8Hrs)

Advances in Cryogenics:

Vortex tube and applications, Pulse tube refrigerator, Cryogenic Engine for space vehicles .
Cryogenic Applications:
Applications in gas industry, cryogenic fluids, space research, Cryobiology, food
processing, electronics, nuclear and high energy physics, chemical processing, metal
manufacturing, cryogenic power generation, medicine, analytical physics and chemistry.
　　　　　　　　　(7Hrs)

Text book
1) Text book: "Cryogenic Systems" By R F, Barron

Reference Books :
1) Cryogenic Engineering, By .R.B Scott, D Van Nostrand Company. 1959.
2) Cryogenic Process Engg, By K. D.Timmerhaus and T.M. Flynn, Plenum press, New
     York,, .1.989.
3) High Vacuum Technology, A Guthree, New Age International Publication.
4) Experimental Techniques In tow temp Physics By G. K White, Osford University Press,
     England, 1959:

8ME2   ELECTIVE-III   ADVANCED MANUFACTURING TECHNIQUE

Paper	: 80 Marks	College Assessment : 20 Marks
Lectures per week	: 3 Hrs	Tutorials per week : 1 Hr,

UNIT I
Non-traditional machines process: Need, classification & historical development. Abrasive machine and finishing operations, high speed grinding, creep feed grinding, belt grinding, hot and cold machining.   (7 Hrs)

UNIT II
Abrasive Jet Machine: Mechanics of AJM. Process parameter and characteristics ultrasonic machining mechanics, process parameter & control, effect of USM on materials, water jet machining.   (8 Hrs)

UNIT III
Electro – chemical machining : Electrochemistry of ECM, tool design, effect of variable on performance chemical milling, EC grinding, Electric discharge machining, machine surface finish & machining accuracy, electron beam. Laser beam and plasma arc machining.
                                                                                                      (9 Hrs)

UNIT IV
High energy rate forming process. Burnishing, dallising and other miscellenous forming and finishing processes, electroforming. (6 Hrs)

UNIT V
Unconventional welding techniques such as inert gas, laser, electron beam, plasma arc, atomic hydrogen, submerged arc, explosive welding techniques, electro slag welding and casting. (8 Hrs)

UNIT VI
 Adhesive bonding, solid phase welding, technique such as ultrasonic weldings, friction welding, recent development in welding, comparative analysis, economics and applications of non traditional processes for machining, welding and forming. (7 Hrs)

Reference Books:
1) Manufacturing Science : A. Ghosh & A. Mallik.
2) Non Traditional Machining: P.C. Paonoey & H. S. Shan.
3) New Technology: A Bhattacharya.

8ME3   **AUTOMATION IN PRODUCTION**

Paper	*: 80 Marks*	*College Assessment : 20 Marks*
Lectures per week	: 3 Hrs	Tutorials per week : 1 Hr,
Practical per week	: 2 Hrs.	

UNIT- I

Automation- Definition, types, reasons for automating, arguments for and against automation. Types of production, functions in manufacturing, Organization and information processing in manufacturing.
Automated Flow 'Lines- Methods of workpart transport, Transfer mechanisms, Buffer storage. Analysis of flow lines- General terminology and analysis, analysis of transfer lines without storage, partial automation, automated flow lines with storage buffers, manual assembly lines. Line Balancing Problem, Methods of line balancing. Automated Assembly Systems- Types, parts delivery system   (7 Hrs)

UNIT- II

Numerical Control Production Systems- Basic concepts, coordinate system and machine motion- Types of NC systems- Point to point, straight cut and continuous path. Machine control unit and other components, Tape and tape readers.
NC part programming- Punched tape and tape formats, NC words, methods of part programming, manual part programming: APT programming, Direct numerical control. Computer numerical control. Adaptive control. Applications and economics of NC.   (8 Hrs)

UNIT- III

Industrial Robotics- Introduction, robot anotomy, robot control systems, accuracy and repeatability and other specifications, end effectors, sensors, introduction to robot programming, safety monitoring.
Robot applications- Characteristics of robot applications, work cell layout, robot applications in material handling, processing, assembly and inspection.   (7 Hrs)

UNIT-IV

Automated material handling & storage-Conveyor systems : Roller conveyer , Skate wheel conveyer, Belt conveyers, Chain conveyers, Slat conveyers , Overhead trolley conveyers , Infloor towline conveyers, Cart on track conveyers . Automated Guided Vehicle Systems - Types :- Driverless trains, AGVS pallet trucks, AGVS unit-load carriers. Vehicle guidance & Routing, Traffic control & safety, System management, Analysis of AGVS systems, AGVS applications.
Automated Storage & Retrieval System -
Types :- Unit load AS/RS , mini load AS/I{S , man on board AS/RS , automated item retrieval system, deep lane AS/RS -Basic components & special features of AS/RS , Carousel storage systems , Work in process storage, quantitative analysis. (8 Hrs.)

UNIT-V

Automated inspection & Group technology:- Automated inspection principles & methods -100%

automated inspection, off -line & on -line inspection, distributed inspection & final inspection;

Sensor technologies for automated inspection , coordinate measuring machines -con~tructiol1 ,

operation & benefits; Machine vision -image aquisition & digitigation, image processing & analysis,

interpretation,

machine vision applications; Other optical inspection methods -Scanning laser systems , linear allay devices, optical tringulation techniques.

Group Technology :- Part families , parts classification & coding, Opitz classification systems, production. flow analysis; Machine cell design -composite pat1 concept , types of cell design , best machine arrangement, benefits of group technology. (9 Hrs.)

UNIT-VI

I) Computer aided manufacturing -Manufacturing planning, manufacturing control ; Computer integrated manufacturing ;

2)Flexible manufacturing systems -Components, Types of systems, FMS layout configuration computer functions, data files, system reports, FMS benefits.

3)Computcr aided process planning: Retrieval CAPP systems, generative CAPP systems, benefits of CAPP .

4)Shop floor control.

Computer Process Control (6 Hrs.)

Text Book:

I)Automation, production System & CIMS   :M P, Groover PHI

2) CAD/CAM :   Zimmers & Groover PIll

References:

1)Numerical Control And Computer Aided Manufacturing
                                    : Kundra, Rao & T ewari TMH

2) Computer Control of Manufacturing Systems
                                    :Yoram Koren ; Mcgraw Hill

Practicals:

1) Performance, Simulation on CNC lathe (atleast two Complex Geometric)
2) Performance, Simulation on CNC milling (atleast two Complex Geometries)
3) Practice Programming on Manual Part Program
4) Practice Programming on APT
5) Case Study on Automated System of any Industry.
6) Performance/ Practical on Robot.
7) Part Coding and Group Technology

8ME4   ENERGY CONVERSION— III

Paper   : 80 Marks   *College Assessment : 20 Marks*
Lectures per week   : 3 Hrs   Tutorials per week   : 1 Hr,
Practical per week   : 2 Hrs.

UNIT I **Refrigeration:**

Introduction, unit of refrigeration, simple vapour compression refrigeration system .

Vapor absorption refrigeration system (concept only) refrigerants Alternative refrigerants introduction to cryogenics and application of cryogenics simple Linde hampson system.
                                                [8 Hrs.]
UNIT II

Air conditioning: Introduction, psychrometric properties and processes, human comfort and factors affecting comfort, Bypass factor, application of Psychrometrics to simple air conditioning systems, Typical summer and winter air conditioning system(concept only) Evaporative cooling, working of Air washer.   [7 Hrs.]

UNIT III

Principle of solar Energy collection, solar energy and sources of power generation, solar constant, Flat plate & concentrating collectors for water and air heating, solar energy storage solar pond,
Applications of solar energy for cooking, drying solar photovoltaic system & Its application working of wind generators & MHD generator (Theoretical treatment is expected)
                                                [8 Hrs]

UNIT IV
Hydraulic systems :
     Study of Hy. Pumps such as vane pump, gear pump, piston pump etc.
Essential elements of a hydraulic system: flow Actuators, Directional control valves pressure control valves, flow control valves, basic hydraulic circuit, meter in & meter out circuits. Use of single, Double actuator, crane, jacks.   [8 Hrs]

UNIT V
Pneumatic systems :
Principle of pneumatics, comparison with hydraulic power transmission. Air preparatory unit, valves & Ind. Pneumatic circuits.   [7 Hrs]

UNIT VI
Energy Auditing :
Introduction, importance of energy audit, uses of energy audit basic terms of energy audit, types of energy audit, procedure for carrying energy audit, instruments used for energy audit, such as power analyzer, multipoint heat flow meter, Lux meter, portable infrared radiation thermometer, thermocouple based temperature indicator.
Energy Conversation & Management :
Need & Importance of energy conservation & Management, payback period, return on Investment

(ROI), life cycle costs, sankey diagram, specific energy consumption. [8 hrs]

Practicals :
1) Performance on vapour compression refrigeration system
2) Experiment on desert cooler
3) Study of vapour absorption refrigeration systems
4) Study & Demonstration on household refrigerator
5) Study & Demonstration on solar application
6) Study & Demonstration on hydraulic pumps & valves.
7) Study & Demonstration of various Industrial hydraulic circuits
8) Study of air preparatory unit
9) Study & Demonstration of various Industrial pneumatic circuits
10) study on energy conservations opportunities preferably in Industries
11) Report on visit to Ice plant OR any refrigeration installation / air conditioning plant
12) Study of Instruments / equipments required for conducting energy audit

BOOKS:
1) Refrigeration & Air Conditioning by – C.P. Arora
2) Thermal Engg.   by – P.L. Ballany
3) Industrial Hydraulics   by – Pipenger
4) Pneumatic system   by – R.S. Mujumdar
5) Energy Management   by – William T. Synder
           1. & Fredaric W. symords Vol. 2
6) Energy management handbook by W.C. Turker

8ME5   COMPUTER AIDED DESIGN

Paper   : 80 Marks   College Assessment: 20 Marks
Lectures per week   : 3 Hrs   Tutorials per week   : 1 Hr,
Practical per week   : 2 Hrs.

UNIT 1: Definition of CAD, CAD Softwares modules (Operating System, Graphics , Applications, Programming, Communication). Rasterization Principle, Rasterization of line, frame buffer, N-bit plane buffers, simple color frame buffer.   (6 Hrs)

UNIT 2: Line Generation using Bresenham's and DDA algorithms for line,circle, ellipse. Two dimensional geometric and co-ordinate transformations like scaling, translation, rotation, reflection, shear. Concept of homogeneous representation and concatenated transformations. Inverse transformations.(Enumeration of entity on graph paper)
        (7 Hrs.)

UNIT 3: Three dimensional geometric and co-ordinate transformation like scaling, translation, rotation and reflection. Bezier Curve (for 4 Control points). Introduction to surfaces and its representation using parametric equation, surface of revolution. Wire frame modeling, solid modeling of basic entities like box, cone, cylinder. CSG & B rep technique using set theory.   (9 Hrs.)

UNIT 4: Fundamental Concept of Finite Element Method: Plain Stress and Strain, Compatibility condition, Minimum potential energy principle. Displacement function, shape function for linear & quadratic bar element. Stiffness matrix, Force Matrix.   (8 Hrs.)

UNIT 5:Truss problems, Two dimensional problems using Constant strain triangle. Beams and Frames (Linear Shape functions only.)   (6 Hrs.)

UNIT 6: Optimisation : Optimal Problem Formation, Engineering optimization problems. Optimisation Algorithms:Single Variable optimization algorithm using Golden search method, Bisection method. Multivariable Optimisation using Simplex search method. Penalty function method.   (9 Hrs.)

Practicals:
1) Introduction to CAD softwares.
2) Program on Bresenham's Line Algorithm.
3) Program on Bresenham's Circle Algorithm.
4) Program on Bresenham's Ellipse Algorithm.
5) Simple examples of two dimensional transformations.
6) Simple examples on three dimensional transformations.
7) Program for generation of any surface.
8) Generation of at least two simple solid models showing geometric properties using any CAD software.
9) One dimensional problems of Finite Element Method.
10) Finite Element Method problems on truss.
11) Finite Element Method problems using two dimensional element.
12) Problem on any one of optimization method.

At least **Eight** exercises are expected in journals. It is preferred to have four exercises from 1 to 6 and remaining four from 7 to 12.

TEXT BOOKS:
1) CAD/CAM, Theory & Practice : Ibrahim Zeid
2) Procedural elements for computer Graphics : D Rogers
3) Introduction to Finite Elements in Engineering : Chandrupatla & A.D. Belegundu
4) Optimization for Engineering Design :Kalyanmoy Deb

References:
1) Computer Graphics : D. Hearn & M.P. Baker
2) Computer Graphics : S. Harrington.

Additional Readings:
1) Mathematical Elements for Computer Graphics Dravid F Rogers , J. Alan Adams
2) Schaum's Outline Series : Theory & Problems of Computer Graphics
    Roy A. Plastock, Gordon Kalley

Syllabus for Eighth Semester B. E. (Mechanical Engineering)

8ME6   PROJECT

University Assessment : 75 Marks   *College Assessment : 75 Marks*
Practical per week   : 6 Hrs.

The project work may conform to anyone of the below stated types of broad based work.

1) Detailed design of some mechanical system. This may comprise of machines, Thermal ,Hydraulic / pneumatic system,& design of some small industry and like.
2) Detailed experimental/Practical verification of some mechanical Engineering, systems.
3) Detailed study of some industry manufacturing some product. This study may be comprising of various aspects such as plant layout, mechanical handling systems, assembly shop, quality control system, maintenance system, various service systems, design, development and planning functions, techno-economic studies etc. Feasibility of small scale industry.
   Study may also comprise of indepth and exhaustive analysis of any one of the above mentioned systems in the context of 2/3 factors belonging to the industry.

4) Detailed study of the literature on a normal topic alongwith the comparative study of various approaches studied under literature.