



**NATIONAL INSTITUTE OF TECHNOLOGY JAMSHEDPUR**  
**JAMSHEDPUR, JHARKHAND – 831014**

(An Institution of National Importance under MHRD, Govt. of India, NEW Delhi)

**Department of Mechanical Engineering**

Course Structure for B.Tech (Hons) Mechanical Engineering – effective for 2018 Batch onwards

First Semester

S. No	Subject Code	Subject Name	L-T-P	Credits
1.	CH1101	Chemistry	3-1-0	4
2.	MA1101	Mathematics-I	3-1-0	4
3.	ME1101	Engineering Mechanics	3-1-0	4
4.	HS1101	English for Communication	3-1-0	4
5.	CS1101	Computer Programming	2-0-2	3
6.	ME1102	Engineering Mechanics Laboratory	0-0-3	2
7.	CH1102	Chemistry Laboratory	0-0-3	2
8.	MF1101	Workshop Practice	0-0-3	2
			Total	25

Second Semester

S. No	Subject Code	Subject Name	L-T-P	Credits
1.	PH1201	Physics	3-1-0	4
2.	MA1202	Mathematics-II	3-1-0	4
3.	EE1201	Basic Electrical and Electronics Engineering	3-1-0	4
4.	CE1201	Environment and Ecology	3-0-0	3
5.	MM1201	Material Science	3-0-0	3
6.	PH1202	Physics Laboratory	0-0-3	2
7.	EE1202	Basic Electrical & Electronics Laboratory	0-0-3	2
8.	ME1203	Engineering Graphics	2-0-2	3
9.		Yoga/ NSS/ NCC/ Life Skills		
			Total	25

Third Semester

S. No	Subject Code	Subject Name	L-T-P	Credits
1.	MA1303	Mathematics-III	3-1-0	4
2.	ME1304	Mechanics of Solids	3-1-0	4
3.	MF1302	Manufacturing Process-I	3-1-0	4
4.	ME1305	Thermodynamics	3-1-0	4
5.	ME1306	Kinematics of Machinery	3-1-0	4
6.	ME1307	Mechanics of Solids Laboratory	0-0-3	2
7.	MF1303	Manufacturing Process-II Laboratory	0-0-3	2
8.	ME1308	Thermodynamics Laboratory	0-0-3	2
			Total	26

#### Fourth Semester

S. No	Subject Code	Subject Name	L-T-P	Credits
1.	MA1404	Numerical Methods and Computational Techniques	3-1-0	4
2.	ME1409	Dynamics of Machinery	3-1-0	4
3.	ME1410	Steam Power System	3-1-0	4
4.	ME1411	Fluid Mechanics	3-1-0	4
5.	HS1402	Introduction to soft skill	2-1-0	3
6.	ME1412	Machine Drawing Lab	0-0-3	2
7.	ME1413	Dynamics of Machinery Laboratory	0-0-3	2
8.	ME1414	Fluid Mechanics Laboratory	0-0-3	2
			Total	25

#### Fifth Semester

S. No	Subject Code	Subject Name	L-T-P	Credits
1.	ME1515	Heat and Mass Transfer	3-1-0	4
2.	ME1516	Vibration and Control	3-1-0	4
3.	MF1504	Manufacturing Process-II	3-1-0	4
4.	HS1503	Industrial Economics	3-0-0	3
5.	ME1517	Design of Machine Elements	3-1-0	4
6.	ME1518	Heat and Mass Transfer Laboratory	0-0-3	2
7.	ME1519	Measurement Laboratory	1-0-3	3
8.	ME1520	Design and Drawing Laboratory	0-0-3	2
			Total	26

#### Sixth Semester

S. No	Subject Code	Subject Name	L-T-P	Credits
1.	ME1621	Fluid Machinery	3-1-0	4
2.	ME1622	Refrigeration and Air conditioning	3-1-0	4
3.	ME1623	Mechanical System Design	3-1-0	4
4.	ME1624	Internal Combustion Engine & Gas Turbine	3-1-0	4
5.	MF1605	Industrial Management	3-0-0	3
6.	ME1625	Fluid Machinery Laboratory	0-0-3	2
7.	ME1626	Applied Thermodynamics Laboratory	0-0-3	2
8.	ME1627	Mechanical System Design Laboratory	0-0-3	2
			Total	25

Seventh Semester

S. No	Subject Code	Subject Name	L-T-P	Credits
1.	ME1728	Computational Mechanics	3-1-0	4
2.	ME1729	Computer Aided Design and Manufacturing	3-1-0	4
3.		Professional Elective-I	3-1-0	4
4.		Professional Elective-II	3-1-0	4
5.		Open Elective-I	3-0-0	3
6.	ME1730	Computational Mechanics Laboratory	0-0-3	2
7.	ME1731	CAD & CAM Laboratory	0-0-3	2
8.	ME1732	Minor Project		2
			Total	25

Eighth Semester

S. No	Subject Code	Subject Name	L-T-P	Credits
1.		Professional Elective-III	3-1-0	4
2.		Professional Elective-IV	3-1-0	4
4.		Open Elective-II	3-0-0	3
5.	ME1833	Major Project		10
			Total	21

**Total Credits: 198**

**Professional Electives to be decided by the department**

1. ME1734: Turbomachinery
2. ME1735: Heat Exchanger Design
3. ME1736: Robotics and its Applications
4. ME1737: Finite Element Method
5. ME 1738:Advanced Thermodynamics
6. ME 1739: Tribology
7. ME 1740: Supply Chain Management
8. ME 1741: Fuels, Combustion and Pollution
9. ME 1742: Total Productive Maintenance and Value Engineering
10. ME 1743: Advanced Energy Conversion systems
11. ME 1844: Machinery Fault Diagnosis and Signal Processing
12. ME 1845: Gas Dynamics and Propulsion
13. ME 1846: Nuclear Power and Safety
14. ME 1847: Polymers and Composites
15. ME 1848: Operation Research
16. ME1849: Automobile Engineering
17. ME1850: Power Plant Engineering
18. ME1851: Mechatronics
19. ME1852: Instrumentation & Control

**Open Electives to be decided by the offering department**

1. CE 1701: Environmental Engineering and Management
2. HS 1704: Organizational Behavior and Industrial Psychology
3. HS 1705: Management Information System
4. ME 1753: Rural Entrepreneurship Development
5. ME 1754: Professional Ethics
6. CE 1702: Continuum Mechanics
7. EC 1801: Soft Computing
8. EE 1802: Artificial Neural Networks
9. EE 1803: Intelligent control
10. ME1855: Green Technologies
11. ME1856: Ancient Indian Science and Technology
12. PH1802: Engineering Applications of Lasers
13. ME1857: Renewable Energy System

# Syllabus of B. Tech. (Hons.), Mechanical Engineering

## FIRST SEMESTER

### **CH1101: Chemistry (3-1-0)**

Thermodynamics: Laws of thermodynamics, system, thermodynamic functions, state of a system, equilibrium, enthalpy, work done in different processes,  $C_p$ ,  $C_v$ , adiabatic PVT relations, Carnot cycle, concept of entropy, Clausius-Clapeyron equation & its applications, Maxwell relations, concept of free energy, chemical potential, Maxwell relations.

Electrochemistry and corrosion: Electrochemical cells, origin of electrode potential, standard potential, Nernst equation, EMF series, rechargeable batteries, Types of corrosion, galvanic series, Cathodic and anodic reactions, differential aeration cells, corrosion prevention methods.

Kinetics & Solution Chemistry: Kinetics of chemical reaction, 1<sup>st</sup>, 2<sup>nd</sup> order reactions, reversible, consecutive and parallel reaction. Steady state approximations, Arrhenius equation, Chain reactions, photo chemical reactions, Solution chemistry and colligative properties, Real and ideal solutions, Diffusion, Osmosis, Osmotic pressure, Lowering of vapor pressure, Elevation in boiling point, Depression of freezing point, Abnormal molecular weight, Degree of association and dissociation.

Chemical Bonding & Co-ordination chemistry: Bonding models in inorganic chemistry, Molecular orbital theory (MOT), Valence bond theory (VBT), and crystal field theory (CFT), Co-ordination chemistry: Co-ordination number, Chelate effect, EAN rule, splitting of 'd' orbital in octahedral, tetrahedral and square planar complex, Example of Bio-inorganic & metals in biological systems

Industrial chemistry: Polymers: types of polymer, polymerization, applications, important synthetic polymers. Refractory & ceramics material: Classification, manufacturing and Applications, Water treatment, Air pollution and Control techniques

### **MA1101: Mathematics-I (3-1-0)**

Successive differentiation, Leibnitz theorem, Taylor's and Maclaurin's theorem with remainders, Indeterminate forms, Concavity and Convexity of a curve, Points of inflexion, Asymptotes and Curvature.

Limit, Continuity and Differentiability of function of several variables, partial derivatives and their geometrical interpretation, Directional derivatives of composite and implicit functions.

Euler's theorem on homogeneous functions, Taylor's expansion of functions of several variables, maxima and minima of functions of several variables, Lagrange's method of multipliers.

First order differential equations : Exact, Linear and Bernoulli's form, Second order differential equations with constant coefficients, Method of undetermined coefficients, variation of parameters, Euler's equations, system of differential equations. Review of limit, continuity, differentiability of functions of complex variables, Analyticity of functions, Cauchy- Riemann equations, Harmonic functions.

Reduction formula for indefinite and definite integrals of type  $\sin^n x$ ,  $\cos^n x$ ,  $\sin^m x \cos^n x$  and their evaluation.

### **ME1101: Engineering Mechanics (3-1-0)**

Fundamental principles of mechanics: Idealization of mechanics, Laws of mechanics, Force vector in 2D & 3D, Direction cosines, Dot and vector product, Moment of a force, Component of moment an axis, Couple & Couple moment, Force system, Reduction of complex force system to simplest form, Equivalent force system, Wrench.

Equilibrium: Definition, Conditions & Criteria of equilibrium, Free body diagram, 2 D & 3D problems on engineering applications. Plane Truss: Simple truss, Idealization of plane truss, Methods of sections & Joints.

Friction: Coulomb's law of dry friction, Roller, wedge & belt friction, Screw jack.

Properties of Sections: Centroid, First moment of area, Theorems of Pappus and Guldinus, Second moment of area, Moment and Product of inertia of plane areas, Transfer Theorems, Polar moment of inertia, Principal axes, Mass moment of inertia.

Kinematics and kinetics of a particle: Types of motion, Rectilinear & curvilinear translation, Relative velocity and relative acceleration, Dependent motion, kinematics w.r.t. a moving frame of reference, Kinematics in normal & tangential component & polar coordinates, Kinetics of particle, D'Alembert's principle, Principle of work & energy, Principle of Impulse & momentum, Collision of two bodies, Central & oblique impact.

Kinematics and Kinetics of rigid body: Kinematics of rotation, Non-Centroidal rotation Plane motion, Instantaneous centre of rotation, D'Alembert's principle, Principle of work & energy & principle of impulse-momentum of rigid body.

Axial force, shear and bending moment: Concept of Internal forces, Relation between axial force, shear force and bending, Shear force and bending moment diagram, Summation method and Singularity function.

### **HS1101: English for Communication (3-1-0)**

Art of communication: Basic grammatical concept, Elementary theories of phonetics, sound of English, Mechanics of sound production, Rules of phonetics with examples, reading, listening and advanced writing skills.

Business Letters, effective speaking (interactive sessions). Essay, poems and stories; The world is too with us: William words worth, the scientific point of view: JBS Haldane, Strange Meeting: Wilfred Owen, If: Rudyard Kipling, The Necklace: G D Maupassant, Piano: D H Lawrence  
Basic concepts in Communications: Nature of communication, Types of communication, Process of communication, Barriers to communication, Characteristics of successful communication, Informal communication: Chat, the grapevine, Rumour. Merits and limitations.

### **CS1101: Computer Programming (2-0-2)**

Digital computer fundamentals: Historical perspective, Early computers, the von Neumann architecture. Pseudo code, and Flowchart. Memory, Variables, Values, Instructions, Programs. Assembly language, High level language, Compiler, Assembler, Operating Systems. Binary and other number system representations and conversion between them.

The C language. Phases of developing a running computer program in C.

Data Concepts in C: Constants, Variables, Expressions, Operators, and operator precedence in C. Managing input and output statements, Sequential control statements, Decision making statements (If-Else constructs), Loop control statements (While construct, Do While construct, For construct).

Different basic data types and their sizes. One-dimensional Arrays: Declaration and Initialization, Two-dimensional Arrays: Declaration and initialization, Multidimensional Arrays. String variables, Reading and writing strings, Arithmetic operations on characters, Putting strings together, Comparison of two strings.

Functions: The prototype declaration, Function definition.

Function call: Passing arguments to a function (by value, by reference). Scope of variables.

Recursive function calls, Tail recursion, Tree of recursion.

Sorting problems: Selection sort, Insertion sort. Sorting in multidimensional arrays. Sorting in arrays.

Search problems: Linear search and binary search. Recursive and iterative formulations.

Pointers: Declaring and dereferencing pointer variables. Pointer arithmetic. Accessing arrays through pointers. Pointer types, Pointer and strings.

Structures in C: Motivation, examples, declaration, and use. Operations on structures. Passing structures as function arguments. Type defining structures.

Self-referential structures, Dynamic data structures, Linked lists with examples.

File operations in C: Input, output, and error streams. Opening, closing, and reading from files.

Searching through files using functions such as fseek(), ftell(), and rewind(). Programming for command line arguments.

## **SECOND SEMESTER**

### **PH1201: Physics (3-1-0)**

Electromagnetic Waves: Introduction to del operator, gradient of a scalar, divergence and curl of vectors, Gauss divergence theorem, Stake's theorem, equation of continuity, Introduction to displacement current, Maxwell's Equations, Wave Equation, Plane electromagnetic waves, Poynting's Theorem, Electromagnetic Boundary Conditions, Reflection and Refraction.

Polarization: Unpolarised light, Production of plane polarized light by grid polarizer, Polarization by reflection and Brewster's Law, Malus' Law, Double refraction, quarter wave plate, half wave plate, Production and analysis of various kinds of polarized lights.

Magnetic properties of matter: Dia, Para and Ferromagnetic materials, Magnetic domains, Magnetic Hysteresis, Calculation of Hysteresis loss, Three magnetic vectors, Magnetic circuit.

Interaction of Radiation with Matter: Compton Effect and pair production (qualitative).

Laser: Coherent waves and interference, Temporal and Spatial coherence, Metastable states, Optical pumping, Population inversion, spontaneous and stimulated emission, Einstein's A and B coefficients, He-Ne laser.

Wave Mechanics: Failure of classical physics, Qualitative review of relevant experiments, de Broglie waves, Phase and Group velocities, Davisson and Germer experiment, Uncertainty principle, wave function and Schrodinger equation, probability interpretation, Application of time-independent Schrodinger equation - Particle in a box.



**MA1202: Mathematics-II (3-1-0)**

Linear dependence and independence, rank and inverse of a matrix, solution of algebraic equations-consistency conditions. Eigen values and Eigen vectors, Hermitian and skew Hermitian matrices.

Convergence of improper integrals, test of convergence, Beta and Gamma functions elementary properties, differentiation under the integral sign.

Series solution, Frobenius Method, Legendre's and Bessel's differential equation, Recurrence formula, Generating functions, orthogonality.

Rectification, double and triple integrals, computations of surfaces and volumes, change of variables in double integrals, Jacobians of transformations.

Scalar and vector fields, level surfaces, directional derivative, Gradient, Divergence, Curl, Laplacian, line and surface integrals, theorems of Green, Gauss and Stokes.

Finite differences, Newton's forward and backward interpolation formulae, Central difference interpolation. Lagrange's interpolation, Trapezoidal rule and Simpson's  $1/3^{\text{rd}}$  rule of integration. Solution of polynomial and transcendental equations-bisection method, Newton-Raphson method and Regula-falsi method

**EE1201: Basic Electrical and Electronics Engineering (3-1-0)**

Electrical circuit: D.C circuit: voltage and current sources, mesh current method, nodal voltage method. Delta star and Star-delta transformation, Thevenin's theorem, super position theorem, Norton's theorem, maximum power transfer theorem

A.C. Circuit: single phase and three phase A.C phasor representation. Electrical Circuit Element's R-L-C, their physical origin based on electromagnetic and electrostatics, R-L, R-C, R-L-C series circuits, sinusoidal steady state: power factor, active and reactive power, parallel and series circuits. Delta and star connections, line and phase quantities, single and three phase power measurement

A.C Fundamentals, Active, Reactive and Apparent power. Basics of transformers, D.C Machines and Induction motor.

Semiconductor devices: construction, working and V-I characteristics of diode, zener diode, LED, photodiodes, SCR, Diac, Triac and their applications.

Transistors: BJT, FET, MOSFET, Construction, working, type of configuration, V-I characteristics, biasing transistor circuits-fixed bias, emitter bias, feedback bias, voltage divider bias, transistor as an amplifier

Operational amplifier: introduction, parameters application-inverting, non-inverting amplifier unity follower, integrator, differentiator, summing circuit. Introduction of logic gates.

**CE1201: Environment and Ecology (3-0-0)**

Ecosystem: Concept of ecosystem. Structure and function of an ecosystem, Producers, consumers and decomposers. Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem. Grassland ecosystem, desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity and its conservation: Introduction-Definition: Genetic, species and ecosystem diversity, Bio-geographical classification of India, Value of diversity: Consumptive use,

productive us, social, ethical, aesthetic and option values, Biodiversity at global, national and local levels, India as a mega-diversity nation, Hot space of biodiversity, threats to biodiversity: Habitat loss, poaching of wildlife., man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Environment pollution: Causes, effects and control measures of: (a) Air Pollution, (b) Water pollution, (c) Soil pollution, (d) Marine pollution. (e) Noise pollution. (f) Thermal pollution, (g) nuclear pollution, Solid waste management: causes effects and control measures of urban and industrial wastes, role of individual in prevention of pollution, Pollution case studies, and Disaster management: floods, earthquake, cyclone and landslides.

Solid issues and the environment: From understandable to sustainable development, urban problems related to energy, Water conservation, rain water harvesting. Watershed management, resettlement and rehabilitation of people: its problems and concerns, case studies. Environmental ethics: issues and possible solutions. Climate change, global warning, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies, Wasteland reclamation, consumerism and waste products, Environment protection act. Air (prevention and control of pollution) act, Water (prevention and control of pollution) act, Wild life protection act, Forest conservation act. Issues involved in enforcement of environmental legislation, public awareness.

### **MM1201: Material Science (3-0-0)**

Introduction: Types of materials from structure to property, Crystal structure: Bravais lattices, Lattice direction and planes. Crystal Imperfections: point, line and planar defect.

Deformation of material: Recovery recrystallization and grain growth, Mechanical properties of materials: Tensile, Impact, Fatigue and Creep of metals.

Electron theory of Metals: Free electron theory, Zone theory, The dependence of the energies on the wave number, The density of state curves, Conductors and insulators, Semiconductors, Dielectric behavior, Ferro-electricity, Piezoelectricity, Magnetism,

Principles of solidification: Nucleation and growth, Homogeneous and heterogeneous nucleation, Phase Diagrams: Phase rule, isomorphous, eutectic, peritectic, eutectoid and peritectoid transformation, Fe-cementite diagram; Heat Treatment of Steel: TTT diagram, different heat treatment process: Annealing, normalizing and Hardening, Hardenability.

Selection of Engineering Materials: Common engineering materials including metals and alloys, ceramics composites, polymers.

### **ME1203 Engineering Graphics (2-0-2)**

Introduction to basic engineering drawing, instruments, sheet layouts, lines, lettering, dimensioning

Projection of points and lines.

Projection of Solids.

Section of solids.

Development of surfaces of solids.

Isometric projections

Orthographic projections. Use of CAD software to draw plan, elevation and other views of different objects.

### **THIRD SEMESTER**

#### **MA1303 Mathematics –III (3-1-0)**

Laplace Transform and its properties, Unit step functions, Dirac delta function, , Periodic functions, Inverse Laplace transform, Convolution theorem, Evaluation of integrals by L.T., Solution of Boundary value problems

Fourier Series and its convergence, Fourier coefficients, Dirichlet's Condition, Change of interval, Half-range series, Complex form of Fourier Series

Fourier integral, Formula, Fourier Transform, Fourier sine and cosine transform, Linearity, Scaling, Frequency shifting and time shifting properties, self reciprocity of Fourier transform, Convolution theorem, Application to boundary value problems

Z-Transform and its properties, initial and final value theorem, Convolution theorem, Evaluation of Inverse Z-transform, Difference equation and its application

Line integration, Cauchy theorem, Cauchy Integral formula, Power series, Taylor's and Laurent's series, singularity and residues

Discrete and continuous random variable, cumulative distribution function, Probability mass function, Probability density function, Mathematical expectation, Mean variance, Moment generating function, Binomial Poisson and Normal Distribution

#### **ME 1304 Mechanics of Solids (3-1-0)**

Concept of Stress - Tension and Compression- pure shear – uni-axial stress and strain, Hooke's Law, Stress-strain diagrams for brittle and ductile materials, elastic constant, Relation between elastic constants - Strain energy in tension and compression - Impact loading, Statically Indeterminate structure, Thermal stress

Biaxial stress and strain, stress at a point, stress transformation, analysis of strain, strain displacement relation, strain transformation, strain measurement, Principal stress and strains, Mohr's Circle of stress and strain

Theory of Simple Bending: Assumptions - Bending stresses in beams - Efficiency of various cross sections - Composite beams. Strain energy in bending, Statically Indeterminate problem. Unsymmetrical Bending, bending of curved bars.

Shear Stress Distribution: Flexural shear stress distribution in different cross sections of beams. Shear Centre.

Torsion of Circular cross sections: Theory of pure torsion - transmission of power through solid and hollow circular shafts. Compound shaft, Tapered shaft, statically indeterminate problem, strain energy in torsion, closed coiled spring -Combined Loading: Bending, axial, shear and torsion.

Deflection of Beams: Slope and deflection of beams - Double Integration method – Macaulay's method – moment area method- conjugate beam method-strain energy method.

Thin and Thick cylinders and Spheres: Stresses in Thin shell, Thick shell, Compound cylinders

Introduction to Theory of Failure, Euler's theory of long column, Rankin-Gordon formula, Empirical Formulae, Eccentrically loaded columns.

#### **MF1302 Manufacturing Processes – I (3-1-0)**

Introduction to metal casting processes: Casting terms, Sand mould making procedure, Composition of moulding sand and its different properties, Advantages and limitations of casting processes, Application of casting process.

Patterns, Materials, Allowances in patterns, Types of patterns, Pattern color code, Gating and riser design, Melting furnaces, Casting defects.

Special casting techniques - Shell mould casting, Investment casting, Die casting and its variants, Centrifugal casting and its variants, Continuous casting.

Introduction to Metal forming processes: Classification of metal forming processes, Plastic deformation and Yield criteria, Hot and Cold working, Forging, Rolling, Extrusion, Wire drawing, Sheet metal operations.

Classification of joining processes, Types of joints and welding positions, Welding heat sources and their characteristics.

Various welding processes: Electric arc welding, Gas welding, Resistance welding, Solid state welding processes, Electron beam welding and Laser beam welding, Metallurgical characteristics of welded joints, Welding defects, Weld testing and Inspection.

### **ME1305: Thermodynamics (3-1-0)**

SI Unit, Definitions & Concepts: System, Property, Energy, Thermodynamic Equilibrium, Work interaction & various modes of work, Heat, State Postulate; Zeroth Law of Thermodynamics, Temperature Scale.

Thermodynamic Properties of Fluids: Pure substance, Phase of substances, Molecular models of matter, Phase change processes in pure substance, Graphical representation of phase change processes, Steam Table

Equation of State, van der Waals Equation of State; Law of corresponding states, Compressibility chart, Pressure-volume; Temperature-volume and Phase diagrams; Mollier diagram and Steam tables.

First Law of Thermodynamics for Non-flow process: Application of I Law for elementary processes, I Law analysis of Non-flow processes

First Law of Thermodynamics for flow process: Application of I Law of Thermodynamics for Flow Process-Steady state, steady flow processes, Throttling process; Transient Flow Processes, Charging & discharging of tanks.

II Law of Thermodynamics: Limitations of the I Law of Thermodynamics, Heat Engine, Heat Pump/Refrigerator. II Law of Thermodynamics – Kelvin Planck and Clausius statements & their equivalence. Reversible & irreversible processes, Criterion of reversibility, Carnot cycle & Carnot principles, Applications of II Law of Thermodynamics: Thermodynamic Temperature scale, Clausius inequality, Entropy, Calculations of entropy change, Principle of entropy increase, T-S diagram, II Law analysis of Control volume.

Thermodynamic Potentials: Maxwell relations: Available energy, Availability; Second law efficiency. Thermodynamic relations, Jacobian methods, Clapeyron and Kirchoff equations, Phase rule.

Power Cycles: Rankine cycle – Ideal, Reheat and Regenerative Rankine cycles.

Gas Power Cycles: Gas Power Cycles; Otto cycle, Diesel cycle, Dual cycle and Brayton cycle.

Refrigeration Cycles: Vapor compression refrigeration, Absorption refrigeration and Gas

refrigeration Cycles.

### **ME1306: Kinematics of Machinery (3-1-0)**

Basic Kinematics concept, Links, Kinematic pairs, Kinematic chains, Mechanisms and inversions, Straight line motion mechanisms, Degree of freedom, Grashoff's Criterion.

Velocity and acceleration in mechanisms, Instantaneous centre of rotation, Aronhold-Kennedy theorem of three centres, Velocity and acceleration diagram, acceleration centres.

Belt, chain and rope drive, Transmission of power through friction clutch, Shoe brakes, Band and block brakes. Law of Gearing, Basic terminology, Geometric and kinematics characteristics of involute and cycloidal tooth profiles, Undercutting and interference, Gear trains, simple, compound and epicyclic gear trains.

Governors, Watt, Porter, Proell and Hartnell governors, Governor effort and power, Sensitivity and Isochronisms.

CAM Profile

## **FOURTH SEMESTER**

### **MA 1404: Numerical Method & Computational Technique**

Number systems and errors, floating point arithmetic, Loss of significance and error propagation, condition and instability, Computational methods for error estimation. Solution of nonlinear equations: Review of Bisection method, Secant and Regular- False method, Newton- Raphson method and their convergence, Fixed point iteration method and its convergence, Muller method. Matrices and system of linear equations: Gauss elimination method and its pivoting strategy, Method of factorization, Inverse of matrix using Gauss elimination method, Error analysis of direct method, Jacobi's iterative method, Gauss- Seidel iterative method, Eigen value problems: Power method and Jacobi method.

Polynomial Interpolation and approximation: Finite difference operator: Forward difference, Backward difference operator, Central difference operator. Error propagation in difference table, Interpolating polynomials using Finite differences. Newton Forward and Backward difference interpolations, Gauss, Stirling and Bessel interpolations. Lagrange's interpolations, Newton Divided difference interpolation. Uniform approximation by polynomials. Least Square approximation by polynomials, Piecewise polynomial approximation

Differentiation and Integration: Numerical differentiation, Maxima and minima of tabulated functions. Numerical Integration: Quadrature formula, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule and their error estimations, Gaussian Integration method, Romberg integration.

Numerical solution to ordinary and partial differential equations: Taylor's series method, Euler's method. Predictor Corrector method, Runge- Kutta second and fourth order methods, local and global truncation errors, Stability of numerical methods. Classification of partial differential equations of second order, Finite difference approximation to derivatives, Solution of Parabolic and Elliptic equation

### **ME1409: Dynamics of Machinery (3-1-0)**

Kinematics analysis of planar mechanism: mobility analysis and range of movements. Dimensional synthesis of planar mechanism, three positions synthesis for function generation, path generation and rigid body guidance, dead centre problem, branch and order defects. Dynamics of plane motion of rigid bodies, dynamically equivalent mass system, forces in mechanism and machine, friction in link mechanism.

Displacement and velocity and acceleration of piston in a slider-crank mechanism, flywheels.

Synthesis of Cams, Synthesis of Flywheels.

Balancing of inertia forces of revolving and reciprocating masses, Synthesis of Cams.

Fundamental of System- zero, first and second order system- application to free vibration.

Transfer Function- application to SDOF forced vibration, whirling of rotating shaft and critical speeds of shafts, vibration isolation, Transfer functions of some standard motion sensors like accelerometer, seismometer and velocity pick up.

### **ME1410: Steam Power System (3-1-0)**

Review of Thermodynamics, Vapour Power cycles, Performance of Vapour Power cycles, Binary Vapour Cycle, Combined Cycle and Co-generation,

Steam Generators, Fire Tube Boilers, Water Tube Boilers, Boiler Mountings and Accessories, High Pressure Boilers. Draught, Performance of Boilers, Combustion of Fuel.

Nozzles and Diffusers-Theory and Design, Efficiency and Critical Pressure, General Relationship and supersaturated Flow.

Steam Turbines, Compounding of Steam Turbines, Impulse Steam Turbines, Impulse Steam Turbine Performance. Impulse-Reaction Steam Turbines, Impulse-Reaction Turbine Performance, Energy Losses in Steam Turbines ,

Condensers and cooling tower: Theory and Design

### **ME 1411 :Fluid Mechanics (3-1-0)**

Introduction: Fluid and its properties, Fluid pressure, Hydrostatic Law, Pressure measurement; Manometers and Pressure Gauges.

Fluid Kinematics: Lagrangian and Eulerian approaches of describing fluid motion. Types of fluid flow, Velocity and acceleration, Streamline and stream-tube, Equation of continuity, Types of motion, Velocity potential function and Stream function.

Fluid Dynamics: Euler's equation of motion, Bernoulli's equation and its practical applications, Pitot tube, Venturimeter, Orificemeter. Impulse-Momentum Equation and Moment of momentum equation Free and forced vortex flows.

Flow in pipes and ducts ; Ideal and real flows, Laminar flow through circular pipe; velocity and shear stress distribution,Hagen- Poiseuille equation,

Turbulent Flow,shear stresses, Karman-Prandtl velocity distribution law, velocity distribution in smooth and rough pipes, energy losses in pipes, Minor and major energy losses, Darcy-Weisbach equation, HGL and TEL, pipes in series and in parallel, Equivalent pipe.

Measurements of fluid flow rates; Orifices & Mouth pieces, Notches and Weirs.

Drag and lift Forces on aerofoil. Dimensional Analysis and Model Testing: Rayleigh's method and Buckingham pi- Theorem method of Dimensional Analysis. Non- dimensional numbers and its significance, Theory of similarity, Model Laws.

**HS1402: Introduction to Soft Skill (2-1-0)**

Speech skills; Rules of Accent, Intonation, Group Discussions and mock interviews (interactive sessions)

Formal Communication: Curriculum Vitae, Minutes, Report Writing

Presentation Skills, Negotiation Skills, Non- verbal Communication and Body Language

Multicultural Communication, Time management, Decision making Emotional Intelligence

**FIFTH SEMESTER****ME1515: Heat and Mass Transfer (3-1-0)**

Introduction: basic concepts and models, Relationship to thermodynamics. Conduction mechanism: Fourier's generation conduction equation in 3-D, 1-D study state conduction with heat generation, Composite plane wall and cylinders, Thermal resistance network, Critical Thickness of Insulations, Extended surface heat transfer

2-D steady state conduction: Solutions for simple boundary conditions, Un-steady heat conduction: Lumped parameters systems, semi-infinite wall with convection boundary conditions, use of Heisler chart.

Convection: Review of hydrodynamics equations of boundary layer theory, velocity and thermal boundary layers, laminar boundary layer analysis on flat plates. Fully developed heat transfer through a smooth pipes, relation between fluid friction and heat transfer, turbulent boundary layers, forced convection correlations.

Free convection: Laminar free convection on a vertical flat plate, empirical co-relations. Boiling and condensation: Mechanism, Laminar film condensation on a vertical plate. Heat Exchangers: Types analysis, LMTD, effectiveness-NTU method.

Radiation: Physical mechanism, radiation properties, black body radiation, grey body, spectra dependence of radiation properties, Kirchoff's Law, Wien's displacement law, View factor, radiation exchange between infinite planes, and between grey bodies, radiation shields, reradiating surface and 3- surface encloses, network representations. Fick's law of diffusion coefficient, analogy between heat and mass transfer.

**ME1516: Vibration and Control (3-1-0)**

Fundamentals & Basic Concept of vibration, Natural frequency, Forced vibration, Resonance Degree of freedom, single DOF, 2-DOF and multi degree of freedom systems, Analysis of undamped free vibrations, Damped free vibration, effect of damping on vibration, different types of damping. Harmonically excited vibration (Forced vibration).

Force and displacement transmissibility, Vibration Isolation, Design of vibration isolators and absorbers, Vibration measuring instruments.

Torsional vibration, Basics of acoustics, Solution of 1- and 3-D wave equations.

Principle of noise control, Introduction to active noise and vibration control, Sound control material: absorbers, barriers, silencers and damping materials.

Feedback System- Block diagram and signal flow representation, state space model. Introduction to PID controller, Application to common control system.

Stability and analysis of dynamical System- Routh- Hurwitz stability criterion, relative stability, Root- locus method, Bode diagram, Nyquist stability criterion, PI, PD and PID controllers; lead, lag and lag-lead compensators, Application to common engineering problems.

### **MF1504:Manufacturing Processes-II (3-1-0)**

Introduction to machining and cutting tool geometry: Role and position of machining in manufacturing routes, basic machining processes

Cutting tool geometry: Purpose of knowing tool geometry; Different conventions or methods of defining tool geometry; Geometry of a single point turning tool; milling cutters and twist drill; Conversion of tool angles of a single point turning tool defined according to different convention by graphical method

Mechanism of machining: Chip formation, mechanism in ductile and brittle materials; Geometry and characteristics of continuous chip formation: chip reduction coefficient and cutting ratio, shear angle, cutting strain, built-up edge formation, classification of chips, shear plane and shear zone theories, orthogonal and oblique cutting, chip tool contact length; Brief overview of chip formation mechanism in milling and drilling.

Mechanics of machining: Purpose of knowing mechanics of machining; Development and action of cutting force; Purpose of estimation of cutting force; Analysis of cutting forces in orthogonal machining using Merchant's circle diagram (MCD); Working principle of measurement of cutting forces by dynamometers; Dynamometers for estimating cutting forces in turning, milling, drilling and grinding

Cutting temperature and tool life; Cutting temperature: Locations and causes of heat generation in machining; Purpose of studying and estimation of cutting temperature; Analytical methods of evaluation of cutting temperature; Measurement of cutting temperature; Role of variation of different geometrical and process parameters on cutting temperature; Control of cutting temperature and cutting fluid application Tool life: Major causes and modes of failure of cutting tools; Mechanisms of cutting tool wear; Geometry and measurement of cutting tool wear; Definition and evaluation of tool life; Taylor's tool life equation; Role of different machining parameters on tool life; Assessment and improvement of cutting tool materials

Grinding, economics of machining and measurement of machined parts: Grinding: Introduction and specification of grinding processes, Description: spark in, steady state and spark out zone; Specification of grinding wheel, Economics of machining: Estimation of machining time and cost; Optimization of cutting speed to minimize machining time and cost

Surface roughness and Surface integrity: Basic principle of measuring surface roughness, Definitions of surface roughness parameters:  $R_a$ ,  $R_z$ ,  $R_{max}$ ; Brief introduction to the features used in assessing surface integrity

Introduction to machine tools: Definition of machine tool; Concept of generatrix and directrix; Major classification of conventional machine tools; Schematics, classifications and specifications of centre lathe, milling and drilling machine

Kinematic systems of common machine tools, Kinematic systems of centre lathe, milling, drilling, shaping, planing and slotting machines

CNC machine tools: Importance and basic concepts; Introduction to programming: Preparatory and miscellaneous codes, Miscellaneous: Capstan and turret lathe; Jigs and fixture; Thread cutting in lathe; Gear milling: simple, compound and differential indexing.



**HS 1503: Industrial Economics (3-0-0)**

Engineering Economy: Equivalence, time value, present value and annual equivalent cost.

Replacement analysis, rate of return evaluation of public activities, generation and evaluation of alternatives in engineering situations, projects, replacement.

Depreciation, bath-tub curve, value engineering.

Accounting: Financial statements, double entry bookkeeping, inventory control.

Costing: Cost concept, material, labour and overhead costs, overhead allocations and absorption: Introduction to job costing, process costing, marginal costing, standard costing, relevant costs for decision making, cost control and cost reduction, measurement and determinants of market power, market power and public policy.

### **ME1517: Design of Machine Elements (3-1-0)**

Introduction: Engineering materials and their properties, manufacturing considerations in machine design. Simple stresses in machine parts, Torsional and bending stresses, Dynamic loads, different couplings.

Design of pressure vessels and pipe joints. Design of keys, couplings, shafts, levers, columns, studs, and power screw, cotter joint, knuckle joints.

Design of Belt drives, pulleys, springs, clutches and brakes.

## **SIXTH SEMESTER**

### **ME1621: Fluid Machinery (3-1-0)**

Introduction: Classification of Fluid Machineries. Dynamic Action of Fluid Jet: Impact of fluid-jet, Impact of fluid jet on fixed and moving flat plates, impact of jet on fixed and moving curved vanes, flow over radial vanes. Euler's fundamental equation, Hydraulic Turbines: Introduction, classification, Impulse Turbine: constructional details, velocity triangles, power and efficiency calculations. Governing of Turbines.

Reaction Turbines: constructional details, working principle, velocity triangles, power and efficiency calculations, degree of reaction, Draft tube, cavitations, performance characteristic curves. Unit and specific quantities, Models relationship, selection of hydraulic turbines.

Positive Displacement Pumps: Reciprocating Pump: Construction and working principle, Slip, Indicator diagram, Accelerating and frictional heads, theory of air vessel, gear oil pump Fluid Systems -constructional details, principle of operation and usages of Hydraulic ram, Hydraulic Accumulator, Fluid coupling and Torque converter.

Roto-dynamic Pumps: Introduction, classification, centrifugal pump: main components, working principle, velocity triangles, effect of shape of blade, specific speed, heads, power and efficiency calculations, minimum starting speed, multistage pumps, performance characteristics, comparison with reciprocating pump.

Air Compressor: Introduction to fans, Blower and Compressor Reciprocating compressor: Introduction, P-V diagram, calculation of isothermal and adiabatic work and efficiency, volumetric efficiency. Effect of clearance, multistage compression, intercooling. Centrifugal compressor: Construction and working static and total heads velocity triangles, slip factor, losses and efficiencies, performance characteristics.

### **ME1622: Refrigeration and Air Conditioning (3-1-0)**

Brief history of refrigeration, refrigerants and environmental issues, reverse Carnot cycle, actual and theoretical cycle

Compressor volumetric efficiency, effect of suction and discharge pressure, sub-cooling and super heating on compressor performance, compound compression with inter cooling, cascading.

Refrigerants: their suitability, charging and leak detection, Ammonia and Li-Br, vapour-absorption systems, air cycle refrigeration, air craft cooling, cryogenics systems, Linde and Claude cycles-applications,

Psychometric processes, Evaporative coolers, cooling towers, coils, Chemical dehumidification, elements of human comfort air conditioning.

### **ME 1623: Mechanical System Design (3-1-0)**

Design of Flywheel and hydraulic press.

Bearing: types and selection, Design of journal, ball, and roller bearings, bearing life, lubrication, sealing and mountings. Hydrodynamic theory of lubrication. Design of bearings using design charts,

Design of gears, gear boxes, chain drives.

Design of I. C. Engine parts: Cylinder, trunk piston, connecting rod, crank shaft and valve gears.

Design of centrifugal pump.

### **ME1624: Internal Combustion Engine & Gas Turbine (3-1-0)**

Introduction, classification, two stroke four stroke (SI and CI) engines, engine parts, engine working principle and valve timing diagram

Engine performance test: purpose and types, measurement of power, Engine system & performance parameters evaluation, theory of combustion, principle of combustion, S.I & C.I. Engine combustion process & parameter & their dependence on engine variables and operating parameters.

Combustion: adiabatic flame temperature, combustion processes & combustion chambers for SI and CI engines, pollutant formation and control, effect of engine variables on combustion processes, knocking in SI & CI engines, petroleum based fuels, gasoline & diesel fuel and their properties, blending, knock rating of engine fuels, Pollutant Formation & Control

Principle, simple, open gas turbine cycle, effect of operating variables on thermal efficiency, regenerative and reheat cycles, gas turbine applications, closed cycle gas turbine, Combined cycle, Gas turbine based-hybrid cycles

### **MF1606: Industrial Management (3-0-0)**

Inventory management and function model (deterministic) and price break up, Work study, Motion study, Flow process Chart. Motion economy therblige.

Man machine chart, time study, work measurement technique, performance rating, standard time, work sampling, ergonomics,

Sampling inspection, acceptance sampling plans, control charts of variables, operating characteristics curves.

Transportation and assignments models, linear programming, simplex method, queuing model (single channel)

CPM, PERT, cost crashing of network, new management concept, TQM, JIT, TPM, six sigma, maintenance management.

## **SEVENTH SEMESTER**

### **ME1728: Computational Mechanics (3-1-0)**

A brief overview of the basic conservation equations for fluid flow and heat transfer, classification of partial differential equations and pertinent physical behavior of parabolic, elliptic and hyperbolic equations, role of characteristic equations

Common method of discretisation; an overview of finite difference, finite element and finite volume methods. Numerical solution of parabolic partial differential equations using finite difference and finite volume methods: explicit and implicit scheme, consistency, stability and convergence.

The finite volume method of discretisation for diffusion problems; one dimensional steady diffusion problems, specification of interface diffusivity, source-term linearization. Discretisation of transient one-dimensional diffusion problem. Discretisation for multi dimensional diffusion problems.

Solution of discretised equations using point and line-iterations, strongly implicit methods, convection diffusion problems, Central difference, upwind, exponential, hybrid and power law schemes, QUICK concept of false diffusion.

Numerical solution of the Navier–stokes system for incompressible flows; stream function vorticity and artificial compressibility methods. Requirement of staggered grid. MAC, SIMPLE, SIMPLEC and SIMPLER Algorithms.

### **ME1729: Computer Aided Design & Manufacturing (3-1-0)**

Introduction- Concept of CAD/CAM, computer system, Hardware in computer Aided Design System.

Product Cycle, computer aided design system, transformation, geometrical modeling, draft Applications

CAD/CAM techniques to finite element data preparation, concept of data structures, Software Portability. Automation: CAM, NC, CNC, DNC, CIM, Part programming.

## **EIGHTH SEMESTER**

### **Professional Electives**

#### **ME1734: Turbo machinery (3-1-0)**

Axial flow compressor: Flow through cascades, terminology, flow separation, radial equilibrium theory, actuator disc theory, effect of tip clearance, secondary flow performance characteristics, surging and installing.

Axial flow turbine: vortex theory, blade design, cooling of turbine blades, performance

characteristics, tip clearance losses, profile losses, secondary flow loss, annulus loss, limiting factor in turbine design.

**ME1735: Heat Exchanger Design (3-1-0)**

Heat exchangers: types and construction, heat and fluid flow fundamentals.

General design consideration and approaches, computer aided design, cost estimation, optimum design.

Design of single phase, liquid to liquid, liquid to gas and gas to gas heat exchangers, design of steam generators and condensers.

Design of heat exchangers for liquid metals and molten salts. Radiative heat exchangers, cooling tower

**ME 1736: Robotics and Robot Applications (3-1-0)**

History of development of industrial robots, Fields of application and future scope, Anatomy and structural design of robot, manipulation, arm geometry, drives and control (Hardware) for motions. End Effectors and grippers pickups etc.

Matching robots to the working place and conditions, interlock and sequence control, reliability maintenance and safety of robots system, application studies in manufacturing processes, e.g. Casting, Welding, machine tools, machining, heat treatment and nuclear power stations, etc.

Synthesis and evolution of geometrical configurations, robot economics, educating, programming and control of robots.

**ME1737: Finite Element Method (3-1-0)**

Introduction to Finite Element Methods, general descriptions, concept of finite elements: discretization and interpolation function, steps of finite element analysis's procedure.

Calculus of Variation: Function and functionals, Euler Lagrange equation, Boundary conditions, determination of functionals for plane and axisymmetric elastic problems, heat conduction problems, plates and shells problems.

Finite elements: One-two and three-dimensional elements, axi-symmetric elements: generalised: local, global and natural co-ordinate systems.

Iso-parametric, interpolation function, field variable model for displacement and temperature. Direct, variational and Galerikan Methods.

Equation of single elements and assembly of elements and solutions. Application to plane and axi• symmetric elastic problems, heat conduction, plates and shells problems.

**ME1738: Advanced Thermodynamics (3-1-0)**

Review of basic thermodynamics: laws of thermodynamics, entropy, and entropy balance for closed and open systems.

Exergy: Concept of reversible work & irreversibility, second law efficiency, exergy change of a system: closed and open system, exergy transfer by heat, work and mass, exergy destruction, exergy balance in closed and open system; Exergy and analysis of industrial system- power system and refrigeration system.

Cycle analysis and optimization; Regenerative reheat Rankine cycle and Brayton cycle, combined cycle power plants, multi-stage refrigeration system.

Thermodynamic optimization of irreversible system: system Finite time thermodynamics principles, optimization studies of various thermal systems, Minimization of entropy generation principle.

Properties of Gas Mixtures; Equation of state and properties of ideal gas mixtures; Change in entropy on mixing; Partial model properties for non-ideal gas mixtures; Equations of state, Thermodynamics of reactive systems: Conditions of equilibrium of a multicomponent system; Second law applied to a reactive system; condition for reaction equilibrium.

### **ME1739: Tribology (3-1-0)**

Definition of Tribology, Economic aspects of Tribology (lubrication, friction and wear).

Basic equations of the theory of lubrication, its solution for idealized and finite bearings.

Calculations of the flow rate.

Thermal equilibrium. Bearing design. Design and selection of anti-friction bearings. Theory of friction.

Wear and their measurement.

### **ME1740: Supply Chain Management (3-1-0)**

Introduction and overview of supply chain management, Inbound and outbound logistics, Supply chain as a source of competitive advantage. Inbound logistics.

Buyer-Vendor co-ordination, Procurement, Vendor development, reduced sourcing and supplier partnership - benefits, risks and critical success factors, multi-level supply control.

Outbound logistics: Customer service, physical distribution planning, channel considerations, inventory strategies and management, transportation infrastructure and management, facility location, Materials handling.

Strategic considerations for supply chain: Porter's industry analysis and value-chain models, the concept of total cost of ownership, supply stream strategies, classification and development guidelines, measuring effectiveness of supply management, logistics engineering.

Operations Research Models for operational and strategic issues in supply chain management.

The Bullwhip Effect and supply-chain management game.

### **ME1741: Fuels, Combustion and Pollution (3-1-0)**

Introduction, fuels gaseous, liquid and solid, sources, method of procurements, transportation and end uses.

National and International perspective-economics and social aspects, and social policies. Physical and chemical characterization.

Chemical and thermodynamics and kinetics. Conservation equations for multi component system Pre-mixed system detonation and deflagration, laminar flame problems and effects of different variables.

Measurement of flame Velocity Flammability limits, Ignition and quenching, Turbulent premixed flames, Non-premixed systems; laminar diffusion flame jet, droplet bumming.

Combustion and solids drying, devolatilization and char combustion coal combustion, pollution; Main pollutants and their environmental impact. NO<sub>x</sub>, CO, CO and SO<sub>x</sub> formation chemistry. Particulate pollutants. Emissions from engines, power plants and industrial applications, LowNO<sub>x</sub> burner and furnace design.

### **ME1742: Total Productive Maintenance and Value Engineering (3-1-0)**

TPM: Introduction to TPM, Productivity, major losses, measurement of overall performance, Pillars of TPM, autonomous maintenance, continuous improvements (kaizen), maintenance Prevention, safety and hygiene, preventative maintenance, predictive maintenance and time based maintenance.

Value Engineering: Definition and concept of VE, type of value, cost v/s quality, FAST diagram phases of VE, general phase, information phase, function phase, creation phase, evaluation phase, application and benefits of VE.

### **ME1743: Advanced Energy Conversion Systems (3-1-0)**

Introduction: Review of Fundamentals of Thermodynamics, Zeroth Law Gas Law, Irreversibility, availability, Second law analysis of power plant cycles.

Introduction to conventional and advanced energy conversion technologies, vapour and gas cycle such as steam power plant, gas turbine, internal combustion engines, combined cycle power plants and stirling engines, Storage technologies: direct energy conversion system, fuel cell. Natural gas, coal, nuclear power plants.

Gas Turbine based system: Analysis of Inter-cooled, reheated, recuperated Gas Turbine cycles, micro-gas turbines for distributed generation, gas turbine-fuel cell hybrid cycles, gas turbine based combined cycles, natural gas and hydrogen fired gas turbine cycles, humidified gas turbine, steam-injection gas turbines, integrated-coal-gasification-combined cycle(IGCC).

Fuel-cells: Types of fuel cells, Proton-exchange fuel Cell, Solid-oxide-fuel cell, Molten carbonate Fuel Cell, Applications.

Direct Energy conversion systems: MHD, Thermionic methods, Thermo-electric.

Nuclear energy: Nuclear reactor principles, Fission energy, Fusion Energy, Advanced Nuclear power reactors, space-based power plants.

### **ME1844: Machinery Fault Diagnostics and Signal Processing (3-1-0)**

Purpose and principles of inspection; Procedural steps for condition monitoring Failures and failure analysis. Fault detection sensors.

Data processing and signal analysis. Condition based maintenance principles, Economic.

On-line-techniques of Vibration and Noise monitoring etc. Offline techniques - NOT, wear debris analysis, Ferrography etc. Common types of sensors and their characteristics and applications; Data acquisition system and process, Feature extraction etc.

Reliability/failure concepts. Application of diagnostic maintenance to specific industrial machinery and plants.

### **ME1845: Gas Dynamics and Propulsion (3-1-0)**

Revision of fundamentals, thermodynamics of compressible flow – wave motion in compressible medium, Mach number and cone, properties.

Steady one dimensional compressible flow through variable area ducts. Converging and diverging nozzles and diffusers.

Effect of heating and friction in duct flow, Rayleigh and Fanno lines. Flow with normal shocks. Oblique shocks and reflection expansion waves. Prandtl-Meyer flow.

Flow over body. Measurement and application. Jet propulsion-types of engines, propulsion fundamentals, Compressors, Combustor and turbines construction and performance. Rocket propulsion-basics, solid and liquid propelled engine. Parametric studies. Construction features.

Single and multi-stage rockets. Thrust chamber and nozzle models. Studies of in-use engine. Environmental aspects.

### **ME1846: Nuclear Power Safety (3-1-0)**

Basic concept of reactor physics, radioactivity, neutron scattering, thermal and fast reactors

Nuclear cross-section, Neutron flux and reaction rates, moderator criteria, reactor core design.

Conversion and breeding, types of reactors, characteristics of boiling water, pressurized water, pressurized heavy water, gas cooled and liquid metal cooled reactors.

Future trends in reactor design and operation, thermal – hydraulics of reactors, heavy water management, containment system of nuclear reactors.

Reactor safety, radiation shields, waste management, Indian Nuclear Power programme.

### **ME1847: Polymers and Composites (3-1-0)**

Introduction : polymeric materials, Engineering plastics, Polymer alloys, Selection of plastics, Mechanical properties, Degradation , Wear resistance, Frictional Properties, Special Properties Structural features. Expanded plastics, Plastics as packaging material. Theoretical aspects; visco• elastic behaviour, Mathematical models for visco-elastic behaviour, Deformation behaviour of plastics, Reinforced plastics.

Analysis of polymer melts flow: Newtonian and Non Newtonian fluid flow, Flow in circular section, Flow in rectangular section etc. Overview and analysis of various plastics forming operations; Extrusion, Injection moulding, Thermo forming, Calendaring, Compression moulding . Blow moulding, Transfer moulding, Processing of reinforced plastics. Die design for simple components.

Classification and characterization of composite materials; Fibrous, Laminated and particulate and composites: laminate and laminates: manufacturer of laminated fibre- reinforced composites Materials. Macro mechanical behaviour of laminar stress-strain relations, engineering constraints for orthotropic materials. Stress-strain relations for laminar of arbitrary orientation, strengths and stiffness of orthotropic lamina: Bi-axial strength theories. Micromechanical behaviour of laminate: Rule of mixtures. Macro-mechanical behaviour of laminates ; Rule of mixtures.

Macromechanical behaviour of laminates: Single layered configurations. Symmetric. Laminates, Anti-symmetric laminates, know symmetric: Strength of laminates: Interlaminar stresses: Design of Laminates. Buckling and vibration of laminated beams, plates and shells.

### **ME 1848: Operation Research (3-1-0)**



Scope and application of operation research.

Linear programming, graphical and simplex method transportation and assignment models. Simulation and Monte-Carlo techniques.

Queuing theory (single and double channel) CPM and PERT and CPM- crashing networks.

Dynamic programming, Sequencing model (n jobs-2machines n- jobs- 3 machines), Replacement problems and Reliability theory.

Inventory models with probabilistic demands and area, quantity constraints, Game theory (competitive strategies), Non -linear programming (Kuhn -Tucker condition).

### **ME1849: Automobile Engineering (3-1-0)**

Description of Power unit: Fuel supply system and engine lubrication, Transmission requirements.

Fluid and automatic transmission system along with their performance requirements, tractive resistance. Different types of steering systems and performance requirements, Stability of vehicles on level road and curve path.

Transmission system along with Belt, Clutches and Gears.

General braking requirements, weight transfer during braking, different type of brakes, general considerations of strength and stiffness of vehicle frame.

Various suspension system, shock absorbers and engine mountages, Tyre –pavement interaction forces, tyre wear & SAE terminology various types of types of ignition system switch wiring diagram.

Testing of vehicles and handling characteristics, Preventive maintenance, troubleshooting & tuning of power unit, pollution due to vehicles emission, Effect of design and operating condition on pollution.

### **ME1850: Power plant Engineering (3-1-0)**

Power Plant types and Economics: History of steam engine, turbines, turbo-machines, pumps, compressor, thermal power plant, overview of hydel power plant, gas turbine power plant, wind power plant, solar power plant, fuel cell power plant etc. Load duration curve, power plant economics, construction cost, fixed cost, interest rates, depreciation rates, fuel cost, present worth, plant net heat rate, load factor etc.

Rankine and binary-vapour cycles: Simple rankine cycle, regenerative- feed heating, re-heating, reheating-regenerative, water-extraction cycle, back pressure, pass-out and mixed pressure turbine cycles.

Fuels, Combustion equipments, Fuel handling systems: Types of fuel, solid, liquid, gas, Examples Coal, fuel oil, natural, cold-derived fuel, synthetic fuel, biomass, combustion reaction, air fuel ratio, heating, value of cold, optimum excess air in boiler, mass balance of furnace, balance draught, draught combustion, equipment of coal, coal crushers, pulverizers, coal handling systems, burners, fluidized bed burners, coal gasifier, combined gas fuel oil burners.

Steam generator, Ash handling systems, Feed water treatment: Types of steam generators, fire tube, water tube, natural circulation, force circulation, critical pressure boiler, electrostatic precipitator, De-mineralization of feed water, steam turbine auxiliary systems: Steam stop valve, tripping devices, oil pullers, filters, ceiling glands etc.

Gas turbine, combined cycle, co-generation and mixed cycle power plant: Gas turbine cycle, inter-cooled gas turbine, reheated gas turbine, recuperated gas turbine, gas turbine based combined cycles, thermodynamics of cycle, performance curves, coal, waste, combined cycles.

Nuclear power plant: Fundamentals of fission reaction, working principle of nuclear reactor, Pressurized water reactor, Boiling water reactor, gas cooled reactor, high temperature gas cooled reactor, Heavy water reactor, Liquid metal fast breeder reactor, Fusion reactor power plant.

Hydro-electric power plant reactor: Advantages–disadvantages, site selection, hydrology, hydrographs, hydroelectric plant layout, catchment area, types of dams, trash rack, tunnel , penstock, hydro-electric plants: High, medium and low head plant, pump –storage hydelplant, mini-and micro- hydel plant, Pelton, Francis and Kaplan turbines.

Governing of Hydel turbines, performance, characteristics curves and selection criterion.

Energy Storage: Thermal, Electro-chemical, Mechanical, hydro, compressed air, adiabatic, hybrid air energy systems, pressurized water sensible energy storage, variable pressure accumulator, expansions accumulator, hydrogen energy storage.

Electrical Equipment on Power Plants: Layout of Electrical equipment, bus-bar, generator, stator, rotor, excitor, switchgears, transformers, circuit breakers, relays, transmission.

Power plant Instrumentation and Air Pollution: Dissolved oxygen, water purity, thermal conductivity, stack gas measurement, Green house effect, acid precipitation, de-sulphurisation, NO reduction and removal, Nuclear Pollution.

### **ME1851: Mechatronics (3-1-0)**

Introduction to Mechatronics Systems, Measurement Systems, Control Systems, Microprocessor based Controllers, Sensors and Transducers – Performance Terminology – Sensors for Displacement, Position and Proximity; Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors – Selection of Sensors.

Pneumatic and Hydraulic Systems, Directional Control Valves, Rotary Actuators. Mechanical Actuation Systems, Cams, Gear Trains, Ratchet and pawl, Belt and Chain Drives, Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors.

System Models And Controllers - Building blocks of Mechanical, Electrical, Fluid and Thermal Systems, Rotational – Translational Systems, Electro-Mechanical Systems – Hydraulic – Mechanical Systems. Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Digital Controllers – Velocity Control – Adaptive Control – Digital Logic Control – Micro Processors Control.

Programming Logic Controllers - Programmable Logic Controllers – Basic Structure – Memory - Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Shift Registers – Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC – PLC Applications

Design Of Mechatronics System - Stages in designing, Mechatronics Systems – Traditional and Mechatronics Design – Possible Design Solutions Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems Automatic Camera, Washing machine.

**ME1852: Instrumentation and Control****(3-1-0)**

General Concepts of Mechanical Instrumentation, Measurements System: Basic detector transducer elements, Intermediate modifying systems, Terminating devices and methods. Classification of instruments as indicators, recorders and integrators – Their working principles, precision and accuracy, Measurement of error and analysis, properties of errors. Measurements of displacements, time, speed, frequency, acceleration, vibrometer, accelerometer, etc.

Pressure Measurement: Gravitational, Bourdon, Elastic transducers, strain gauge, Pressure cells, Measurement of high and low pressure, Dynamic characteristic of pressure measuring devices.

Temperature Measurement: Bi-metallic, pressure and resistance thermometer, Thermocouples, Pyrometer and Thermistors, Calibration. Pressure and temperature measurement in rotating systems – slip rings.

Flow Measurements: Orifice, flow nozzle, venturi, pitot tube, rotameter, Turbine type

Anemometer, Hot-wire anemometer, Magnetic flow meter, Ultrasonic flow meter - Calibration.

Density Measurement: Phenometer, Hydrometer, differential bubbling, Liquid level Measurements.

Viscosity: Capillary tube viscometer, efflux viscometer, falling sphere viscometer, Rotating cylinder viscometer.

Humidity: Sling psychrometer, Absorption hydrometer, Dew point meter.

Strain: Strain gauges, types, surfaces preparation and bonding technique, Wheatstone Circuit, Temperature compensation, Gauge rosettes, Calibration.

Force Measurement: Scales and balance, Elastic force meter, Strain gauge, Load cells Hydraulic and pneumatic load cells.

Torque Measurement: Mechanical torsion meter, Optical torsionmeter, Electrical torsion meter, Strain gauge torsion meter. Open and closed systems, Servomechanisms, Transfer function, Signal flow graphs, Block diagram algebra, Hydraulic and pneumatic control systems. Two-way control, proportional control, differential and integral control. Simple problems.

Time response of first order and second order systems. Concept of stability. Necessary Condition for stability, Routh stability constraint, Polar and Bode plots, Nyquist stability Criterion. Simple problems.

**Open Electives****CE1701: Environment Engineering & Management****(3-0-0)**

Man, environment and ecosystems, their inter relationships. Types of environment pollutants, their sources and effects.

Indoor pollution, air pollution, sources, quantities effects and controls technologies.

Noise pollution industrial wastes and their treatment, solid wastes, generation, collection, processing and disposal.

Environmental impact and auditing. Introduction to Environmental laws and policies. Global issues on environment

**HS1704: Organizational Behaviour and Industrial Psychology (3-0-0)**

Personality self awareness; perception and attribution, learning, values and attitudes.

Motivation; Groups, Group Dynamics, Teams; Skills for Managing Teams- Communication conflict, Power and Influence; Leadership.

What is an organization; Determinants and Parameters of Organizational Design; Organization and Environment Organizational Strategy; Power and conflicts in organization

Organization and decision making and Strategy formulation; Organizational culture; Organizational failure and Pathology; Organizational change and Development, Organizational Learning and Transformation.

**HS1705: Management Information System (3-0-0)**

Management and system: Advance in Management. The process of MIS Development: MIAS Organization, Information Dynamics.

Planning: Design and implementation of MIS:IS strategic Planning MIS Design-Group Design Concepts: Acquiring information system

System life cycle: Information Flow: Entity Relationship Modeling: Data Modeling Detailed process Analysis, Data Flow Diagrams.

Decision making system with MIS: System Concept for MIS; Data:Information and Communication;

Problem solving and decision making; IS Security. Control System and Failure, Future Trends in MIS.

**ME1753: Rural Entrepreneurship Development (3-0-0)**

Introduction: Entrepreneur:Evolution, Characteristics, Types, Functions of Entrepreneur-Distinction between an Entrepreneur and a Manager,Concept, Growth of Entrepreneurship in India, Role ofEntrepreneurship in Economic Development.Rural Entrepreneurship: Concept, Need, Problems, RuralIndustrialization in Retrospect, How to Develop RuralEntrepreneurship, NGOs and Rural EntrepreneurshipWomen Entrepreneurship - Concept, functions, Growth ofWomen Entrepreneurs, Problems, Development of WomenEntrepreneurs - Recent Trends, Entrepreneurial MotivationConcept, Theories, factors, Entrepreneurial CompetenciesConcept, Major Entrepreneurial Competencies Small Enterprises: Definition, Characteristics, Relationshipbetween Small and Large Units, Rationale, Objectives, Scope, Opportunities for an Entrepreneurial Career, Role of small Enterprise in Economic development, Problems of SSIs.

Project Identification And Selection (PIS) Meaning of Project, Project Identification, Project Selection,Project Formulation: Meaning, Significance, Contents,Formulation, Planning Commission's Guidelines forFormulating a Project Report, Specimen of a Project Report,Network Analysis, Common Errors in Project Formulation,Project Appraisal Concept, Methods of project appraisal,Growth of Business Ideas, Intellectual Property.

Financing of Enterprises: Need for Financial Planning, Sources of finance, CapitalStructure, Term-loan, Sources of Short-Term Finance,Capitalization, Venture capital, Export Finance, InstitutionalFinance To Entrepreneurs, Preparation of Business Plans,Commercial Banks, Other financial institutions like IDBI,IFCI, ICICI, IRBI, LIC, UTI, SFCs, SIDCs, SIDBI,

EXIM Bank Institution Support To Entrepreneurs: Need for Institutional support - Small Entrepreneurs: NSIC, SIDO, SSIB, SSICS, SISI, DICs, Industrial Estates Specialized Institutions, TCOs Brief introduction about Marketing of products and services, Human resource issues, Total quality management issues for small enterprises, Growth strategies in small businesses, sickness in small businesses, small enterprises in international business

Export Documentation and Procedure For Small Enterprises: Electronic commerce and small enterprises, Franchising Leading the Growing Company and Planning For Management Succession: Leadership in the new Economy, Hiring the Right Employees, Building the Right, Organizational culture and structure, the challenge of Motivating Workers, Management Succession: Passing the Torch of Leadership

### **ME1754: Professional Ethics (3-0-0)**

Human Values: Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

Engineering Ethics: Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

Engineering As Social Experimentation: Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

Safety, Responsibilities And Rights: Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Global Issues: Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility.

### **CE1702: Continuum Mechanics (3-0-0)**

Vectors and tensors, analysis for stresses, principal stresses and principal planes, stress invariants, equation of equilibrium, octahedral stresses.

Analysis of strains, principal strains, octahedral strains, large deformations and finite strains, elgerian, lagrangian and almansi, green's and cauchy's strain tensors.

Compatibility equations, elastic stress-strain equations, generalized hookean law.

Principle of virtual work, nonlinear constitutive laws, hypo and hyper elastic solids, two dimensional plane stress, plane strain and axi-symmetric formulations, Cartesian and polar coordinate systems, three dimensional elasticity for isotropic and anisotropic solids, boundary value problems, torsion and bending theory.

Material yield criteria-von mises, tresca, Mohr-coulomb, drucker-parger etc., isotropic and

kinematics hardening, normality principle, plastic flow rule, plastic potential, elasto-plastic stress-strain relations- prandti-rauss equations, levy-mises relations, hardening modulus, generalized elasto-plastic stress-strain relations.

### **EC1801: Soft Computing (3-0-0)**

Introduction to Soft Computing, Fuzzy Sets, Fuzzy Rules and Fuzzy reasoning.

Fuzzy interference System Fuzzy logic controller design.

Artificial Neural Network- Introduction. Artificial neural model,.Learning rules- Unsupervised Learning.

Supervised Learning, Back Propagation network (BPN). Radial Basis Function (RBF) and Neuro- fuzzy Networks, Genetic Algorithm, Adaptive Genetic Algorithm

### **EE1802: Artificial Neural Networks (3-1-0)**

Introduction : AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation.

Searching : Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Greedy best first search, A\* search Game Playing: Adversial search, Games, minimax, algorithm, optimal decisions in multiplayer games, Alpha-Beta pruning, Evaluation functions, cutting of search.

Knowledge Representation & Reasons logical Agents, Knowledge – Based Agents, the Wumpus world, logic, propositional logic, Resolution patterns in propositional logic, Resolution, Forward & Backward. Chaining.

First order logic. Inference in first order logic, propositional Vs. first order inference, unification & lifts forward chaining, Backward chaining, Resolution.

Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units.

Introduction to Data Mining: Machine Learning, DBMS, OLAP, Statistics, Data Mining Goals, Stages of the Data Mining Process, Data Mining Techniques, Knowledge Representation Methods, Applications. Data preprocessing, Data cleaning, Data transformation, Data reduction, Discretization and generating concept hierarchies, Data mining knowledge representation, Representing input data and output knowledge , Visualization techniques

### **EE1803: Intelligent Control (3-1-0)**

Introduction: control foundations, biomimicry, Instinctual neural control, multilayer perceptron, radial basis function neural network, design example, stability analysis, Fuzzy and expert control, standard, Takagi-Sugeno, mathematical characterizations, design example.

Planning systems: autonomous vehicle guidance for obstacle avoidance, model predictive control, Attentional systems: attentional strategies for predators/prey. Learning and function approximation (function approximation problem), adaptive control introduction

Learning/adaptation: training neural networks and fuzzy systems with least squares and gradient methods, stable fuzzy/neural adaptive control. Evolutionary methods, genetic algorithm, evolutionary design

Foraging, bacteria and connections to optimization and control, Foraging, bees and connections to optimization, Swarm stability: cohesion, foraging. Competitive foraging games, coordinated vehicular guidance applications

### **ME1855: Green Technologies**

**(3-1-0)**

Renewable Energy Resources & Systems: energy sciences, its importance, utility and conversion into various forms, Modeling and Simulation.

Energy, Ecology and Environment: concept and theories of ecosystems, - energy flow in major manmade ecosystems- agricultural, industrial and urban ecosystems - sources of pollution from energy technologies and its impact on atmosphere - air, water, soil, and environment - environmental laws on pollution control – innovation and sustainability: - eco-restoration/ phyto-remediation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies

Solar Energy: Solar radiation: measurements and prediction. Indian's solar energy potential and challenges, Solar thermal energy conversions systems: flat plate collectors, solar concentrators and other applications. Solar Photovoltaic: Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication

Wind Energy: Wind Resource: Meteorology of wind, Indian's wind energy potential and challenges,

Bioenergy: Biomass as energy resources; bio energy potential and challenges- Classification and estimation of biomass; Source and characteristics of biofuels: Biodiesel, Bioethanol, Biogas. Types of biomass energy conversion systems waste to energy conversions

### **ME1856: Ancient Indian Science and Technology (3-1-0)**

Introduction: Why are ancient Indian science and technology relevant today? What is science? How is it different from technology? Philosophy of ancient Indian technology, how is different from modern technology? Ancient Indian Scientific methods. Glimpses of ancient Indian science and technology?

Material Technology: Mining, Metals and Metallurgy, Iron Making and craftsmanship, Wootz Steel Technology.

Extraction of Zinc in ancient India, Glass making, Bead making Techniques, Ceramic Technology.

Water Harvesting Technology, Irrigation Systems, Town planning, Building construction, Sanitation, Agriculture and Textile Technology.

### **PH1802: Engineering Applications of LASERs (3-1-0)**

LASER Fundamentals Stimulated and Spontaneous Emission, Population Inversion, Optical Pumping, Einstein Coefficients and Light Amplification, Light Amplification, The Threshold

Condition, Temporal and Spatial Coherence of LASER Light, Measurement of Temporal Coherence length.

Laser Interferometry and Speckle Metrology Homodyne and Heterodyne Interferometry, Holographic Interferometry, Double-Exposure Interferometry, Real-Time Interferometry, Time-Average Interferometry, , Recording and Reconstruction of Hologram, Display Holography, Laser Interferometry Lithograph, Speckle Metrology.

Application of LASERs in Optical Communications Light Wave Communications, Carrier Wave Communication, Analog Modulation, Amplitude Modulation, Frequency Modulation, Digital Modulation, Pulse Code Modulation, Bit Rate Required for Speech, Standard Bit Rates, Optical Fibers in Communication, Attenuation of Optical Fibers, Numerical Aperture of the Fiber, Multimode and Single-Mode Fibers, Spatial Frequency Filtering.

LASERs in Industry Laser Welding, Hole Drilling, Laser Cutting, Laser Tracking, LIDAR, Lasers in Medicine, Precision Length Measurement.

Velocity Measurement LASER Doppler Anemometry (LDA), Measurement of Fluid Velocity.

### **ME1857: Renewable Energy System (3-1-0)**

Energy demand and availability, energy resources, basic concepts of heat and fluid flow for energy systems, Solar energy systems, Solar radiation data.

Solar energy collection, Storage and Utilization, Water and air heating, Power generation, Refrigeration and Air-conditioning, Economics,

Micro and small Hydro Energy Systems, Systems and Economics, Special engines for low heads, Tidal power.

Bio-mass Energy Systems: Various bio-mass sources and waste, Bio-conversion technologies, Bio-gas, Power generation, I.C. Engines modifications, systems economics.

Wind Energy, wind data, wind mills, performance and economics, Integrated Energy systems, Systems Design and economics