B.TECH.(MECH)

COURSE DESCRIPTION WITH COURSE OBJECTIVES

ME113			
MECHANICAL ENGINEERING -I			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	A fundamental understanding of the laws of thermodynamics and their application to a wide range of systems with work and heat interactions.		
CO2:	Concept of entropy and irreversibility of a process and application of thermodynamic relationships to solve practical problems.		
CO3	Gas and vapour power cycles and the efficiencies.		
CO4:	Properties of steam and its application in power generation.		
CO5:	Construction and working of various boilers and IC engines.		

UNIT I

Thermodynamics: Thermodynamic properties, closed and open systems, flow and non-flow processes, gas laws, laws of thermodynamics, internal energy. Application of First Law in heating and expansion of gases in non-flow processes. First Law applied to steady flow processes.

Second law of thermodynamics: Kelvin-Planck and Claussius statements. Reversible processes, Carnot cycle, Carnot theorem. Entropy, physical concept of entropy, change of entropy of gases in thermodynamic processes.

UNIT II

Properties of Steam: Difference between gas and vapour, change of phase during constant pressure process. Generation of Steam, triple point and critical point. Internal energy and entropy of steam. Use of steam tables and Mollier chart, heating and expansion of vapour in non-flow processes, measurement of dryness fraction.

UNIT III

Vapour Power Cycles: Introduction, Carnot Cycle. Desirable properties of working fluid used for power plants. Rankine cycle. Expansive and non expansive working.

UNIT IV

Gas Power Cycles: Introduction. Air Standard efficiency, other engine efficiencies and terms. Otto, diesel and dual cycles. Calculation of efficiency, mean effective pressure and their comparison.

Internal Combustion Engines: Introduction. Classification, terminology and description of IC Engines. Four stroke and two stroke petrol, gas and diesel engines. Valve timing diagrams. Comparison of petrol and diesel engines. Simple carburettor. Ignition system of SI engine, diesel fuel pump and injectors.

Learning Resources:

Texts/References:

1. M. L. Mathur and F. S. Mehta: Thermal Engineering, (Vol. I, SI Edition), Jain Brothers, New Delhi.
2. R. K. Purohit: Foundation of Mechanical Engineering; Scientific Publishers (INDIA), Jodhpur.
3. P. K. Nag: Engineering Thermodynamics, TMH.

ME114			
WORKSHOP PRACTICE			
ecture :	-	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	3 hrs/ Week	**Credits:**	1
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Practical performance in carpentry shop.		
CO2:	Smithy Shop, Simple exercises involving basic operations like bending, drawing, punching, shaping, upsetting, and riveting.		
CO3	Fitting Shop, Simple exercises involving basic operations like sawing, chipping, filling, drilling, reaming, threading with taps and dies.		
CO4:	Sheet Metal and Plumbing Shop: Demonstration of basic tools, pipe fittings and operations.		

Practicals:

Carpentry Shop: Acquaintance with types of wood, tools and their uses. Simple exercises involving basic operations like sawing, planning, chiselling, etc. Preparation of simple joints, cross half lap joint, dovetail joint, bridle joint, tennon and mortise joint.

Smithy Shop: Acquaintance with types of tools and their uses. Simple exercises involving basic operations like bending, drawing, punching, shaping, upsetting, and riveting.

Fitting Shop: Acquaintance with tools, measuring and marking tools, precision measuring tools and their uses. Simple exercises involving basic operations like sawing, chipping, filling, drilling, reaming, threading with taps and dies.

Sheet Metal and Plumbing Shop: Demonstration of basic tools, pipe fittings and operations.

Learning Resources:

Texts books/References:

1. S.K. Hajra Choudhury and A.K. Hajra Choudhury: Elements of Workshop Technology (Vol. I and II), Media promoters & Publishers Pvt. Ltd

ME123			
MACHINE DRAWING-I			
Lecture :	-	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	3 hrs/ Week	**Credits:**	1
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to BIS codes.		
CO2:	Introduction to Orthographic Projection.		
CO3:	How to draw the missing views and Sectional Views.		
CO4:	Knowledge about Riveted and Welded Joints, Screw Fastenings.		
CO5:	Knowledge of Conventional representation of threads, Different types of lock nuts, studs, machine screws, cap screws and wood screws.		

Practicals:

Introduction, conventional representation of different materials used in machine drawing, Introduction to BIS codes.

Orthographic Projection: First and third angle methods of projection. Preparation of working drawing from models and isometric views.

Drawing of missing views.

Dimensioning: Different methods of dimensioning.

Sectional Views: Concept of sectioning. Revolved and oblique section.

Sectional drawing of simple machine parts.

Riveted and Welded Joints: Types of rivet heads and riveted joints.

Processes for producing leak proof joints. Symbols for different types of welded joints.

Screw Fastenings: Nomenclature, thread profiles, multistart threads, left and right hand threads. Square headed and hexagonal nuts and bolts.

Conventional representation of threads. Different types of lock nuts, studs, machine screws, cap screws and wood screws. Foundation bolts.

Different types of joints: Knuckle joint, cotter joint and universal joint.

Learning Resources:

Texts books/References:

1.S.K. Hajra Choudhury and A.K. Hajra Choudhury: Elements of Workshop Technology (Vol. I and II), Media promoters & Publishers Pvt. Ltd

ME124			
WORKSHOP TECHNOLOGY			
Lecture :	2 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	3 hrs/ Week	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Basic terms used in Mechanical Engineering and their definitions which will also help them in mechanical workshop along with theory exam.		
CO2:	Machining, machining mechanisms and safety techniques.		
CO3	Fundamental Production techniques i.e. welding, foundry and machining.		
CO4:	Constructional details, working and chief operations that can be performed on some basic machine tools like Lathe, Shaper, Drilling etc.		
CO5:	Use of measuring and inspection tools and instruments on right place.		

UNIT I

Welding: Introduction to welding, types of welding. Oxyacetylene gas welding, types of flames, welding techniques and equipment. Principle of arc welding, equipment and tools. Soldering and Brazing.

UNIT II

Lathes: Classification, constructional details of centre lathe. Main operations and tools used on centre lathes.

Shaper: Types of shapers. Constructional details of standard shaper, shaper tools and main operations.

UNIT III

Drilling Machines: Types of drilling machines. Constructional details of pillar type, and radial drilling machines. Main operations. Twist drills, drill angles and sizes.

Measurement and Inspection: Classification of measuring instruments, linear and angular measurement, comparators.

UNIT IV

Forming: Basic descriptions and applications of hot and cold working processes, forging, bending, shearing, drawing and forming operations.

Foundry: Moulding tools and equipments. Moulding sands, properties of moulding sand, sand mould making process.

Practicals:

Practical exercises on welding, pattern making, foundry and machining operations.

Learning Resources:

Texts books/References:

1.S.K. Hajra Choudhury and A.K. Hajra Choudhury: Elements of Workshop Technology (Vol. I and II), Media promoters & Publishers Pvt. Ltd

BS211			
MATHEMATICS-III			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
	Pre-requisites: Mathematics		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Interpolation: Finite differences, various difference operators and their relationships, factorial notation		
CO2:	Study of Numerical Differentiation and Integration based on various methods.		
CO3	Laplace Transform		
CO4:	Numerical integration by Trapezoidal and Simpson's rule		
CO5:	Applications of Laplace Transform, study of Fourier Series and Harmonic analysis		

UNIT I

Interpolation: Finite differences, various difference operators and their relationships, factorial notation. Interpolation with equal intervals; Newton's forward and backward interpolation formulae, Gauss forward and backward interpolation formulae, Stirling's and Bessel's central difference interpolation formulae. Lagrange's interpolation formula for unequal intervals.

UNIT II

Numerical Differentiation and Integration: Numerical differentiation based on Newton's forward and backward, Gauss forward and backward interpolation formulae; Numerical integration by Trapezoidal and Simpson's rule.

Numerical Solutions of Ordinary Differential Equations: Picard's method, Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta methods.
Gauss forward and backward interpolation formulae; Stirling's and Bessel's central difference interpolation formulae.

Numerical Differentiation and Integration: Numerical differentiation based on Newton's forward and backward, Gauss forward and backward interpolation formulae;

UNIT III

Laplace Transform: Laplace transforms of elementary functions; Basic properties of Laplace transform; Initial value theorem, final value theorem and convolution property of Laplace transform; Inverse Laplace transforms.

Numerical integration by Trapezoidal and Simpson's rule. Numerical Solutions of Ordinary Differential Equations: Picard's method, Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta methods.

UNIT IV

Applications of Laplace Transform: Applications of Laplace transform to solve ordinary differential equations and simultaneous differential equations.

Fourier Series: Fourier series, even and odd functions; Half range series; Change of interval; Exponential form of Fourier series; Harmonic analysis.

Learning Resources:

Texts books/References:

1. H.C. Saxena: Text Book of Finite Differences and Numerical Analysis, S. Chand and Co.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain: Numerical Methods for Scientific and Engineering computation, New Age International (P) Ltd.
3. N.P. Bali and Manish Goyal: A Text book of Engineering Mathematics, Laxmi Publication Pvt. Ltd., New Delhi (VII Edition).
4. S.P. Goyal and A.K. Goyal: Integral Transforms, Jaipur Publishing House, Jaipur.

ME211			
MECHANICS OF SOLIDS-I			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	1 hrs/ week	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
	Pre-requisites: Mechanics		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction of stress and strain and properties of materials.		
CO2:	Knowledge of principal stress and strain and its application.		
CO3	Relation between bending moment and shear force.		
CO4:	Introduction of torsion in different types of shafts.		
CO5:	Introduction of column and its different type of formulas.		

UNIT I

Fundamentals: Stress and strain, engineering stress and strain, true stress and strain. Saint-Venant's principle. Stress-strain diagrams, mechanical properties of materials, elasticity and plasticity. Shear stress and strain, pure shear, complementary shear. Linear elasticity and Hooke's law. Poisson's ratio, volumetric strain, bulk modulus of elasticity. Elastic constants and relation between elastic moduli. Stress and strain in axially loaded members. Temperature and prestrain effects, statically indeterminate problems. Composite bars. Dynamic loading. Strain energy.

UNIT II

Analysis of Stress and Strain: Stress at a point, stress components, stresses on inclined planes. Plane stress and strain. Mohr's circle representation of plane stress and strain. Principal stresses and strains, maximum shear stresses. Hooke's law for plane stress, strain energy for plane stress. Application to components under combined loading, thin spherical and cylindrical shells, shafts under bending. Triaxial and spherical state of stress. Generalised Hooke's law.

Stresses in thin cylindrical and spherical shells subjected to internal and external pressures. Thick cylinders, compound cylinders, stresses due to rotation.

UNIT III

Beams under Flexural Loads: Bending moment and shear force, relation between load, shear force, and bending moment. Bending moment and shear force diagrams for simply supported, cantilever, fixed and overhang beams under static loading of different types viz. point loads, uniformly distributed loads, linearly varying loads, and couples. Pure bending. Theory of simple bending of initially straight beams. Flexural stresses in beams. Built up and composite beams. Shear stresses in beams of rectangular, circular and I-section. Shear formula, effect of shear strain. Bending of curved bars.

UNIT IV

Torsion: Torsion of solid and hollow circular shafts. Non-uniform torsion. Statically indeterminate torsional members. Torsion in composite shafts and thin walled tubes. Combined bending and torsion, effect of end thrust. Keys and couplings.

Columns: Buckling and stability, critical load. Euler’s theory for initially straight column with different end conditions, equivalent length, limitation of Euler's formula. Rankine's formula. Columns under eccentric loading. Secant, Perry's and Indian Standard formulae.

Practicals:

Tension test on UTM and determining mechanical properties. Compression test. Charpy test. Izod test. Hardness testing. Performance of torsion test, bending test.

Learning Resources:

Texts Books/ References :

1. James M. Gere and Stephen P. Timoshenko: CBS Publishers & Distributors,Delhi.
2. B. C. Punmia: Strength of Material and Mechanics of Structures (Vol. I).
3. E.P. Popov: Introduction to Mechanics of Solids, Prentice Hall.

ME212			
MATERIALS SCIENCE			
Lecture :	2 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	2
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Different types of engineering materials viz. Ferrous & non ferrous materials, alloys and plastics.		
CO2	Mechanical properties of materials, and heat treatment.		
CO3:	Crystal structures and imperfections.		
CO4:	Mechanism of plastic deformation and theories of recrystallisation**.**		
CO5:	Phase Transformation in Alloys and equilibrium diagram of iron-carbon alloys and allotropic forms of iron.		

UNIT I

Engineering Materials: Effects of alloying elements in steel. Low alloy steels, stainless steel, magnetic steels, tool steels, materials for high and low temperature service. Brasses and Bronzes. Aluminium base alloys. Bearing Materials. Engineering Plastics.

Crystalline Nature of solids: Crystal structure, space lattice and constants, Miller indices, allotropy. Imperfection in crystals, point and line defects, grain boundary and its effect on properties.

UNIT II

Plastic Deformation of Metals: Mechanism of plastic deformation, role of dislocation, slip and twining. Work hardening, theories of recrystallisation and grain growth. Elementary treatment of creep, fatigue and fracture. Methods of studying macro and microstructure.

UNIT III

Phase Transformation in Alloys: Mechanism of solidification in pure metals, free energy, critical size of nucleus. General principles of phase transformation in alloys, phase rule and equilibrium diagrams, relationship with structure and properties. Equilibrium diagrams of common binary systems. Equilibrium diagram of iron-carbon alloys, allotropic forms of iron and various forms of carbon in iron-carbon alloys.

UNIT IV

Phase Transformation in Alloys: Mechanism of solidification in pure metals, free energy, critical size of nucleus. General principles of phase transformation in alloys, phase rule and equilibrium diagrams, relationship with structure and properties. Equilibrium diagrams of common binary systems. Equilibrium diagram of iron-carbon alloys, allotropic forms of iron and various forms of carbon in iron-carbon alloys.

Learning Resources:

Texts books/References:

1. SK Hajra Choudhury and AK Hajra Choudhury: Elements of Workshop Technology, Vol. I, Media Promoters & Publishers Pvt. Ltd., Bombay.
2. JS Campbell: Principles of Manufacturing Materials and Processes, TMH.
3. Richard L. Little: Welding and Welding Technology, TMH Co. Ltd., New Delhi.
4. R. K. Purohit: Mechanical Engineering, Scientific Publishers, Jodhpur

ME213			
FOUNDRY AND WELDING TECHNOLOGY			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Impar the knowledge of pattern material, types and allowances used for pattern manufacturing. Different types of molding sand and molding method. Application of core, core print and core boxes.		
CO2:	Students will learn about the different machines used in foundry shop, also learning of various types of furnaces used in this shop.		
CO3	Classification of welding with the principles of gas welding and arc welding and various others welding processes and also actual performance of welding.		
CO4:	Students are able to do actual welding in industries.		
CO5:	Students will have an idea about the newer welding processes, which will help them to stand in market.		

UNIT I

Foundry: Classification of casting processes. Patterns- types, materials, methods of construction and allowances. Core prints and core boxes. Colour coding for patterns and core boxes. Moulding materials. Types and properties of moulding sands, sand additives, sand preparation, testing of moulding sands. Sand moulding processes. Special moulding processes viz. carbon dioxide moulding, shell moulding, ferro-silicon moulding, dicalcium moulding, cement-sand moulding, foam moulding, hot and cold box moulding methods, plaster moulding, ceramic moulding. Core materials, core sands and binders, types of cores, core making, core testing.

Foundry Mechanisation: Moulding and core making machines, patterns for machine moulding, sand preparation and material handling systems. Cupola furnace, electric arc and induction furnaces.

UNIT II

Solidification of casting and flow properties of liquid metals. Design principles of gating and risering systems, different types of gates and risers, riser location. Use of padding and chills, exothermic and insulating sleeves applications.

Principle of casting design. Cleaning and finishing of castings, casting defects and methods of casting inspection.

Other Casting Processes: Permanent mould casting, investment casting, centrifugal and semi-centrifugal casting methods, centrifuging, continuous casting, die casting, die casting machines

UNIT III

Welding: Classification of welding processes, metallurgy of weld. Oxyacetylene gas welding, equipment and tools used, types of flames, types of joint, various position welding. Oxyacetylene torch cutting of metals. Principle of arc welding, AC and DC arc welding machines and tools, arc characteristics and control. Manual metal arc welding electrodes, classification and applications. Other arc welding methods like carbon arc, metal inert gas (MIG), tungsten inert gas (TIG), atomic hydrogen, plasma, submerged, flux-cored, and electro slag arc welding.

UNIT IV

Other welding and related methods: Resistance welding. Thermal spraying, thermit welding, pressure welding, solid state welding methods. Brazing and soldering.

Newer welding methods: Electron beam welding, laser beam welding.

Welding defects and remedies. Destructive and non-destructive testing methods for welded joints.

Practicals

Pattern making, moulding and casting exercises involving cores and considering allowances. Study of cupola and induction furnaces. Experiments on foundry sand testing like moisture, green strength, etc.
Exercises/demonstration on advanced metal arc (TIG, MIG, etc.), oxyacetylene welding and cutting, resistance welding and metal spraying.

Learning Resources:

Texts books/References:

1. SK Hajra Choudhury and AK Hajra Choudhury: Elements of Workshop Technology, Vol. I, Media Promoters & Publishers Pvt. Ltd., Bombay.
2. JS Campbell: Principles of Manufacturing Materials and Processes, TMH.
3. Richard L. Little: Welding and Welding Technology, TMH Co. Ltd., New Delhi.
4. R. K. Purohit: Mechanical Engineering, Scientific Publishers, Jodhpur

ME214			
KINEMATICS OF MACHINES			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Mechanisms and their motions under different degrees of freedom		
CO2:	Determine the positions, velocities and accelerations of links and points on mechanisms		
CO3	Gear mechanism, gear trains, classification and analysis, familiarity with gear standardization.		
CO4:	The operation and perform basic analysis of machine elements such as bolts, gears, gearboxes, clutches, disk brakes, band brakes.		
CO5:	Design of cams.		

UNIT I

Mechanisms: Kinematic pairs, kinematic chains, and mechanisms, limits and disguise of pairs, equivalent linkages. Mobility, Grübler's and Kutzbach's criteria. Four bar chain, slider crank chain, and double slider crank chain and their inversions. Various mechanisms viz. Pantograph, straight line mechanisms, steering mechanisms, Hooke's joint, Geneva mechanism.

Kinematic Analysis of Plane Mechanisms: Instantaneous centres, Aronhold-Kennedy's theorem, angular velocity ratio theorem, velocity analysis using instant centres. Velocity and acceleration using graphical method, Coriolis component of acceleration. Algebraic method for velocity and acceleration analysis of four bar chain and slider crank chain.

Introductory concepts of complex algebra and vectorial methods of analysis, loop closure equation and numerical solutions using computers (No numerical problems).

UNIT II

Kinematic Synthesis of Planar Mechanisms: Steps and classes of synthesis. Dimensional synthesis, precision points, structural error, Chebychev spacing. Freudestein's methods of synthesis and application to simple function generation problems for four-bar chain.

Cams: Classification of cams and followers. Radial cam nomenclature. Analysis of basic follower motions viz. uniform velocity, simple harmonic, uniform acceleration and retardation, and cycloidal motions. Synthesis of cam profile using graphical approach for roller, flat faced, and knife edged followers. Analysis of follower motion for tangent came with roller follower and circular arc cam with flat faced follower.

UNIT III

Gear**:** Law of gearing, velocity of sliding between teeth in mesh. Involute and cycloidal profile for gear teeth and their characteristics. Interchangeable gears, tooth systems. Spur gears, spur rack, arc and path of contact, contact ratio. Interference and undercutting, minimum number of teeth to avoid interference. Parallel axis helical gears. Tooth proportions, equivalent spur gear. Herringbone gears. Crossed axis helical (spiral) gears, velocity ratio and efficiency. Straight bevel gears, tooth proportions, velocity ratio, equivalent spur gear, other types of bevel gears. Worm and worm gear, nomenclature, velocity ratio and efficiency.

Gear Trains: Simple, compound, reverted, and epicyclic trains. Gear train applications, gear boxes and differentials. Determining velocity ratio by numerical and tabular methods

UNIT IV

Drives with Flexible Connectors**:** Types of belts and belt drives, Slip and creep. Centrifugal tension, condition for maximum power, initial tension. V belt and rope drives. Chain drives, types of power transmission chains, velocity ratio.

Brakes and Dynamometers: Block brake, band brake, band and block brake. Braking action, Braking system of automobiles. Absorption and transmission type dynamometers.

Learning Resources:

Texts books/References:

1. S.S. Rattan: Theory of Machines, McGraw Hill.
2. P. L. Ballaney: Theory of Machines, Khanna Publishers, Delhi.
3. Joseph E. Shigley and John J. Uicker, Jr.: Theory of Machines and Mechanisms (International Edition), McGraw Hill Inc.
4. R. S. Khurmi and J. K. Gupta: Theory of Machines, Eurasia Publishing House (Pvt.) Ltd., New Delhi.
5. H. H. Mabie and C. F. Reinholtz: Mechanisms and Dynamics of Machinery. John Wiley & Sons.

ME215			
MACHINE DRAWING-II			
Lecture :	-	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	3 hrs/ Week	**Credits:**	1
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to pipes and pipe joints.		
CO2:	Knowledge about different types of valves.		
CO3	Ideas of Limits, fits, tolerances, conventional symbols, surface finish, etc		
CO4:	How to Prepare assembly and knowledge of production drawings indicating tolerances.		

Practicals:

Pipes and Pipe joints: Standard conventional symbols for pipe joints and fittings, piping diagrams.

Bearing: Ball, roller, and needle bearings.

Valves: Stop, gate, globe, check, buterfly and needle type valves, safety valves.

Limits, fits, tolerances, conventional symbols, surface finish, etc. Familiarisation with various BIS and other codes currently in vogue.

Preparation of assembly and production drawings indicating tolerances, surface finish, etc. in detail of simple machine components and assemblies like couplings, clutches, gear assemblies, tool post, reciprocating engine components, viz. piston, connecting rod, cross head, etc.

Learning Resources:

Texts books/References:

1. N. D. Bhatt: Machine Drawing, Charotar Book Stall, Anand.
2. V. Laxminarayan and ML Mathur: A Text Book of Machine Drawing, Jain Brothers, New Delhi.
3. P. S. Gill: Machine Drawing: S. K. Kataria & Sons, New Delhi.

EE213			
ELECTRICAL ENGINEERING-II			
Lecture :	2 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction of D.C. Machines.		
CO2:	Knowledge about transformer, its phasor diagram and equivalent.		
CO3	Knowledge of induction motor and speed control by rotor resistance.		
CO4:	Elementary idea of armature winding.		
CO5:	Introduction of Synchronous Motors.		

UNIT I

D.C. Machines: Characteristics curves of d.c. generators and motors, application of motors for different uses, starting and speed control of motors.

UNIT II

Transformers: Phasor diagram and equivalent circuits, regulation efficiency and their determination. Open circuit, short circuit and Sumpner's test.

UNIT III

Induction Motors: Polyphase induction motors – starters, equivalent circuit, effect of rotor resistance, toruqe-slip curves, speed control by rotor resistance, pole changing and cascading, use in industry. Single phase induction motor – starting methods.

UNIT IV

Alternators: Elementary idea of armature winding. Calculation of induced e.m.f., factors affecting generating e.m.f. Open circuit, short circuit and load characteristics. Voltage regulation and its determination by synchronous impedance methods. Synchronising.

Synchronous Motors: Methods of starting. Power angle characteristics of cylindrical rotor machine, operation of synchronous motor as a condenser and as a reactor. Applications in industries.

Practicals:

Lab practicals will be as per the theory syllabus.

Learning Resources:

Texts books/References:

1. Nagrath and Kothari: Electrical Machines.
2. Ashfaq Hussain: Fundamentals of Electrical Engineering,

BS221(EC, EE, ME, MI)			
MATHEMATICS-IV			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
	Pre-requisites: Mathematics		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Study of Ordinary Differential Equations		
CO2:	Study of Fourier Series		
CO3	Partial Differential Equations: Lagrange's method		
CO4:	Solutions of System of Linear Equations,study of Gauss Jordan method ,Gauss elimination method and Eigen values and Eigen vectors		
CO5:	Statistics and Probability Distribution Functions		

UNIT I

Ordinary Differential Equations: Second order differential equations with variable coefficients; Exact form; Part of complimentary function is known; Change of dependent and independent variables; Variation of parameters.

Fourier Series: Fourier series, even and odd functions; Half range series; Change of interval; Exponential form of Fourier series; Harmonic analysis.

UNIT II

Partial Differential Equations: Lagrange's method; Standard forms, Charpit's method; Linear partial differential equation with constant coefficients.

UNIT III

Solutions of System of Linear Equations: Matrix methods, Gauss elimination method, Gauss Jordan method.

Eigen values and Eigen vectors: Cayley-Hamilton theorem; Matrix iteration methods, power and inverse power method.

UNIT IV

Statistics: Correlation and regression; Principle of least square method and curve fitting.

Probability Distribution Functions: Random variable; Mathematical expectations; Moment generating functions; Discrete and continuous distribution functions; Binomial, Poisson and Normal distributions.

Learning Resources:

Texts books/References:

1. J.L. Bansal and H.S. Dhami: Differential Equations (Vols.-II), Jaipur Publishing House, Jaipur (2005).
2. N.P. Bali and Manish Goyal: A Text book of Engineering Mathematics (VII Edition), Laxmi Publication Pvt. Ltd., New Delhi.
3. R.K. Jain and S.R.K. Iyengar: Advanced Engineering Mathematics (II Edition), Narosa Publishing House, New Delhi.
4. S.C. Gupta and V.K. Kapoor: Mathematical Statistics, Sultan Chand & Sons, New Delhi.

ME221			
MECHANICS OF SOLIDS-II			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Terminology useful in subject for better understanding of the concepts.		
CO2:	Variour properties with reference to stress strain curve for both ductile and brittle materials.		
CO3	Types of deflections and various methods to solve deflection problems.		
CO4:	Analisis of Statically Indeterminate Beams along with springs and its types **.**		
CO5:	Effect of combined loads on structural members and theories of elastic failure.		
CO6:	Energy stored in various members and its calculation.		

UNIT I

Deflection of Beams: Differential equations of deflection curve, sign convention. Moment curvature relation. Transverse deflection of beams under static loading. successive integration methods, conjugate beam method, superposition method, area-moment method, methods using discontinuity functions. Deflection of simple non prismatic beams. Strain energy in bending.

UNIT II

Deflection of Statically Indeterminate Beams: Statical indeterminacy. Superposition, moment-area, and successive integration methods. Continuous beams, use of three-moment equations.

Springs: Close coiled helical spring subject to axial load and couple. Open coiled helical spring subjected to axial pull and torque. Springs in series and parallel. Thin flat spiral spring. Leaf springs, quarter elliptical springs. Stresses and defections in leaf springs.

UNIT III

Members Subjected to Combined Loads: Short struts subjected to eccentric loads, shafts subjected to combined bending and twisting loads, equivalent twisting moments and equivalent bending moments. Members subjected to combined axial, bending and torsional loads.

Theories of Elastic Failure: The necessity for theory, different theories, significance and comparison.

UNIT IV

Energy Methods: Principal of virtual work, reciprocal theorems, unit load method. Strain energy and complementary strain energy. Strain energy due to axial, bending and torsional load. Castigliano's theorems. Application of energy methods for determination of deflections of simple structural members and structures, defection of beam due to shear.

Learning Resources:

Texts books/References:

1. James M. Gere and Stephen P. Timoshenko: CBS Publishers & Distributors,Delhi.
2. B. C. Punmia: Strength of Material and Mechanics of Structures (Vol. I),
3. S. H. Crandall, N. C. Dahl and S.J. lardner: An Introduction to Mechanics of Solids, TMH.
4. E.P. Popov: Introduction to Mechanics of Solids, Prentice Hall.

ME222			
ENGINEERING THERMODYNAMICS			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Introduction of work, heat and different thermodynamic properties.
CO2:	Zeroth law and first law of thermodynamic and application of non steady flow processes.
CO3	Introduction of second law of thermodynamic and thermodynamic relations.
CO4:	Properties of pure substance and knowledge about phase diagrams.
CO5:	Analysis of chemical equilibrium and mixture of gases and vapours.

UNIT I

Introduction: Microscopic and macroscopic points of view, limits of Thermodynamics. Homogeneous and heterogeneous systems, thermodynamic properties and state, heat and work.

Zeroth Law of Thermodynamics: Thermodynamic equilibrium, thermodynamic and international practical temperature scales.

First Law of Thermodynamics: Application to non-steady flow processes. Comparison of SFEE and Bernoulli's equation. Variable specific heat, processes involving variable specific heat, energy charts.

UNIT II

Second Law of Thermodynamics: Equivalence of Kelvin-Planck and Claussius statements. Reversible and irreversible cycle. Carnot cycle. Corollaries of second law and entropy, Claussius inequality, principle of increase of entropy. Availability, irreversibility and efficiency. Second law analysis of systems.

Thermodynamic Relations: Differential relationship for systems of constant composition. Helmoltz and Gibbs function. Variable specific heat. Joule-Kelvin coefficient, Clausius-Clapeyrnon equation.

UNIT III

Properties of Pure Substances: Ideal gas, PVT surfaces, equation of state, Vander Wal's equation. Beatic-Bridge equation and other equations of state. Virial coefficients. Law of corresponding states, use of generalized compressibility charts. Development of table for thermodynamic properties. Phase diagrams. Pressure, volume, temperature, entropy, enthalpy-entropy, pressure-enthalpy - entropy pressure enthalpy diagrams. Representation of processes in various phase diagrams.

UNIT IV

Mixture of Gases and Vapours: Vapour mixture. Mixture of ideal gases, Dalton's law, Amagat-Ledue law, Gibb's Law. Irreversible mixing process for ideal gases, mixture of ideal gases and vapour. Gravitational and volumetric analysis.

Chemical Equilibrium: Thermodynamics of combustion, internal energy and enthalpy of formation, first and second law analysis.

Learning Resources:

Text Books/ References:

1. P. K. Nag: Engineering Thermodynamics, TMH.
2. C. P. Arora: Engineering Thermodynamics, TMH.
3. Y. Cenegel and M. Boles: Thermodynamics: An Engineering Approach, McGraw Hill.

ME223			
MANUFACTURING PROCESSES			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Introduction of different metal working processes.
CO2:	Introduction of sheet metal working and its different processes.
CO3:	Production of powder, manufacturing of parts by powder metallurgy and their applications.
CO4:	Production of screw threads, gears and uses of dies.
CO5:	Knowledge of Abrasive Machining and Unconventional Machining Methods.

UNIT I

Metal Working: Hot and cold rolling, continuous rolling. Drop forging, drop hammers, dies for drop forging, upset and press forging, forging presses, forging rolls, forging defects. Hot and cold extrusion including impact extrusion and extrusion cold forging. Seamless tubes manufacturing processes, swaging. Wire, bar and tube drawing.

UNIT II

Sheet Metal Working: Classification of processes. Process capabilities, process planning and elements of tooling of shearing (blanking, piercing, trimming, shaving, notching), drawing and forming processes. Sheet metal presses. Punch and die sets. Compound, progressive, and combination dies. Drop hammer forming, Guerin process, bulging, stretch forming, spinning and explosive forming. High velocity forming of metals.

UNIT III

Powder Metallurgy: Introduction, production of powder, manufacturing of parts by powder metallurgy and their applications.

Moulding and extrusion of plastic, forming and drawing of plastic sheets.

Production of screw threads, rolling, milling, and uses of dies. Production of gears, milling, shaping, and hobbing, finishing of gears.

UNIT IV

Abrasive Machining: Types and classification. Surface, cylindrical, and centreless grinding. Tool and cutter grinders. Grinding wheels, abrasives, bonding processes, selection of grinding wheels. Honing, lapping, and superfinishing methods, polishing and buffing.

Unconventional Machining Methods: Abrasive jet, electric discharge, electrochemical, ultrasonic, electron beam, plasma arc and laser beam machining. Electrolytic grinding, chemical milling.

Practicals:

Demonstration/exercises related to forging and sheet metal working. Exercises/study on grinding machines. Exercises/study on non-traditional machining processes.

Learning Resources:

Text Books/ Reference:

1. P.C. Sharma: A Text Book of Production Technology, S. Chand & Co., New Delhi.
2. SK Hajra Choudhury and AK Hajra Choudhury: Elements of Workshop Technology, Vol. I. Media Promoters & Publishers Pvt. Ltd., Bombay.
3. Pandey and Shan: Modern machining Process, TMH.

ME224			
DYNAMICS OF MACHINES			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
	Pre-requisites: Mathematics		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	How forces acts on a machine component like connecting rod, crank etc .		
CO2:	How a flywheel is required to run a IC engine.		
CO3	How an aeroplane and ship remains stable.		
CO4:	Types of lubrication and bearings and clutches.		
CO5:	Balancing of unbalanced forces in engines and locomotives.		

UNIT I

Static Force Analysis: Conditions for equilibrium, free body diagrams. Static force analysis of simple four-bar linkages, slider crank mechanisms, cam-follower systems, and gear systems with graphical and analytical methods. Consideration of friction.

Dynamic Force Analysis: Inertia force and torque, D' Alembert's principle, principle of superposition. Graphical and analytical dynamic force analysis of four bar mechanism and slider crack mechanism. Shaking forces and moments. Dynamically equivalent systems, application to single cylinder reciprocating engines. Gas force, bearing loads, shaft torque, shaking forces and moments determination.

UNIT II

Flywheel: Turning moment diagrams, coefficient of fluctuation of speed and energy, mass of flywheel, flywheel applications.

Gyroscopic Forces: Precessional motion, gyroscopic couple. Effect on stability of ships and aeroplanes, effect on four wheeled and two wheeled vehicles negotiating a curve, gyroscopic stabilisation of ships.

UNIT III

Friction and lubrication: Dry friction, static and dynamic friction. Friction on inclined plane, friction of pivots and collars, single and multiple disc clutches. Friction circle of turning pair and friction axis of a link. Rolling friction, antifriction bearings. Viscous and greasy friction. Film lubrication, Tower's experiment, Brone Reynold's theory, Sommerfield diagrams. Hydrostatic lubrication.

Governor: Types of governors. Analysis of Watt, Porter, Proell and spring loaded governors. Effect of friction, controlling force curves, sensitiveness, stability, hunting, isochronism, and effort of governor. Inertia governors.

UNIT IV

Balancing: Static and dynamic unbalance. Balancing of rotating masses in one and different planes, analytical and graphical methods. Balancing of reciprocating engines, primary and secondary inertia forces. partial primary balancing of locomotives, variation of tractive effort, swaying couple, hammer blow. Balancing of coupled locomotives. Balancing of multicylinder inline and radial engines, direct and reversed crank method, balancing of V engines. Balancing machines.

Learning Resources:

Texts books/References:

1. Joseph E. Shigley and John J. Uicker, Jr.: Theory of Machines and Mechanisms, McGraw Hill Inc.
2. P. L. Ballaney: Theory of Machines, Khanna Publishers, Delhi.
3. R. S. Khurmi and J. K. Gupta: Theory of Machines, Eurasia Publishing House (Pvt.) Ltd., New Delhi.
4. H. H. Mabie and C. F. Reinholtz: Mechanisms and Dynamics of Machinery. John Wiley & Sons.
5. Amitabha Ghosh and A. K. Mallik: Theory of Mechanisms and Machines, Affiliated East West Press Pvt. Ltd., Delhi.

ME225			
CAD LAB-I			
Lecture :	-	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	4 hrs/ Week	**Credits:**	2
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to Computer Aided Drafting.		
CO2:	How to draw the 2-D drawing and its dimensioning.		
CO3	Knowledge of viewing, printing, and dimensioning commands.		
CO4:	How to create different types of layers, hatching etc.		
CO5:	Knowledge about 3-D drawing.		

Practicals:

Introduction to Computer Aided Drafting using popular softwares like AutoCad. Drawing entities. Drawing, modifying, viewing, printing, and dimensioning commands. Drawing aids, coordinate systems, layers, hatching, etc. Blocks. Simple 2-D drawing and dimensioning exercises.

Learning Resources:

Texts books/References:

1. AutoCad: Reference Manual
2. George Omura: Mastering AutoCad.

ME226			
STEAM POWER ENGINEERING			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Basic terms useful in understanding steam generation, and steam power plants.
CO2:	components of steampower plant
CO3	Construction and working Analytical knowledge of all the efficiency of of high pressure boilers along with boiler testing.
CO4:	Heat transfer phenomenon related with boilers and its accessories.
CO5:	All the aspects of Rankine cycle and effect of thermodynamic variables on its efficiency
CO6:	Different types of turbines, condensers, nozzles with their performances.
CO7:	Knowledge of regenerative and reheat cycles and T-S and P-h graphs.
CO8:	Steam tables and Mollier charts and there utility.

UNIT I

Steam Generators: Natural circulation and forced circulation high pressure boilers viz. Lamont, Loeffler, and Benson boilers. Introduction to super critical pressure boilers. Testing of boiler. Heat balance sheet, problems involving combustion.

Boiler Draught: Boiler draught. Natural draught, height of chimney. Artificial draught, fans. Equivalent evaporation, efficiency and heat balance.

UNIT II

Vapour Power Cycles: Rankine cycle, effect of thermodynamic variables on its efficiency. Reheat cycle. Regenerative cycle, efficiency, disposal of bled steam, condensate. Regenerative water extraction cycle. Binary vapour cycle. Steam for heating and process work, back pressure turbine, pass out or extraction turbine, mixed pressure turbine. Second law analysis of steam power plant.

UNIT III

Condensers: Elements of condensing plant, advantages. Jet, surface, and evaporative condensers. Air in condenser and methods of extraction. Vacuum and condenser efficiency, cooling water requirement, capacity of air pump.

Steam Nozzles: Type of nozzles, steam flow through nozzles, application of SFEE, critical pressure, throat and exit areas for optimum discharge, friction effect. Super saturation phenomenon, effect of variation of back pressure. Theory of steam injectors.

UNIT IV

Steam Turbines: Types and classification. Impulse and reaction turbines. Flow of steam through turbine, blade sections and height. Velocity diagrams, application of SFEE. Diagram, stage and other efficiencies, condition for maximum efficiency. Methods of reducing rotor speed for turbines. Reheating and bleeding of turbines, reheat factor. Turbine characteristics and performance. Methods of governing, emergency governors.

Turbine Construction Details: Steam turbine components description. Nozzles, rotors, blades and their attachment, turbine glands, couplings. Balancing of axial thrust.

Practicals:

1. Study of high pressure boilers.
2. Study of steam turbines.
3. To determine dryness fraction of steam.
4. Study of condensers.
5. Test on steam nozzle. To obtain P-T relationship for saturated steam by Mercet boiler.
6. To conduct boiler trial test and obtain its efficiency.
7. Volumetric analysis of dry flue gases by Orsat apparatus.

8. To determine calorific value of coal by Bomb calorimeter

Learning Resources:

Texts books/References:

1. ML Mathur and FS Mehta: Thermal Engineering, (Vol. I & II, SI Edition), Jain Brothers, New Delhi.
2. R. Joel: Basic Engineering Thermodynamics: Pearson Education.
3. G. Rogers and Y. Mayhew: Engineering Thermodynamics Work and Heat Transfer, Pearson Education.
4. R. K. Purohit: Mechanical Engineering (SI Units), Scientific Publishers, Jodhpur.

ME311			
MECHANICAL VIBRATIONS			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Causes and effect of vibrations with its types.		
CO2:	The motions, along with a body can vibrate like harmonic and non harmonic motions.		
CO3	Undamped free vibrations and damped free vibrations of one, two and multi degrees of freedom systems.		
CO4:	Various types of forcing methods like harmonic excitation and non harmonic excitation on support and mass.		
CO5:	Materials for vibration isolation and its measuring instruments.		
CO6:	Various methods for finding the frequency of vibrations for all types of systems like rotating shaft, simple pendulum, spring mass systems etc.		

UNIT I

Vibrations: Types of vibrations. Degrees of freedom, continuous and lumped systems, natural frequency, resonance. Simple harmonic motion, vectorial and complex number representation. Fourier series and harmonic analysis.

Undamped Free Vibrations: Formulation of equations of motion for single degree of freedom system by Newton's law, D'Alembert's principle, and by energy approach. Solutions for given initial conditions for simple systems. Free flexural and torsional vibrations. Equivalent stiffness.

UNIT II

Damped Free Vibrations: Types of damping, free damped vibrations of single dof system with viscous damping. Damping coefficient and factor. Overdamped, critically damped, and underdamped systems. Logarithmic decrement. Viscous dampers. Frequency and rate of decay of amplitude with Coulomb damping.

Forced Vibrations: Forced vibrations with constant harmonic excitation, transient and steady state solutions. Magnification factor and phase difference. Forced vibrations with rotating unbalance, reciprocating unbalance, and with motion excitation of support. Non harmonic excitation. Vibration isolation and transmissibility, material for vibration isolation. Principles of vibration measuring instruments.

UNIT III

Multi Degrees of freedom Systems: Introduction to concepts of coupling of equations of motion, principal modes, orthogonality of modes, mode shapes, modal matrix. Free vibrations of simple two degrees of freedom rectilinear and torsional systems. Undamped vibration absorbers.

Approximate and numerical method for multi degrees of freedom systems- Rayleigh's method, Dunkerley's method, and Holzers's method. Application to simple systems. Geared systems.

UNIT IV

Continuous Systems: Discrete vs. continuous systems. Free vibrations of strings, longitudinal and transverse vibrations of beams, torsional vibrations of shafts.

Critical Speeds of Shafts: Whirling of shafts, critical speed of light shaft having single rotor with and without damping, critical speeds of shaft with two rotors. Secondary critical speed.

Practicals:

Experimental verification of gyroscopic effect, Experiment on Governors, Balancing experiment, Whirling of shafts, Experiments on single and multiple degrees of freedom systems

Learning Resources:

Texts books/References:

1. G. K. Grover: Mechanical Vibrations, Nem Chand & Bros., Roorkee.
2. Francis S. Tse, Iwan E. Morse and Rolland T. Hinkle: Mechanical Vibrations, CBS Publishers & Distributors, Delhi.
3. Leonard Merovitch: Elements of Vibrations Analysis (International Edition), McGraw Hill Inc, Singapore.
4. W. T. Thomson, Theory of Vibrations and Applications, Prentice Hall.

ME312			
FLUID MECHANICS			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to fluid mechanics and study of fluid properties and different fluid phenomenon.		
CO2:	Study of fuid static and pressure measurement.		
CO3	Types of flow and different laws of fluid flow and their applications.		
CO4:	Flow measurement using venturimeter and orificemeter.		
CO5:	Study of ideal flow and viscous flow.		
CO6:	Flow through pipes and head losses and dimensional analysis.		
CO7:	boundary layer and effect of flow round a body.		

UNIT I

Introduction: Continuum concept. Viscosity, effect of temperature and pressure. Incompressible and compressible fluids, Newtonian and Non Newtonian fluids, ideal fluid. Surface tension, capillarity, vapour pressure and cavitation.

Fluid Statics: Pressure, units and scales of measurement, general differential equation, manometry. Fluid forces on submerged surfaces. Buoyant force, stability of floating and submerged bodies, metacentric height.

Governing Equations of Fluid Flow: Flow classifications, stream, streak and path lines. Generalised continuity equation, Euler's equation of motion, Bernoulli's equation, momentum equation, angular momentum equation, and their application to fixed and moving blades, vanes, jets, etc.

Flow Measurement: Free orifice, jet, vena contracta. Orifice in pipes. Mouthpiece, venturimeter, notches and weirs.

UNIT II

Ideal Flow: Irrotational flow, velocity potential, Laplace's equation, stream function. Flow net, vortex and circulation. Potential flow solution for two dimensional problems, superposition, half body, Rankine body, circular cylinder and circular cylinder with circulation. Tormado Method of images, additional methods for obtaining potential flow solution.

Viscous Flow: Equation of motion for viscous fluid, Navier Stokes equations. Laminar and turbulent flow, Reynold's experiment. Simple solution of Navier Stokes equations for laminar flow between parallel plates, circular and annular tubes. Hagen-Poiseuille flow, plane Poiseuille flow and Couttee flow. Turbulent flow, mixing length hypothesis applied to pipe flow, velocity distribution in smooth and rough pipes.

UNIT III

Flow Through Pipes: Head loss and friction in rough and smooth pipes, Darcy-Weisbach equation, variation of friction factor with Reynold's number, Prandtl number. Universal pipe friction flows, Colebrook formula. Loss of head due to sudden enlargements, contraction, entrance, exit, obstruction, bend, pipe fittings. Total energy and Hydraulic gradient lines. Flow through pipe line, pipes in series and parallel. Transmission of power through pipes.

Dimensional Analysis and Dynamic Similitude: Buckingham's theorem, Superfluous and omitted variables. Dimensionless ratios. Reynold, Froude, Mach, Weber, and Euler numbers, and their applications. Similitude, model studies, undistorted model, distorted model, scale effect.

UNIT IV

Boundary Layer: Description of boundary layer, boundary layer thickness, boundary layer separation and control. Prandtl boundary layer equation and solution. laminar boundary layer, momentum equation for the boundary layer on flat plate in uniform free stream with no pressures gradients; Approximate momentum analysis -Laminar boundary layer, Turbulent boundary layer, Viscous sublayer, combined Laminar and turbulent boundary layers.

Flow Round a Body: Drag, skin friction drag, pressure drag, Combined skin friction and pressure drag

(profile drag),wave drag, lift induced drag. Flow past sphere and cylinder.

Practicals:

Verification of Bernoulli's theorem. Measurement of flow through venturimeter, orifice, notches and mouthpieces, and determining their coefficient of discharge. Flow through pipes and measurement of fluids.

Learning Resources:

Texts books/References Book:

6. Victor L. Streeter: Fluid Mechanics, McGraw Hill Book Co., Singapore.
7. R. K. Rajaput: Fluid Mechanics and Machines, S. Chand & Co.
8. R. K. Bansal: Fluid Mechanics and Machines,
9. Irving Shames: Mechanics of Fluids, McGraw Hill.
5. R.K. Purohit: Fundamentals of Fluid Mechanics, Scientific publisher,jodhpur

ME313			
MACHINE TOOLS			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Lathe machine main operations including taper turning and thread cutting.		
CO2:	Mechanism involved in feed of Shaper and Planer machine along with main operation.		
CO3	Operation, tools, twist drill, reamer and tap involved in Radial drilling machine.		
CO4:	Principal operations performed on Boring machine		
CO5:	Milling machine operations, indexing methods, gear cutting and processes CO6: Work holding devices on each machine mentioned in above outcome		

UNIT I

Lathes: Classification. Constructional details of centre lathe and its principal parts, accessories, attachments, and work holding devices. Main operations including taper turning and thread cutting, change gear calculation. Lathe tools.

Batch and Mass Production Machines:. Capstan and turret lathes. Automatic machine tools- Single and multispindle automats, their operation and tool layout. Hydraulic tracer controlled machine tools.

UNIT III

Drilling Machines: Classification. Constructional details of sensitive, pillar and radial drilling machines. Work and tool holding devices. Main operations. Tools, twist drill, reamer and tap.

Boring Machines: Classification. Horizontal and vertical boring machines. Precision boring machines, jig boring machines. Principal operations, boring tools, work holding devices.

Broaching Machines and tools.

UNIT IV

Milling Machines: Types and classification. Constructional details and principle of operation of horizontal, vertical, and universal milling machines. Work and cutter holding devices, attachments. Milling cutters. Milling operations and processes. Indexing methods and gear cutting.

Introduction to principles and operations of numerically controlled machine tools, machining centre, transfer machines and methods.

Practicals:

Exercises on lathe, shaper, planer, and milling machines.

Learning Resources:

Texts books/References:

1. SK Hajra Choudhury and AK Hajra Choudhury: Elements of Workshop Technology, Vol. II, Media Promoters & Publishers Pvt. Ltd., Bombay.
2. R.K. Jain & SC Gupta: Production Technology, Khanna Publishers, New Delhi.
3. JS Campbell: Principles of Manufacturing Materials and Processes, Tata McGraw-Hill Company Ltd, New Delhi.
4. H.M.T. Publication, Production Technology, Tata McGraw Hill.

ME314			
IC ENGINES			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
	Pre-requisites: Thermal Engineering		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction and classification of different type of IC engines.		
CO2:	Knowledge of Combustion and fuel injection phenomena in IC engines.		
CO3	Understanding of different types of IC engines fuels and their requisite properties.		
CO4:	Introduction of Engine Friction, Lubrication and Cooling systems.		
CO5:	Knowledge of Performance and Testing parameters of IC engines.		

UNIT I

Introduction: Classification, various engine efficiencies and performance parameters. Basic air cycles, deviations from ideal cycles. Combustion in S.I. Engines: Ignition limits. Stages of combustion, effect of engine variables on flame propagation, rate of pressure rise. Abnormal combustion, detonation or knocking, effects and control of detonation, theories and chemistry of detonation, effect of engine variables on detonation. Abnormal combustion. Carburetion: Properties of air-fuel mixtures, mixture requirements for different engine conditions. Transient mixture requirements. Elementary carburettor, calculation of air-fuel ratio. Description of important carburettors. Petrol injection, electronic fuel injection. Ignition System of SI Engines: Types of basic ignition systems. Firing order, ignition timings, ignition advance mechanisms. Spark plugs. Electronic ignition system.

UNIT II

Combustion in CI Engines: Stages of combustion. Air-fuel ratio in CI engines. Variables affecting delay period. Diesel knock, effect of engine variables, control of diesel knock. Cold starting of CI engines. Combustion Chambers: Requirements and design principles of combustion chambers, main features of widely used combustion chambers for SI and CI engines. Fuel injection: Heat release pattern, types of injection systems. Types of fuel pumps, injectors, and injector nozzles. Injection timing.

UNIT III

Engine fuels and Combustion: Fuels for SI engines, gasoline, requirements of ideal gasoline. Effect on engine performance. Knock rating of SI fuels, HUCR, Octane number, research and motor octane numbers. Important properties of diesel fuel. Cetane number, diesel index, Aniline point. Fuel additives or dopes. Exhaust gas analysis. Two Stroke Engines: Introduction, valve timings. Scavenging processes and parameters, scavenging systems, scavenging pumps.

Introduction to free piston, rotary combustion, dual fuel, and multi-fuel engines. Effect of atmospheric conditions on performance of I.C. Engines. Supercharging, methods and types of super charging.

UNIT IV

Engine Friction, Lubrication and Cooling: Break up of total engine friction, effect of engine variables on engine friction. Lubrication systems. Lubricating oils, classification, properties and service ratings. Oil pumps and filters. Crankcase ventilation. Areas of heat flow and temperature distribution, necessity of cooling. Types of cooling systems, air and water cooling. Thermostatic control. Radiators and cooling fans. Performance and Testing: Performance parameters. Measurement of speed, fuel and air consumption, brake horse power. Friction horse power measurement methods. Indicated power measurement, high speed indicators. Performance of SI and CI engines, heat balance sheet. Air Pollution: Introduction to air pollution, causes and control of air pollution.

Practicals:

Study of 4 stroke and 2 stroke petrol engine. Study of 4 stroke and 2 stroke diesel engine. Study of various types of carburettors. Study of various type of combustion chambers for SI and CI engines. Study of ignition systems for SI engines. Study of fuel injection system of CI engines. Morse test on 4 cylinder petrol engine. Performance test on an automobile engine under variable speed. Study of lubrication system. Study of cooling system. Study of Wankel rotary engine. Study of gas

turbine. Exhaust gas analysis.

Learning Resources:

Text Books/ References:

1. M. L. Mathur and R. P. Sharma: A Course in Internal Combustion Engines, Dhanpat Rai & Sons, Delhi.
2. Ganesan: IC Engines, TMH.
3. J. Heywood: Internal Combustion Engine Fundamentals, McGraw Hill.
1. H.N. Gupta, Fundamentals of Internal Combustion Engines, PHI Learning Pvt. Ltd.
2. Richard Stone, Introduction to Internal Combustion Engines, Society of Automotive Engineers

ME315			
MACHINE DESIGN- I			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	1 hrs/ Week	**Final Examination:**	80
Practical :	-	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Engineering materials and their mechanical properties.		
CO2:	Design procedure of machine components with Indian standards under the effect of various loads.		
CO3	Design of Cotter joints, Knuckle joints and design of curved members.		
CO4:	Design of permanent joints like riveted joints and welded joints etc.		
CO5:	Design of shaft, coupling, helical spring and laminated springs.		

UNIT I

Introduction: Meaning and phases of design, design process, design considerations. Engineering materials and their mechanical properties, BIS designation of materials. Preferred numbers. Factor of safety, selection of allowable stresses. Types of load and stresses, impact loads, theories of failure. Stress concentration, theoretical stress concentration factors and charts. Stress intensity factor and fracture toughness. Fatigue, S-N diaigram, endurance limit and modifying factors, fatigue stress concentration factor, design for fatigue, fluctuating stresses, Soderberg, Goodman and modified Goodman formulae. Surface endurance shear.

Design of Beams and levers.

UNIT II

Design of Detachable Joints: Cottered joints, pinned joints and turnbuckle. Design of bolted joints with and without preload, gasketed joints, design under fatigue loading. Bolted joints subjected to eccentric loading. Design of nuts, types of locking devices.

Design of Curved Members: Design of crane hooks, circular rings, chain rings, chain links, etc.

UNIT III

Design of Permanent Joints: Design of riveted joints, structural and pressure vessel (boilers) riveted joints, joints under eccentric loading. Design of welded joints. Eccentric loading on riveted and welded joints.

Design of columns.

UNIT IV

Design of Shafts, keys, couplings. Design of helical and laminated springs. Fatigue considerations.

Learning Resources:

Texts books/References:

1. V. B. Bhandari: Design of Machine Elements, TMH
2. Joseph Edward Shigely: Mechanical Engineering Design, McGraw Hill Book Company, Singapore.
3. R. S. Khurmi and J. K. Gupta: A Text Book of Machine Design, Eurasia Publishing House (Pvt.) Ltd., New Delhi.
4. N. C. Pandya and C. S. Shah: Elements of Machine Design, Charotar Book Stall, Anand.

ME316			
INDUSTRIAL ENGINEERING-I			
Lecture :	2 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	2
	Pre-requisites: Data Base Management Systems		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	History of Indian Craft trade system.		
CO2:	How Organizations work with the help of well developed Organizations and Management systems.		
CO3	Basic Management and Industrial Engineering Terminologies, which will help students to know the subject better.		
CO4:	Scientific Management and its growth with the view points of several management gurus.		
CO5:	How Personal Management is performed and Trainings are given.		
CO6:	How Job evaluation is done and Remuneration is decided.		
CO7:	Industrial Relations and Labour legislation.		
CO8:	To evaluate various costs associated with Industrial Engineering.		

UNIT I

Introduction: Historical development, functional areas of business and the need for integrating these through the development of business goals

Organisation: Meaning of organisation, administration and management. Ownership. Forms of business organisation, sole proprietorship, partnership, joint stock companies, cooperative societies, public enterprises.

Principles of organisation, types of organisation structures. Forms of organisation, line, functional, line and staff, and committee. Authority and responsibility, delegation of authority, span of control. Organisation charts.

UNIT II

Management: Principles and elements of management. Functions of management, planning, organisation, staffing, directing, coordination, and control. Types and levels of management, management structure. Scientific management, development of management thought with reference to the work of Taylor, Gilberth, Mayo and Kurt Lewin.

UNIT III

Personnel Management: Objectives, organisation, functions and responsibilities of personnel management, relationship with other departments. Brief idea about motivation, morale, perception, leadership attitudes, frustration, fatigue, accidents, values, opinion.

Man power Planning, recruitment, selection, job specification and job qualification. Training and placement.

Wage payment System: Job evaluation, merit rating, methods of wage payment, time wages, piece wage system, incentive schemes.

Industrial Relations and Labour legislation: Management union relations, trade union movement, collective bargaining, employees participation in management. Brief ideas about various labour acts.

UNIT IV

Elements of costing and Financial statements: Classification of costs, direct and indirect cost, labour, material and over-head, Prime cost, factory cost, fixed cost, variable cost, increment cost, Allocation of over head costs. Analysis of Break even chart. Depreciation of plant, building and facilities. Method of computing depreciation.

Learning Resources:

Texts books/References:

1. Banga and Sharma: Engineering Economics and Industrial Organisation. Khanna Publishers, New Delhi.
2. Kumar Surendra: Personnel Management and Industrial Relations. Satya Prakashan, New Delhi.
3. EI Lon.: Elements of Production Planning and Control.
4. R Lal: Essentials of Industrial Management. Bhatia Bhawan, Patna.
5. Philippo: Personnel Management

ME317			
CAD LAB-I			
Lecture :	-	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	4 hrs/ Week	**Credits:**	2
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to CATIA and solidworks.		
CO2:	Knowledge of Solid modeling using CATIA AND SOLIDWORKS.		
CO3	How to create curves and surfaces.		
CO4:	Introduction of Extruded solids. 3-D primitives. 3-D operations like union, intersecting, etc. 3-D transformation.		
CO5:	Making a part from sketch and how to Assembling different parts.		

Practicals:

Solid modeling using popular software like Mechanical Desktop, Inventor, CATIA, Pro-Engineer, or Ideas. Drawing curves and surfaces. Extruded solids. 3-D primitives. 3-D operations like union, intersecting, etc. 3-D transformation. Making a part from sketch, Assembling different parts. Simple 3-D modeling exercises

The students is expected to master modeling simple parts using any one of the packages as per availability.

Learning Resources:

Texts books/References:

1. Reference Manuals of the relevant software

ME321			
HEAT TRANSFER			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
	Pre-requisites: Thermal Engineering		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Thermal Engineering		
CO2:	Understanding of conduction heat transfer from different surfaces.		
CO3	Knowledge of free and forced convective heat transfer.		
CO4:	Introduction of Insulations and Heat Exchangers.		
CO5:	Basic knowledge of theories of radiant heat transfer and radiaon exchange between different surfaces.		

UNIT I

Introduction: Modes and mechanism of heat transfer, basic laws. Conductivity, heat transfer coefficients. Conduction: General differential equation of conduction. Steady state one dimensional conduction through plane and composite slabs, cylinders and spheres with and without heat generation including viscous heating, dielectric heating and linearly varying heat generation. Electrical analogy. Insulation: Selection of insulation material and thickness of insulation. Factors influencing conductivity. Critical thickness of insulation. Thickness of insulation to prevent freezing/condensation in pipes.

UNIT II

Fins: General equation for fin. Heat transfer through fins of rectangular, triangular and parabolic profile. Effectiveness and efficiency of fin, Biot number, optimum dimensions and arrangement of fins. Thermometer well, related applications of fin theory in heat transfer from pipe flow, different temperature heat sources at ends of rods with heat generation and convection, etc.

Unsteady State Unidirectional Conduction: Newtonian heating and cooling, response of thermocouple.

UNIT III

Forced Convection: Introduction, equation of laminar boundary layer on a flat plate and in a tube, laminar forced convection on a flat plate and in a tube. Reynold's analogy. Dimensional analysis, empirical relationships.

Natural Convection: Dimensional analysis. Convection with phase change, empirical relationships, description of condensing flow, theoretical model of condensing flow. Boiling heat transfer.

Heat Exchangers: Types of heat exchangers. Log Mean Temperature Difference (LMTD). Overall heat transfer coefficient, fouling factor. Condensers and evaporators. Heat exchanger performance, effectiveness and Number of Transfer Units (NTU). LMTD and NTU methods, analysis restricted to parallel and counter flow heat exchangers.

UNIT IV

Radiation: Theories of radiant heat exchange. Absorption, transmission, and reflection of radiant energy. Emission, black body and monochromatic radiation, Planck's law, total emissive power and Stefan Boltzman's law. Grey bodies, Kirchoff's law, Wien's law. Solid angle and intensity of radiation, Lambert's cosine law. Radiation exchange between black surfaces, geometric configuration factor and its determination for simple geometries. Grey body radition exchange between surfaces. Electrical analogy and its application to simple problems. Non luminous gas radiation. Errors in temperature measurement due to radiation. Combined heat transfer coefficient with radiation and convection.

Practicals:

To measure thermal conductivity of metal bars. To measure thermal conductivity of insulating powders. To study temperature distribution along the length of fin in natural and forced convection. Experiment on heat transfer in forced convection. Experiment on heat transfer in natural convection. To determine emissivity of given surface. To determine Stefan-Boltzman

constant and verify the law. To determine rate of heat transfer, LMTD and overall heat transfer coefficient for parallel flow heat exchanger. To determine rate of heat transfer, LMTD and overall heat transfer coefficient for counter flow heat exchanger. To study response of thermocouple.

Learning Resources:

Text Books/ References:

1 J. P. Holman: Heat Transfer, McGraw Hill.
2. D. S. Kumar, Heat and Mass Transfer, S. K. Kataria & Sons, Delhi
3. F. P. Incorpera, D. P. Dewitt, Fundamental of Heat and Mass Transfer, Wiley.
4. S.P. Sukhatme: A Text Book on Heat Transfer, Orient Longman.
5 S. Domkundwar: A Course in Heat & Mass Transfer, Dhanpat Rai & Sons, Delhi.

ME322			
FLUID MACHINES AND SYSTEMS			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction of Classification of machines and hydraulic turbines.		
CO2:	Explain contractual details of different types of turbines and Principles of Similarity.		
CO3	How to Reciprocating and rotodynamaic Pumps work.		
CO4:	Knowledge about Gear Pumps, vane pumps, hydraulic ram, jet pumps, well pumps, deep well pumps etc.		
CO5:	Knowledge about Hydraulic Power Transmission.		

UNIT I

Introduction: Application of momentum and moment of momentum equations to flow through hydraulic machinery, Euler's fundamental equation. Classification of machines.
Hydraulic Turbines: Classification of turbines. Impulse turbine, constructional details, velocity triangles, power and efficiency , governing of Pelton wheels. Reactions turbines, Francis and Kaplan turbines, constructional details, velocity triangles, power and efficiency calculation, degree of reaction, draft tube, cavitation.
Principles of Similarity: Unit and specific quantities, performance characteristics, Selection of Water turbines. Thomas cavitation factor.

UNIT II

Reciprocating Pumps: Reciprocating pump, theory, indicator diagram, slip, effect of friction and acceleration, theory of air vessel

Rotodynamic Pumps: Classification. Centrifugal pumps, vector diagrams, specific speed, head, power, and efficiency calculations. Model testing and performance characteristics. Selection of pumps.

UNIT III

Miscellaneous Fluid Machines: Gear Pumps, vane pumps, hydraulic ram, jet pumps, well pumps, deep well pumps, pumps of hydraulic pumped storage plants, air lift pump. Reversible hydraulic machines (pump turbines), types, construction and their characteristics.

Hydraulic Power Transmission: Hydro-kinetic system, function, methods of control, constant and variable delivery systems, common uses of hydrostatic systems. Hydro kinetic transmission systems, theory of hydraulic couplings and torque converters, operating characteristics, common uses of hydro kinetic systems.

UNIT IV

Miscellaneous Fluid Machines: Gear Pumps, vane pumps, hydraulic ram, jet pumps, well pumps, deep well pumps, pumps of hydraulic pumped storage plants, air lift pump. Reversible hydraulic machines (pump turbines), types, construction and their characteristics.

Hydraulic Power Transmission: Hydro-kinetic system, function, methods of control, constant and variable delivery systems, common uses of hydrostatic systems. Hydro kinetic transmission systems, theory of hydraulic couplings and torque converters, operating characteristics, common uses of hydro kinetic systems.

washers. Air conditioning systems, plant layout, controls, transmission and distribution of air.

Practicals:

Study of and obtaining various characteristic curves of Pelton, Francis, and Kaplan turbines.

Study of and obtaining performance curves for centrifugal and reciprocating pumps.

Learning Resources:

Text Books/ Reference Book:

1. R. K. Rajaput: Fluid Mechanics and Machines, S. Chand & Co.
2. R. K. Bansal Fluid Mechanics and Machines,
3. R.K. Purohit: Fundamentals of Fluid Mechanics, Scientific Publishers, Jodhpur.
4. Irving Shames: Mechanics of Fluids, McGraw Hill.

ME323			
INDUSTRIAL INSPECTION AND QUALITY CONTROL			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Introduction of Interchangeable Manufacture and Non-destructive Testing.
CO2:	Dimensional and geometrical accuracy of machined surface and types of errors.
CO3	How to control the quality of a product and need of quality control.
CO4:	Knowledge about Statistical Quality Control.
CO5:	Introduction to Sampling Plans and various types of sampling plans.

UNIT I

Interchangeable Manufacture: Deviations, limits of size, tolerances, allowances, types of fits, hole basis and shaft basis systems, BIS system of limits and fits. Design of limit gauges and gauge materials, numerical problems.

Non-destructive Testing: Radiography, magnaflux and fluorescent penetrant inspection, eddy current and ultrasonic tests

Alignment testing of lathes. Acceptance testing of machine tools.

UNIT II

Metrology: Dimensional and geometrical accuracy of machined surface, types of errors. Standards of measurement. Gauge blocks. Mechanical, electrical, optical and pneumatic type comparators. Auto-collimators, optical interferometry, measurement of screw threads and gears. Surface roughness specification and methods of measurement.

UNIT III

Quality Control: Quality improvement, need of Control, process capability analysis, quality capability study. Statistical quality control; objective, applications, organization, cost aspects, theory of statistical tolerances.

Quality circles. Introduction to TQM; introduction to international quality certifications.

UNIT IV

Statistical Quality Control: General theory of control charts, group control charts, control charts with variable sub-group size, moving average and moving range charts, acceptance control charts cumulative sum control charts and difference control charts.

Sampling Plans: Acceptance sampling, single, multiple and sequential sampling plans, multi-level continuous sampling, acceptance sampling by variables, sampling plans using different criteria, comparison of various types of sampling plans.

Practicals:

Exercises/study on linear and angular measurements using slip gauges and sine bar. Measurement of screw threads and gears, Experiments on ultrasonic flaw detection and measurement. Surface roughness measurement, comparators, etc. Drawing of control charts.

Learning Resources:

Text Books/ Reference Book:

1. RK Jain: Engineering Metrology, Khanna Publishers, New Delhi.
2. H.M.T. Publication, Production Technology, Tata McGraw Hill.

6 A. Mitra, Quality control and improvement, Pearson Education, Delhi.

ME324			
REFRIGERATION AND AIR CONDITIONING			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction of basic principle of different refrigerating systems.		
CO2:	Understanding the effect of different components on the refrigerating machines.		
CO3	Knowledge of different Refrigerants and Refrigeration Equipments.		
CO4:	Introduction of Psychrometry and different Psychrometry processes.		
CO5:	Designing of airconditioning system and Estimation of airconditioning load.		

UNIT I

Refrigeration: Principles of refrigeration, ice refrigeration, freezing mixtures, cooling by gas, reversible expansion, evaporation. Units of refrigeration, coefficient of performance. Heat pump.

Air Refrigeration Systems: Second law of thermodynamics applied to the refrigeration. Reversed Carnot cycle, Bell-Coleman cycle, Aircraft refrigeration.

Mechanical Vapour Compression Systems: Theoretical vapour compression system, undercooling, dry and wet compression. Deviation of actual cycle from ideal cycle. Volumetric efficiency of compressor and its effect on refrigeration cycle. Flash chambers and precoolers, Compound compression with intercooling, water intercooling and flash intercooling.

UNIT II

Vapour Absorption Systems: Vapour absorption cycle. Simple and practical vapour absorption system, Electrolux refrigerator.

Water vapour, steam jet, and thermo-electric refrigeration systems. Low Temperature Refrigeration: Cascading and liquification of gases.

UNIT III

Psychrometry: Thermodynamic properties of moist air, perfect gas relationship for approximate calculation. Adiabatic saturation process, psychrometric chart and its use, elementary psychrometric processes.

Air Conditioning: Types of airconditioning, Evaluation of comfort, comfort charts. Estimation of airconditioning load. Outside and inside design conditions, condition line, sensible heat factor. Cooling and humidification, Apparatus Dew Point and bypass factor. Humidification and dehumidification methods, air washers. Air conditioning systems, plant layout, controls, transmission and distribution of air.

UNIT IV

Psychrometry: Thermodynamic properties of moist air, perfect gas relationship for approximate calculation. Adiabatic saturation process, psychrometric chart and its use, elementary psychrometric processes.

Air Conditioning: Types of airconditioning, Evaluation of comfort, comfort charts. Estimation of airconditioning load. Outside and inside design conditions, condition line, sensible heat factor. Cooling and humidification, Apparatus Dew Point and bypass factor. Humidification and dehumidification methods, air washers. Air conditioning systems, plant layout, controls, transmission and distribution of air.

Practicals:

Study of vapour compression and vapour absorption systems. Study of Electrolux refrigerator. Study of refrigeration accessories. Study of window airconditioner. Study and determining COP of ice plant. Study and determining of COP of water cooler. To determine COP of vapour compression refrigeration rig. Study of charging of vapour compression refrigeration system. Study of leak detection devices. Study of domestic refrigerator. Study of evaporative cooling system. Study and test on heat pump.

Learning Resources:

Text Books/ Reference Book:

1. JL Threlkeld: Thermal Environmental Engineering, Prentice Hall.
2. C. P. Arora: Refrigeration and Air-conditioning, TMH.
3. S Domkundwar and S C Arora: Refrigeration and Air Conditioning, Dhapat Rai & Sons, Delhi.
4. W. Stoecker: Refrigeration and Air-conditioning, McGraw Hill.

ME325			
MACHINE DESIGN- II			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	1 hrs/ Week	**Final Examination:**	80
Practical :	-	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	How to design different IC engine components.		
CO2:	How to design clutches and brakes.		
CO3	Design of Power Transmission Elements and gear transmission system.		
CO4:	How to design the different types of Bearings.		
CO5:	Design of pressure vessels, flywheel and rotating discs.		

UNIT I

Design of IC Engine Components: Design of crank shaft, connecting rod, piston.
Design of clutches and brakes.

UNIT II

Design of IC Engine Components: Design of crank shaft, connecting rod, piston.
Design of clutches and brakes.

UNIT III

Design of screw motion mechanisms, screw jack, toggle jack, lead screw etc.
Bearings: Design of journal bearings. Selection of ball and roller bearings.

UNIT IV

Design of pressure vessels: Thin cylinders and spheres. Design of thick cylindrical shells subjected to internal and external pressures. Compound cylinders. Design of cylinder heads and cover plates.
Design of flywheels and rotating discs.

Learning Resources:

Texts books/References:

1. V. B. Bhandari: Design of Machine Elements, TMH
2. Joseph Edward Shigely: Mechanical Engineering Design, McGraw Hill Book Company, Singapore.
3. R. S. Khurmi and J. K. Gupta: A Text Book of Machine Design, Eurasia Publishing House (Pvt.) Ltd., New Delhi.
4. N. C. Pandya and C. S. Shah: Elements of Machine Design, Charotar Book Stall, Anand

ME326			
INDUSTRIAL ENGINEERING-II			
Lecture :	2 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	2

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Basic terms useful in understanding the subject and its importance in corporate and general life.
CO2:	Principles of plant layout and Different types of layouts of shop flores.
CO3	Field and scope of material management along with material planning.
CO4:	Material handling and types of equipments.
CO5:	Plant Maintenance and Maintenance polices along with its types.
CO6:	Broad analysis of Production Planning and Control and the various terms related with it.
CO7:	Value engineering and work study with charts associated with it.
CO8:	Solving techniques of various numerical problems related to production forcasting, planning and control.

UNIT I

Plant Location: Major factors, influencing the location of an industry and choice of site.Plant Layout: Principles of plant layout, use of travel charts. Flow Pattern, Process Layout and Product Layout and combination, Line balancing.

UNIT II

Materials Management: Field and scope of material management. Material Planning and programme. Types of inventories. Inventory control. Vendor development, rating, standardisation and coding. Procedure for purchase and storage.
Materials Handling: Functions, engineering and economic factors, relationship to plant layout. Selection, operation and maintenance of material handling equipment. Types of equipment

UNIT III

Plant Maintenance: Maintenance polices, preventive,Breakdown and corrective.

Production Planning and Control: Types of production, Function of production planning and control, planning. Pre-planning, sales forecasting, routing. scheduling, despatching and control, Gantt charts. Project planning. Introduction to network techniques, CPM and PERT, time estimates.

UNIT IV

Work Study: Concept of productivity, method study, motion economy, process chart symbols. Flow diagram, operation analysis and operation chart, SIMO charts. Work measurement, use of stop watch procedure for time study data. Use of time study data with practical applications. Performance rating.

Value engineering: Value engineering and value analysis, product enrichment.

Practicals:

Stop watch time study- determining standard time. Performance rating. Bolt and washer assembly experiment. Pegging board experiment.

Learning Resources:

Texts books/References:

1. Memoria and Agarwal: Business Organisation
2. Buffa: Operations management
3. R.M. Barnes. Time and Motion Study, Asia Publication.
4. Starr & Miller. Inventory Control- Theory & Practice. Prentise Hall India.

ME327			
COMPUTER APPLICATIONS IN MECHANICAL ENGINEERING			
Lecture :	-	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	2 hrs/ Week	**Credits:**	1
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to MATLAB .		
CO2:	Writing Programmes in C and/or MATLAB for numerical solutions of problems related to mechanical.		
CO3	Use of statistical packages		
CO4:	Use of data presentation packages		

Practicals:

Writing Programmes in C and/or MATLAB for numerical solutions of problems related to mechanical engineering. Use of statistical packages, data presentation packages, etc.

Learning Resources:

Texts books/References:

1.Reference Manuals of the relevant software

ME411			
CAD/CAM			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
	Pre-requisites: Machine tool		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Computer graphics and tools for designing and drafting.		
CO2:	Develop a good knowledge about construction and operation of numerical control systems and machines.		
CO3	Process planning and Part programming for manufacturing with CNC machines.		
CO4:	Identification of parts into Part Families for Group Technology in Cellular Manufacturing and planning for full FMS.		
CO5:	Basic anatomy and working of ROBOTS and their use in manufacturing with full control of operations in an organisation through computer systems.		

UNIT I

Design process, application of computers for design, benefits of CAD. CAD system components.
Computer graphics: Software configuration of a graphics systems, functions of a graphic package, constructing the geometry, transformations. Wire frame versus solid modeling.
Introduction to numerical control, basic components of NC system, Problems with conventional NC, computer numerical control, direct numerical control, adaptive control machining systems.

UNIT II

NC coordinates and motion control systems, punched tape in NC, tape coding and format. Manual and computer assisted part programming, simple exercise in APT language.

UNIT III

Group technology: Part families, parts classification and coding systems, group technology machine cells, benefits of group technology.
Flexible manufacturing systems: Introduction, components of FMS, application work stations. Computer control and functions - planning, scheduling and control of FMS, knowledge based scheduling.

UNIT IV

Robot technology: Robot physical configurations, basic robot motions, end effectors, work cell control and interlocks, robotic sensors.
Computer-integrated manufacturing: Types of manufacturing systems, machine tools and related equipment, material handling system, benefit of CIMS.

Practicals:

Use of popular analysis and simulation packages (for example ANSYS, CATIA, etc.) for engineering analysis related to mechanical engineering. Use/Demonstration of CNC programming and simulation software.
The students will be required to undertake a couple of minor projects in analysis and design using computers.

Learning Resources:

Text Books/ Reference Book:

1.M. P. Groover and E.W. Zimmers: CAD/CAM- Computer Aided Design and Manufacturing, Prentice-Hall of India, New Delhi.

2. Surendra Kumar and A.K. Jha: Technology of Computer Aided Design and Manufacturing CAD/CAM, Dhanpat Rai & Sons, Delhi.

3.Steven Harrington: Computer Graphics- A Programming Approach, McGraw Hill.

4.D.F. Rogers and A. Adams: Mathematical Elements for Computer Graphics, McGraw Hill Inc., New York

5.I.D. Faux and M.J. Pratt: Computational Geometry for Design

ME412			
INSTUMENTATION AND CONTROL			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to measurement and generalised measurement system.		
CO2:	Instrument classification and their static and dyanamic characteristics and performance parameters.		
CO3	Detector transducer element, signal conditioning element and different display or recording elements of an instrument .		
CO4:	Measurement of stress, strain, force and torque.		
CO5:	Measurement of pressure and calibration of instrument .		
CO6:	Measurement of tempreture, displacement,vibration and flow and calibration.		
CO7:	Study of control system and concepts of control system .		

UNIT I

Measurement: Generalised measurement system, instrument classification, standards of measurement, calibration.

Static and Dynamic Characteristics: Static performance parameters. Impedance loading and matching. Types of errors and uncertainties, propagation of uncertainties, statistical treatment of uncertainties, single sample and multi sample data, goodness of fit, dynamic response. Compensation.

Transducer and Signal Conditioning Elements: Various Primary and secondary transducers. Digital transducers. Introduction to signal conditioning elements.

Terminating Devices: Analog electric meter indicators, electronic counters, digital multimeters, cathode ray oscilloscope, oscillographs, galvanometric type and servo type potentiometric recorders, x-y plotters, single point and multi-point recorders.

UNIT II

Strain and Stress Measurement: Resistance strain gauges, backing materials, bonding materials and methods, gauge factor, gauge configuration, strain gauge bridge circuits, temperature compensation, calibration, semiconductor (piezo-electric) strain gauge. Indicating device. Use of strain gauges on rotating shafts. Strain gauge rosettes.

Force and Torque Measurement: Hydraulic and pneumatic load cells. Strain gauge and piezo-electric based load cells. Separation of force components, calibration. Torque transducers.

Pressure Measurement: Bourdon type gauge, Low and high pressure measurement, Mcleod gauge, thermal conductivity gauge, ionisation gauge, strain gauge, pressure cells. Dynamic pressure measurement. Calibration and testing.

UNIT III

Temperature Measurement: Bimetallic, pressure, metal resistance thermometers. Thermisters, thermo-electric thermometering. Thermocouple, laws of thermocouple, calibration. Error compensation. High speed temperature measurement. Pyrometry, optical pyrometers.

Displacement Measurement: Transducers for displacement measurement, LVDT, resistance strain gauge. Angular velocity measurement, photocell method, Stroboscope.

Vibration Measurement: General theory of seismic instruments. Vibration pick-ups, accelerometers, transducers for vibration pickups and accelerometers, calibration. Frequency measurement, FFT analyser

UNIT IV

Flow Measurement: Positive displacement and obstruction meters, measurement by drag effects. Hot wire and magnetic flow meters. Flow visualisation methods - Schileren technique, pressure probes.

Miscellaneous Measurement: Water level measurement. Acoustic measurement, sound level meter.

Control Systems: Concept of open and closed loop system. Feedback. Servomechanisms and servosystems. Representation of control systems, block diagrams. Hydraulic, electric, and pneumatic systems. Concept of stability.

Practicals:

Experiment on temperature measurement using thermocouple and calibration, temperature measurement using RTD and thermisters, Water level measurement using capacitive transducer, strain measurement, characteristics of LVDT, vibration measurement, pressure gauge calibration, force measurement.

Learning Resources:

Text Books/References:

1.B.C. Nakra and K. K. Chaudhry: Instrumentation Measurement and Analysis, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

2.D. S. Kumar: Mechanical Measurements and Control, Metropolitan, New Delhi.

3.Thomas G Beckwith, N. Lewis Buck, and Roy D Marangoni: Mechanical Measurements, Narosa Publishing House, New Delhi.

4.K. Ogate: Modern Control Engineering, Prentice Hall of India

ME413			
PRODUCTION ENGINEERING			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Advanced course of metal cutting and metal forming, understand the mechanism of chip formation with cutting forces and temperature generation during machining. More familiar with metal cutting mechanics.
CO2:	Estimation of tool life and identification of tool wear. Familiar with various types of chips and their role in metal cutting.
CO3	Familiar with the second part of metal working. Familiar with analytical part of metal forming and power requirement during operation.
CO4:	Basic analytical understanding of all types of metal forming processes.
CO5:	Familiar with jigs, fixtures and its types. Design principles of dies and application of dies. Introduction of safety engineering.

UNIT I

Mechanics of Metal Cutting: Geometry of single point and multi point cutting tools, tool signature systems. Orthogonal and oblique cutting. Mechanism and geometry of chip formation, types of chips. Forces on chips. Velocity, stress, strain and strain rate, power, and energy relationships in orthogonal cutting. Theories on metal cutting. Friction and thermal aspects, measurement of cutting force and chip-tool interface temperature. Mechanics of multipoint cutting tools viz. milling, drilling and broaching tools.

UNIT II

Theory of Machinability: Evaluation of machinability, tool life, tool failure. Mechanisms of tools wear, effect of cutting parameters, surface finish. Economics of machining, optimum cutting speed. Cutting tool materials and their characteristics, chip breakers, cutting fluids and their applications.

UNIT III

Metal Working Analysis: Fundamentals of theory of plasticity, flow conditions, plane strain criterion, friction in metal working. Elementary analysis of wire drawing, tube drawing, rod and strip drawing. Theory of forging. Elementary theory of rolling, Nadai's theory of rolling, rolling power requirement calculation.

UNIT IV

Tool Design: Design Principles of forging and sub-setting dies, elements of design of sheet metal press tools and dies. Design of single point cutting tools, form tools, and milling cutters.
Jigs and Fixtures: Introduction, design considerations and materials. Principles of location. Clamping and locating devices. Drilling jigs and bushes. Classification and types of milling fixtures.
Safety Engineering: Safety devices in production shops, safety codes.

Learning Resources:

Text Books/References:

1. SK Hajra Choudhury and AK Hajra Choudhury: Elements of Workshop Technology, Vol. I, Media Promoters & Publishers Pvt. Ltd., Bombay.
2. JS Campbell: Principles of Manufacturing Materials and Processes, TMH.
3. Richard L. Little: Welding and Welding Technology, TMH Co. Ltd., New Delhi.
4. R. K. Purohit: Mechanical Engineering, Scientific Publishers, Jodhpur

ME414			
POWER PLANT ENGINEERING			
Lecture :	2 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	2

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Principal types of power plant and sources of energy.
CO2:	Layout of storage of plants and selection of turbine.
CO3	Working of Steam power plant, Coal feeding and burning methods, and Pulverised fuel systems, Ash handling system, Draught System.
CO4:	Types of Diesel power plant and comparison with steam power plant.
CO5:	Gas turbine power plants based on open cycle and closed cycle.
CO6:	Nuclear Power plant and types of nuclear reactor
CO7:	Unconventional methods of Power generation

UNIT I

Introduction: Introduction to generation of electrical power, sources of energy, comparative merits, principal types of power plants. Review of growth of power and development of different types of power plants in India, future possibilities.

UNIT II

Steam Power Plants: Selection of site, general layout of plant. Supply, storage and handling of coal. Coal feeding and burning methods, related equipment, pulverised fuel systems and furnaces. Ash handling and dust collectors. Draught systems, condensers, spray ponds and cooling towers, feed water treatment. Steam pipe materials, types of joints and fittings, expansion joints and pipe lagging. Commissioning and testing of power plants.

Diesel Power Plants: Fields of use, components of diesel electric power plant, types of diesel engines used, performance of diesel electric power plant, comparison with steam power plants.

UNIT III

Gas Turbine Power Plants: Components of gas turbine power plant, open cycle and closed cycle plants, choice of working fluid, arrangement of plant components. Combined gas and steam power plant. Comparison with diesel and steam power plants.

Nuclear Power Plants: Elementary concepts of physics of energy generation by nuclear fission. Nuclear reactor types and classification, boiling water reactor, gas cooled reactor, analysis of steam-gas system, organic cooled moderate reactors, liquid metal cooled reactors. Liquid fuel reactors, breeders and fast reactors. Radiation shielding, radio-active waste disposal, safety aspects. Selection of site. Nuclear fuel production and handling.

UNIT IV

Unconventional Methods of Power Generation: Introduction to solar energy and its utilisation, solar cells, thermo-electric and thermionic devices, fuel cells, magnetohydrodynamic energy conversion, geothermal, tidal and wind power plants.

Power Plant Economics: Plant costs. Influence of interest rate, depreciation, operating costs on the selection of equipment. Incremental cost. Comparison of operating costs of thermal, hydel and nuclear power plants. Different systems of tariff. Load prediction and curves. Influence of load factor, capacity factor, utilization factor and diversity factor on plant location and selection of unit sizes.

Learning Resources:

Text Books/References:

1. S. Domkundwar and S. C. Arora, A course in power plant engineering, Dhanpat Rai & Sons, Delhi.
2. P.K. Nag: Power Plant Engineering – Steam & Nuclear, TMH.
3. Skrotzki: Power Stattion Engineering & Economy, McGraw Hill.

ME415			
DESIGN ENGINEERING			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20+30
Tutorial :	-	**Final Examination:**	50
Practical :	2 hrs/ Week	**Credits:**	4

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Introduction to Design Engineering.
CO2:	Knowledge of Design for Production.
CO3	Design Optimisation and Strength, stiffness and rigidity considerations in product design.
CO4:	Introduction of Human factors in engineering design.
CO5:	Introduction about Economic Factors Influencing Design and Modern Approaches to Product Design.

UNIT I

Introduction to Design Engineering: Morphology of design, need analysis, specification of a problem. Problem formulation and problem analysis, design process and design cycle, creative design and introduction to decision making. Analysis of the product, standardization, simplification. Basic design considerations.

Design for Production: Producibility requirements in the design of machine components. Design for forging, casting, machining ease and powder metallurgical parts.

UNIT II

Strength, stiffness and rigidity considerations in product design.

Design Optimisation: Search for alternative solution and optimization aspects in design, qualitative discussions of various optimisation techniques.

UNIT III

Human factors in engineering design: Aesthetic and ergonomic considerations. Design of controls and displays.

Value Engineering: Nature and measurement of value, maximum value, normal degree of value, importance of value, the value analysis job plan. Steps to problem solving and value analysis, value analysis tests, material and process selection in value engineering.

UNIT IV

Economic Factors Influencing Design: Product value. Design for safety, reliability and environmental considerations. Economic analysis, profit and competitiveness, break-even analysis. Economics of a new product design.

Modern Approaches to Product Design: Concurrent Design, Quality Function Deployment (QFD).

Practicals:

Creative Design Project: A comprehensive design of a machine/device to perform a given task and/or a computer aided design of a machine or machine component to be done as a project during the semester.

Learning Resources:

Text Books/ References:

1. Chitale and Gupta: Product Design and Manufacturing, Prentice Hall of India.
2. Ulrich, K. T., and Eppinger, S.D., Product Design and Development, McGraw-Hill.

ME416(a)			
FINITE ELEMENT METHOD			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Introduction to FEM.
CO2:	Knowledge of Principle of stationary (or minimum) potential energy, principle of virtual work.
CO3	Knowledge of Finite element formulation for one dimensional bar and heat transfer problems.
CO4:	Finite element formulation of one dimensional beam problem from minimum potential energy and Galerkin approach.
CO5:	Finite element formulation for two dimensional structural and heat transfer problems – minimum potential energy and Galerkin approaches.

UNIT I

Review of matrix algebra, theory of elasticity, stress-strain relations, strain-temperature relations, plane stress, plane strain, axisymmetric case.

Introduction to FEM with direct or stiffness formulation for bar problem. Element stiffness matrix, assembly, imposition of boundary conditions, solution of global system, stress and support reaction computation.

Computation details, storage schemes for global matrices. Solution of equations in static analysis. Gauss elimination, Cholesky's factorisation.

UNIT II

Principle of stationary (or minimum) potential energy, principle of virtual work. Rayleigh-Ritz method. Galerkin method. Variational formulation of FEM. Piecewise polynomial interpolation. Shape functions, degree of continuity. Shape functions for C^0 and C^1 elements. Lagrangian and Hermite interpolations. General displacement based formulation for structural problems. Consistent element nodal loads. Equilibrium and compatibility in FE model. Convergence requirements.

Finite element formulation for one dimensional bar and heat transfer problems. Linear and quadratic elements. Natural coordinates, isoparametric formulation.

UNIT III

Finite element formulation of one dimensional beam problem from minimum potential energy and Galerkin approach. Beam element. Coordinate transformations, truss and frame elements. Application to simple beam, truss and frame problems.

UNIT IV

Finite element formulation for two dimensional structural and heat transfer problems – minimum potential energy and Galerkin approaches. Natural (area) coordinates. Linear triangular element for structural (CST element) and heat transfer problems. Plane bilinear element. Isoparametric plane bilinear and triangular elements. Numerical integration, Gauss quadrature. Jacobian matrix.. Applications to simple stress analysis and heat transfer problems (restricted to CST element only).

Learning Resources:

Texts books/References:

1. T. R. Chandrupatla and A. D. Belegundu: Introduction to Finite Elements in Engineering, Prentice Hall of India, New Delhi.
2. R. D. Cook, D.S. Malkus and M.E. Plesha: Concepts and Applications of Finite Element Analysis, John Wiley & Sons.
3. P. Sheshu: Text Book of Finite Element Analysis, Prentice Hall of India.
4. K.J. Bathe: Finite Element Procedure, Prentice Hall of India.

ME421			
GAS DYNAMICS AND TURBINES			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3

Course Outcomes:	**Upon completion of this course the students will be familiar with:**
CO1:	Introduction to elementary gas Dynamics: integral equation of conservation of mass, momentum, and energy as applied to control volumes.
CO2:	Gas Turbine Cycles: Carnot cycle, Joule cycle, Sterling cycle, Brayton cycle, Ericsson cycle, Atkinson cycle. Closed and open cycles and numerical problems.
CO3	Knowledge of Positive Displacement Air Compressors, Centrifugal Compressors, Axial Flow Compressors.
CO4:	Knowledge of Axial Flow Gas Turbines, workdone and torque calculation. Velocity triangles
CO5:	Knowledge of Jet and Rocket Propulsion

UNIT I

Elementary Gas Dynamics: Integral equation of conservation of mass, momentum, and energy as applied to control volumes. One dimensional flow equation, sonic velocity, Mach number and waves. Isentropic flow of perfect gas, stagnation properties. Isentropic flow through converging and converging-diverging nozzles, critical pressure, choking, operation under varying pressure ratios. Adiabatic flow with friction in constant area ducts, Fanno relations. Normal shock, formation of shockwaves, governing equations.

UNIT II

Gas Turbine Cycles: Carnot cycle, Joule cycle, Sterling cycle, Brayton cycle, Ericsson cycle, Atkinson cycle. Closed and open cycles. Cycles with regeneration, heat exchanger, intercooling and reheating. Deviation from ideal cycle, cycles with multistage compressions, losses in actual cycles. Various efficiencies, polytropic efficiency and turbine performance.

Combustion Systems: Types of combustion chambers,combustion chamber arrangements. Combustion efficiency. Fuel injection systems.

UNIT III

Positive Displacement Air Compressors: Classification of air compressors. Work done, thermal and volumetric efficiency, effect of clearance in reciprocating air compressors. Multistage reciprocating air compressors, intercooling. Positive displacement rotary compressors, roots blower, Lysholm, screw type and vane type.

Centrifugal Compressors: Euler's equation for rotating machines, general thermodynamic energy analysis. Elementary aerofoil theory. Constructional details, method and theory of operation of centrifugal compressors. Energy transfer, velocity triangles. Slip factor, power input factor, pressure coefficient, efficiency. Sizing of inducer section, prewhirl. Impeller types, effect on performance. Diffuser. Losses in compressors, compressor characteristics. Surging and choking.

Axial Flow Compressors: Description, principle of operation. Efficiencies, workdone and torque calculation, velocity triangles. Degree of reaction. Aerofoil blading, drag and lift coefficients. Performance Characteristics. Centrifugal v/s axial flow compressors.

UNIT IV

<u>Learning Resources:</u>

Texts books/References:

1. P. R. Khajuria and S. P. Dubey: Gas Turbines and Propulsive Systems, Dhanpat Rai & Sons, New Delhi.
2. M. L. Mathur and F. S. Mehta: Thermal Engineering, (Vol. I & II, SI Edition), Jain Brothers, New Delhi.
3. E. Rathakrishnan: Gas Dynamics, PHI.

ME422			
OPERATIONS RESEARCH			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
	Pre-requisites: Mathematics		
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Optimisation needs and applications in real life situations using mathematical modelling and solution techniques.		
CO2:	Develop a good knowledge about formulating problems into linear programming and to solve using various techniques.		
CO3	Using the probability theory in planning and designing service facilities and estimation of waiting time for delivery estimation.		
CO4:	Inventory planning and management for reducing the cost and decision making in ensuring material and machine availability.		
CO5:	Competitive bidding and strategy making for winning customers with future estimation and decision making with objective analysis.		

UNIT I

Introduction: Characteristics and scope of O.R., formulations of problem and methodology.
Linear Programming: Mathematical formulation of problem, graphical solution. Simplex and revised simplex methods, unrestricted and bounded variables, degeneracy and cycling, perturbation methods. Duality. Sensitivity analysis.

UNIT II

Transportation, allocation, and assignment problems.
Queuing Theory: Queuing systems and disciplines, arrival and service rate distributions, waiting time and queue length for Poisson queues.

UNIT III

Inventory Models: Elements of costs, lead time, inventory control techniques, ABC analysis. Economic lot size problems with deterministic demand and supply rate including considerations of shortages and price breaks. Buffer stock, reorder level, and reorder point. Economic run length.
Replacement Problems and Reliability: Economics of replacement, replacement of items that deteriorate with time or that break down completely with or without value of money remaining same, group replacement policy. Introductory concepts of system reliability.

UNIT IV

Theory of Games: Two-person zero sum games, saddle point, games without saddle points, dominance property, graphical methods, formulation of game problem as LPP.
Simulation: Event type simulation, generation of random phenomena, Monte Carlo technique, simulation steps, application to queuing problems.
Decision Making: Decision under certainty, under risk, and under uncertainty. Decision trees.

Learning Resources:

Text Books/ References:

1.Kanti Swarup, P. K. Gupta, and Man Mohan: Operations Research, Sultan Chand & Sons, New Delhi.
2.S.D.Sharma, Operations Research, Kedar Nath Ram Nath &Co.
3.H.A. Taha, Operations Research- An Introduction, PHI

ME423(c)			
ADVANCED JOINING TECHNOLOGY			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Analysis of heat sources for material joining, Effects of welding parameters on heat distribution, analysis of flow of heat in weld, heat zones in fusion welding		
CO2:	Knowledge of Modern welding processes like EBW, LBW, Diffusion bonding, Ultrasonic welding, etc,		
CO3	Knowledge of Stresses in welding, weldment design for pressure vessels, heavy structures, offshore structures and submarine pipe lines.		
CO4:	Knowledge of Inspection and testing of welds. Inspection codes for weldments		
CO5:	Knowledge of Failure of welds.		

UNIT I

Analysis of heat sources for material joining, Effects of welding parameters on heat distribution, analysis of flow of heat in weld, heat zones in fusion welding. Welding metallurgy and heat treatment of welding.

UNIT II

Modern welding processes like EBW, LBW, Diffusion bonding, Ultrasonic welding, etc, Brazing, soldering, adhesive bonding and solid state bonding. Pulsed current welding processes.

UNIT III

Stresses in welding, weldment design for pressure vessels, heavy structures, offshore structures and submarine pipe lines. Welding of ceramics, plastics, composites. Influence of oxides, slag and fluxes on welding of ceremics, plastics and composits.

UNIT IV

Inspection and testing of welds. Inspection codes for weldments.

Failure of welds. Liquide penetrate inspection, magnetic particle inspection, eddy current, ultrasonic x-ray testing and NDT of welds.

Learning Resources:

Texts books/References:

1. M.M. Schwartz: Metal Joining Manual, McGraw Hill, New York.
2. L. P. Connur: Welding Handbook (Vol. I and II), American Welding Society.
3. P.T. HouldCraft: Welding Process Technology, Cambridge University Press.

ME424(a)			
NON -CONVENTIONAL ENERGY SOURCES			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to Conventional and Alternative Energy Sources.		
CO2:	Knowledge of wind energy and Wind farms		
CO3	Knowledge of Solar Energy and Instruments for measurement		
CO4:	Knowledge of Collection of Solar Energy and Photo voltaic technology		
CO5:	Knowledge of Geothermal Energy and Biomass		

UNIT I

Conventional and Alternative Energy Sources: Effect on environment of fossil, fuels, nuclear energy and hydroelectric power. Alternative energy sources- solar, wind, geothermal, tidal and wave, biomass etc.

Wind Energy: Nature and potential, wind mill types, their merits and demerits, design of wind rotors and control systems. Wind farms.

UNIT II

Solar Energy: The sun and the earth, spectral distribution of extra terrestrial radiations. Solar constant, depiction of solar radiation in the atmosphere. Solar radiation at the earth surface, sun earth angle, derived solar angles, solar time measurement and estimation of solar radiation. Instruments for measurement, radiation properties of gauge material, transmission of radiation through transparent media.

Collection of Solar Energy: Flat place collection construction, types, working, material selection, design considerations and testing procedure. Focussing collectors types, concentration tracking mechanism. Application of solar energy- Solar water and air heaters, distillation, drying of materials, power generation, cookers, solar refrigeration. Photo voltaic technology.

UNIT III

Geothermal Energy: Geological setting, different geothermal systems, utilisation of geothermal energy, its economical and environmental comparison. Brief description of different utilisation techniques for ocean thermal energy, and tidal and wave energy.

UNIT IV

Biomass: Nature and potential, different bio conversion techniques, production of bio solid, liquid and gaseous fuels.

Learning Resources:

Texts books/References:

1. A. N. Mathur and N. S. Rathore: New and Renewable Energy Sources, Bohra Ganesh Publishers, Udaipur.
2. G. D. Rao: Non Conventional Energy Sources, Khanna Publishers, New Delhi.

ME428			
AUTOMOBILE ENGINEERING			
Lecture :	3 hrs/ Week	**Internal Assessment:**	20
Tutorial :	-	**Final Examination:**	80
Practical :	-	**Credits:**	3
Course Outcomes:	**Upon completion of this course the students will be familiar with:**		
CO1:	Introduction to Power Unit, engine types, classification and Rotary Engines and fuel cells		
CO2:	Knowledge of Chassis and Suspension system		
CO3	Knowledge of Transmission: Clutches, fluid flywheels, torque converters		
CO4:	Knowledge of Brakes and Tyres		
CO5:	Knowledge of Steering mechanism and Electric Car		

UNIT I

Power Unit: Engine types, classification, cylinder heads, cylinder head gasket, piston rings, carburettors, fuel injection equipment. Multi port fuel injection. Temperature stress in various engine parts. Power and torque, characteristics of power for specific road performance. Rotary Engines and fuel cells.

Chassis and Suspension: Loads on the frame, general considerations of strength and stiffness, engine mountings, various suspension arrangements, leaf and coil springs, shock absorber.

UNIT II

Transmission: Clutches, fluid flywheels, torque converters. Rolling, air and gradient resistance. Propulsive force required. Determination of overall gear ratio, specific performance.

Gear Box: Simple gear box, synchromesh gears, overdrive and flywheel transmission efficiency, Universal joints, types, propeller shaft, differential type of rear and front axles.

UNIT III

Brakes: Servoaction, brake components, Bendix and Gerling system lock-head, Hydraulic brakes, vacuum land air brakes, retarders.

Tyres: Pneumatic tyres, static and rolling proportions, effects of camber, tyre characteristic diagram. Radial and tubeless tyres.

UNIT IV

Steering: Steering geometry, Ackermann and Davis steering mechanisms, steering column, worm and worm wheel, cam and lever steering gears dops and draglink power steering.

Vehicle Dynamics: Longitudinal stability, dynamic stability, directional stability, stability on a curve, effect of braking on the stability.

Electric Car: General discussions on the suitability of electric car.

Learning Resources:

Texts books/References:

1. R. B. Gupta: Automobile Engineering, Satya Prakashan, New Delhi.
2. Kirpal Singh: Automobile Engineering.
3. C. P. Nakra: Basic Automobile Engineering, Dhanpat Rai & Sons, New Delhi.
4. W. H. Crouse: Automotive Mechanics, Tata McGraw Hill.
5. W. H. Crouse: Automotive Transmission and Power Train,McGraw Hill.
6. W. H. Crouse: Automobile Chassis and Body, McGraw Hill.