

**National Institute of Foundry & Forge
Technology**

Hatia, Ranchi - 834 003 (Jharkhand)

Course Structure and Syllabi for

B. Tech.

(Manufacturing Engineering)



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B. TECH. (MANUFACTURING ENGINEERING) - COURSE STRUCTURE

Year	Sem.	Course No.	Subject	L-T-P	Credits	Total
I	I	ME111	Mathematics I	3-1-0	4	25
		ME112	Principles of Electrical Engineering	3-0-2	4	
		ME113	Chemistry	3-0-2	4	
		ME114	Engineering Mechanics	3-1-0	4	
		ME115	English for Professional Communication	3-1-0	4	
		ME116	Engineering Graphics I	1-0-2*2	3	
		ME117	Workshop Practice I	0-0-2	1	
		ME118	EAA (NCC/NSS/PT)	0-0-2	1	
I	II	ME121	Mathematics II	3-1-0	4	26
		ME122	Basic Electronics	3-0-2	4	
		ME123	Solid Mechanics	3-1-2	5	
		ME124	Physics of Materials	3-0-2	4	
		ME125	Introduction to Computers and Programming Languages	3-0-2	4	
		ME126	Engineering Graphics II	1-0-2*2	3	
		ME127	Workshop Practice II	0-0-2	1	
		ME128	EAA (NCC/NSS/PT)	0-0-2	1	
II	I	ME211	Mathematics III	3-1-0	4	28
		ME212	Fluid Mechanics	3-1-2	5	
		ME213	Materials Science and Engineering	3-0-2	4	
		ME214	Industrial Economics	3-0-0	3	
		ME215	Engineering Thermodynamics	3-1-0	4	
		ME216	Environmental Pollution and Control	3-0-2	4	
			Elective I	3-0-0	3	
		ME2017	EAA (NCC/NSS/PT)	0-0-2	1	
II	II	ME221	Heat and Mass Transfer	3-1-0	4	26
		ME222	Metal Casting and Welding Technology	4-0-2	5	
		ME223	Kinematics and Dynamics of Machines	3-1-0	4	
		ME224	Scientific Computation	3-0-2	4	
		ME225	Metal Forming Technology	3-0-2	4	
		ME226	Control Theory and Applications	3-1-0	4	
		ME227	EAA(NCC/NSS/PT)	0-0-2	1	

Year	Sem.	Course No.	Subject	L-T-P	Credits	Total
III	I	ME311	Operational Research I	3-1-0	4	24
		ME312	Design of Machine Elements	3-0-2	4	
		ME313	Principles of Metal Cutting	3-0-2	4	
		ME314	Machine Tools	3-0-2	4	
		ME315	Engineering Metrology	3-0-2	4	
		ME316	Computer Graphics	3-0-2	4	
III	II	ME321	Advanced Manufacturing Processes	3-0-2	4	24
		ME322	Finite Element Methods and Applications	3-0-2	4	
		ME323	Advanced Metal Forming	3-0-2	4	
		ME324	Industrial Engineering	3-1-0	4	
		ME325	Manufacturing Systems Engineering	3-1-0	4	
		ME326	Technology of Special Foundry Processes	3-0-2	4	
IV	I	ME411	Quality Assurance and Reliability	3-0-0	3	25
		ME412	Forging Die Design and Manufacture	3-0-2	4	
		ME413	Machine Tools Design	3-0-2	4	
		ME414	Materials Management	3-0-0	3	
		-	Elective II	3-1-0/ 3-0-2	4	
		-	Elective III	3-1-0/ 3-0-2	4	
		ME415	Industrial Training	-----	1	
		ME416	Colloquium	0-2-0	2	
IV	II	-	Elective IV	3-0-2/ 3-1-0	4	22
		-	Elective V	3-1-0/ 3-0-2	4	
		-	Elective VI	3-1-0/ 3-0-2	4	
		ME421	Major Project	-----	10	

- For elective course no. see the list of electives

TOTAL CREDITS (8 SEMESTERS) = 200

ELECTIVES

Elective I

Introduction to Sociology	-MEE 2111
Industrial Psychology	- MEE 2112
Management Concepts and Techniques - An Introduction-	MEE 2113
French Language	-MEE 2114
German Language	-MEE 2115

Elective II

Material Handling Systems and Equipment	-MEE 4121
Automobile Engineering	-MEE 4122
Geometric Modeling for Manufacturing	-MEE 4123
Advanced Numerical Modeling	-MEE 4124
Advanced Welding Technology	-MEE 4124

Elective III

Manufacture of Plastics and Ceramic Products	-MEE 4131
Facility Layout and Design	-MEE 4132
Rapid Prototyping and Reverse Engineering	-MEE 4133
Operational Research II	-MEE 4134
Heat Treatment Technology	-MEE 4135

Elective IV

Project Management	-MEE 4241
Knowledge Management for Competitiveness	-MEE 4242
Supply Chain Management	-MEE 4243
Industrial Tribology	-MEE 4244
Methoding of Castings	-MEE 4245

Elective V

Total Quality Management	-MEE 4251
Design for Manufacturing and Assembly	-MEE 4252
Micro and Nano Manufacturing	-MEE 4253
Concurrent Engineering	-MEE 4254
Design and Manufacturing of Composites	-MEE 4255

Elective VI

Fluid Power Control	-MEE 4261
Mechatronics	-MEE 4262
Non-Destructive Testing	-MEE 4263
Evolutionary Computing	-MEE 4264
Laser Applications in Manufacturing	-MEE 4265

DETAILED SYLLABUS

Semester-I

MM111 Mathematics I

(3-1-0) 4 Credits

Matrices: Definitions, Addition and multiplication, Square matrices of different types, Determinants, Adjoint and inverse of a matrix, Elementary transformation, Rank, Normal form, Solution of line equations, Solvability, Matrix algebra, Cayley-Hamilton theorem, Eigen values and Eigen functions.

Coordinate geometry of two dimensions: Coordinate systems, Projections and directions, Plane, Straight line, Sphere, Cylinder, Cone and conicoids.

Vector analysis (with geometrical interpretation and applications): Elementary discussion, Product of two or more vectors, Geometry of line, plane and sphere in terms of vectors.

Differential calculus: Continuity and differentiability, Differentiation, Successive differentiation, Successive differentiation, Expansion of function remainders, Indeterminate forms, Partial differentiation, Total differential coefficients, To differential, Approximate calculations, Jacobians, Reduction of Laplacian operator in different coordinate systems.

Differential equation: Introduction.

ME112 Principles of Electrical Engineering

(3-0-2) 4 Credits

DC Circuits: Circuit Elements & their characteristics, Circuit Analysis using KCL, KVL, solution of Mesh & Nodal equations of R-L-C networks, Circuits theorems – Superposition, Thevenin, Norton, Max. Power transfer & Reciprocity Theorem.

AC Circuits analysis: Periodic wave form, Peak, Average, RMS, Form factor of AC quantity, RLC circuits with sinusoidal excitation, Phaser notation, Reactance & Impedance, Series and Parallel Resonance.

Polyphase Circuits: Three phase system, star – Delta connected sources and loads. 3- Wire & 4 – wire system, Phaser diagram, Balanced and Unbalanced systems line & phase values, Power measurement.

Magnetic Circuits: Definition of magnetic quantities, concepts of magnetic and electrical analogy, B-H curve, cyclic magnetization, Leakage, Hysteresis & Fringing, Core losses.

Electromagnetic induction: Faraday's law, dynamic Induction, Fleming's RHR & LHR, Self and Mutual Induction, Lenz's Law, Coupling coefficient.

ME113 Chemistry

(3-0-2) 4 credits

Chemistry of engineering materials with particular reference to metals, alloys, ceramics and glasses, introduction to Water treatment techniques.

Electrochemistry-Electrochemical reactions, Electrochemical cells, laws of electrolysis, conductance, electroplating, electroanalytical methods of chemical analysis such as conductometry, potentiometry and polarography.

Thermochemistry- Heat of combustion, heat of formation, Hess's law of heat of summation, heat of neutralization, calorimetry.

Polymers-Classification of polymers, properties of polymers, methods of polymerization, common polymer resins such as phenolic resin, amine resin, alkyd resin, polyesters, epoxy resin, polyurethane and furan polymers.

Spectroscopy - Emission and absorption spectroscopy, origin of spectra, principles, methods of chemical analysis based on spectroscopy, such as atomic and molecular absorption.

ME114 Engineering Mechanics

(3-1-0) 4 Credits

Introduction: Fundamental concepts and principles; Introduction to SI units; Review of vector Algebra; Important vector quantities;

Statics of particles: Concept of force; resultant of forces; resolution of forces; Equilibrium of particle.

Statics of rigid bodies: Definition of rigid body; Dot product and cross product of two vectors; mixed triple product of three products; Moment and couple; Varignon's theorem; Equivalent system of forces; simplest resultants; Equilibrium of rigid bodies.

Analysis of structures: determination of forces in members of plane trusses by method of joints and sections.

Friction: the laws of dry friction; wedges; square threaded power screws; belt friction.

Properties of surface: Centroids and centers of gravity of areas and lines, volumes; Theorems of Pappus-Guldinus; Second moment of inertia, of an area; Polar moment of inertia; Parallel axis theorem.

Kinematics of particles: Position, velocity and acceleration of a particle in rectilinear and curvilinear motion; Relative motion; Motion of projectiles; Tangential and normal components of acceleration.

Kinetics of particles: Newton's second law of motion; Equation of motion; Dynamic equilibrium.

Kinematics of rigid bodies: Introduction; Translation; Rotation about a fixed axis; General plane motion; Absolute and relative velocity in plane motion; Plane motion of a particle relative to a rotating frame - Coriolis acceleration; Motion about a fixed point; General motion.

ME115 English for Professional Communication

(3-1-0) 4 Credits

Communication: Its role, process, barriers, dealing with barriers, Psychology insights into communication, Role of personality- personality types, transactional analysis.

Verbal Skills: Sound pattern, phonetics, pronunciation, modulation, stress, elision, vocal qualifiers, rhythm, vocal segregates, characteristics and sound patterns.

Non verbal Skills: Paralanguage, gestures, prescemics, Kinesics

Listening Skills: Types and techniques of developing it.

Presentation Skills: Making presentation, audio-video use (visual aids), the role of PLAN in presentation, characteristic of good speech and presentation

Written Skills: Fundamentals of English Grammars, usage, Editing, Effective writing, drafting, proposals, report, official letter writing, use of positive and negative language, persuasive letters, orders, messages, Style-concise, precision and vocabulary
Use of language for specific goal/audience/reader

ME116 Engineering Graphics I

(1-0-2*2) 3 Credits

Introduction: Importance of Engineering Drawing, Drawing instruments and uses, BIS specifications, Layout of drawing sheets. Lines, lettering and dimensioning.

Conic Sections: Ellipse, Parabola and Hyperbola

Curves: Cycloid, Epicycloid, Involutives, Spirals and Helices

Projections: Theory of projections. Orthographic projections. Projection of points and straight lines.

Projections of Solids: Projections of solids with the axis parallel, perpendicular and inclined to reference planes. Auxiliary projections.

Intersection of Surfaces: Intersection between prism, cylinder and cone combinations with axes in the same plane.

Development of Surfaces: parallel line, Radial line, Triangulation and Approximate development methods of surfaces of solids.

Pictorial Projections: Isomeric projections and Isomeric Views of Solids and Combination of solids, Perspective Projections of Solids and Combination of Solids using Visual Ray method and Vanishing Point method.

Sections of Solids: Section planes. Projections of solids with section planes parallel, perpendicular and inclined to reference planes. True shape of sections.

Computer Aided Drafting: Introduction to computer Aided Drafting.

ME117 Workshop Practice I

(0-0-2) 1 Credit

Machining of wood and plastic materials, fitting, smithy, tools and processes. Selected exercise in carpentry, fitting and hand forging. Use of measuring tools, instruments and gauges.

Semester-II

ME121 Mathematics II

(3-1-0) 4 Credits

Vector Calculus: Differentiation of vectors and their products, Differential operators, Gradient, Divergence, Curl in relation to scalars and vectors and their functions, Physical interpretations : Line and Surface integrals, Gauss and Stokes theorems.

Complex Analysis: Introduction, analytic functions, Cauchy-Riemann equations, Line integral, Cauchy integral theorem and formula; Taylor and Laurent series, Cauchy's residue theorem, Single point, Point at infinity, Liouville theorem, Jordan's lemma, Evaluation of definite integrals, Bromwich contour integral, Branch points and contour integrals.

Algebra: Series - Tests of convergence and divergence of series, Proofs of tests, Convergence of infinite products.

Integral Calculus: Methods of integration, Integration of irrational algebraic and trigonometric functions, Reduction formulae, Definite integrals, Geometrical properties, Quadrature, Rectification, Volumes and surfaces, Differentiation and integration of integrals, Gamma and Beta functions, Multiple integrals with change of variable, Application to centre of gravity and moment of inertia.

ME122 Basic Electronics

(3-0-2) 4 credits

Semiconductor Diode Characteristics: Qualitative theory of pn-junction, pn-junction as a diode, Current components in a pn-diode, the volt-Amp. Characteristics/diode resistance, Breakdown diodes, Photo diodes, LEDs.

Transistor Characteristics: The junction transistor, transistor current components, transistor as an amplifier, Transistor construction, detailed study of the current in a transistor, the transistor-Alpha, the common-Base configuration, the common- Emitter configuration, the common- Collector configuration, transistor biasing technique and thermal stabilization.

Field-Effect Transistor: Junction field-effect transistor, pinch-off voltage, JFET volt-Amp. Characteristics, the insulated gate FET (MOSFET), a generalized FET amplifier, biasing of FET, the FET as a voltage-variable resistor (VVR)

Rectifier: Half wave rectifier, Ripple factor, Full wave rectifier, Full wave circuits, the Bridge rectifier voltage-multiplier, Filters (L-filter, C-filter, L-C filter)

Untuned Amplifiers: Classification of amplifiers, push-pull amplifiers, class-A large signal amplifier, class-B & class-AB and their operation, RC coupled amplifier, low frequency response of an RC-coupled stage.

Feedback Amplifier and Oscillators: Feedback concept, general characteristic of negative feedback amplifiers, voltage series feedback, current shunt feedback, voltage shunt feedback, operational-amplifier, basic uses of op-Amp., Sinusoidal oscillators, the Phase shift oscillators, Resonant-circuit oscillators, Crystal oscillators.

Digital Electronics: Number system, Boolean algebra, Universal logic gates, Realization, Karnaugh's map, Flip-Flop, Registers and Counters.

ME123 Solid Mechanics

(3-1-2) 5 Credits

Introduction: Types of loads; Concepts of stress and strain; Normal and Shearing stress; Stress-strain Diagram; Hooke's law; Deformation of Axially loaded Members; Statically Indeterminate problems; Thermal stresses and strains; Deformation of compound bars; Lateral strain ;Poisson's ratio; Generalized Hooke's law; Bulk Modulus; Shearing strain; Elastic constants and their relationships.

Torsion: Theory of torsion; Deformation in a circular shaft; Statically Indeterminate Problems; Power transmission Shafts.

Pure bending: Theory of simple Bending; Deformation in a Symmetric Member in pure Bending; Normal Stresses due to bending of beams; Bending of composite beams.

Transverse loading: Horizontal Shear flow; Shearing Stresses in beams; Shear stress, Distribution in common types of Beams.

Shear force and Bending Moment: Relation among loads, Shearing force and Bending Moment; Shearing force and Bending Moment diagrams for cantilever, Simply-Supported and Overhanging Beams; Maximum Bending Moment and points of contra-flexure.

Transformation of Stress: Principal Stress and their Planes; Mohr's Circle for Plane Stress; Combined loading.

Thin walled Pressure vessels: Hoop and Longitudinal Stresses in Thin Cylindrical and spherical shells subjected to internal pressure; Changes in Dimensions and volumes.

Columns: Buckling of Columns due to axial loads; Euler's formula for Column with different end conditions.

ME124 Physics of Materials

(3-0-2) 4 Credits

Nature of waves and particles, Wave-packets and uncertainty, Wave particle duality, Wave mechanics and its mathematical tools, Classical and quantum statistics, Statistics of discrete energy levels, Black body spectral density, Bose condensation; Free electrons, density of states, Kronig-Penny model, Effective mass, Band structure, Electrons in various types of solids, Particle in quantum well, Harmonic oscillator, Application to semiconductor doping, Non-periodic materials; Tunneling of particles and examples, Tunneling through multiple barriers and semiconductor junctions; Interaction among quantum wells: materials under electric and magnetic fields, magnetic resonance effects; **Nanostructures** – Concepts of electrons in low dimensional confinement, Quantum wells and Super-lattices leading to new device concepts; **Lasers** - Einstein coefficients, Population inversion, Light amplification, Optical resonators, Characteristics of lasers; **Superconductors**

ME125 Introduction to Computers and Programming Languages

(3-0-2) 4 Credits

Introduction to computer systems; Representation of data in computers; Number systems. FORTRAN language: FORTRAN preliminaries, input and output statements, format specifications, control statements, arrays, subprograms, file processing. C++ language: Introduction, constants, variables and data types. Operators and expressions, Input/output streams, decision making and branching, looping, functions, arrays and pointers, Objects and classes.

ME126 Engineering Graphics II

(1-0-2*2) 3 Credits

Introduction to design process and drawings.

Conventions: Code of practice for engineering drawing - Methods of dimensioning - Representation of details like drilled and tapped holes, counter-sunk and counter-bored holes, etc. - Representation of standard components like bolts, nuts, washers, etc.

Assembly concepts: Methods and concepts of assemblies - Assembly requirements - Methods of assembly using bolts, nuts, screws and pins - Methods of arresting motion of a member in an assembly.

Assembly drawing practice: Making free hand sketches of typical sub-assemblies, like flange couplings, stuffing box, journal bearings, rolling element bearings, keyed joints, cotter

joints, gears, belts, brackets and C-clamps. Detailed three view drawings of assemblies of (i) stop valve (ii) tail stock (iii) hydraulic cylinder and piston (iv) four speed gear box (v) universal joint (vi) cross head (vii) connecting rod (viii) safety valve (ix) machine vice and (x) screw jack. Assembly drawing with sectioning and bill of materials; Assembly and disassembly; Detailed part drawings from assembly drawings.

Production drawings - Limits, fits and tolerances, dimensional and geometric tolerances, surface finish symbols. Computer aided design and use of software packages for engineering drawings.

ME127 Workshop Practice II

(0-0-2) 1Credit

Metal casting, welding, sheet metal fabrication and basic machining processes; Materials, tools and instruments used; Elementary exercises in molding, casting, gas and arc welding, sheet metal forming, turning, shaping and milling.

Semester-III

ME211 Mathematics III

(3-1-0) 4 Credits

Differential Equations: Definitions, Differential Equations of First Order: of First Degree and higher, Singular Solutions, Geometrical Interpretation of Differential Equations, Linear Equations of Higher Order with: Constant Coefficients and Variable Coefficients (Second Order and Homogeneous equations), Simultaneous Differential Equations of One or More Variable, Partial Differential Equations, Total Differential Equations, Geometrical Interpretations, Solution of Laplace Equation, Heat Conduction Equation and Wave Equations by Separation of Variables in Cartesian, Cylindrical & Spherical Polar Coordinate Systems.

Special Functions: Solution of Legendre and Bessel Differential Equations, Different Kinds of Associated Functions, Generating Functions, Orthogonality Conditions, Expansion of Functions in terms of Legendre Polynomials and Bessel Functions.

Integral Transforms: Definitions, Laplace Transforms, Inverse Laplace Transforms, Fourier Series- Expansion, Conversion into Different Intervals. Fourier Integral Formula, Fourier Mellin Theorem, Infinite and Finite Fourier Transforms & Hankel Transforms, Definite Integrals with the Help of Transforms, Application of Transforms to the Solution of Boundary Value Problems, Heat and Wave Equations.

ME212 Fluid Mechanics

(3-1-2) 5 Credits

Introduction. Definitions. Fluid properties: classification of fluids and flow regimes. Fluid statics: Stationary fluids and liquids subjected to constant linear acceleration and to constant rotation. Fluid kinematics: Lagrangian and Eulerian descriptions, pathlines, streaklines and streamlines, acceleration. Integral flow analysis: Reynolds transport theorem, conservation of mass/continuity equation and conservation of linear and angular momentum for a control volume in inertial and accelerating reference frames, energy equation, Bernoulli's equation, engineering applications. Differential analysis of flow: Continuity and Navier-Stokes equations. Dimensional analysis and Similitude theory. Inviscid flows: Irrotational flow,

circulation, velocity potential and applications. Viscous flows in pipes and ducts. External viscous flows: concepts of boundary layer, momentum integral equation, drag and lift, separation.

ME213 Materials Science and Engineering

(3-0-2) 4 Credits

Structures of materials – crystal structure, substructure, microstructure, etc. Phase diagram and phase transformation. Diffusion phenomenon. Principles of heat treatment. Mechanical behavior – strength, hardness, deformation, creep, fatigue, etc. Mechanisms of strengthening and toughening of materials. Surface Engineering.

ME214 Industrial Economics

(3-0-0) 3 Credits

Micro: Economics - Nature, definition, scope and method; Equilibrium analysis; Statics, dynamic and comparative status; Demand analysis, Utility analysis; Indifference curve analysis; Elasticity of demand; Consumer's surplus; Production factor, Capital formation, Labor; Production possibility curve and production function; Laws of return; Cost and cost curves; Markets and their structures; Price determination; Monopoly, duopoly and oligopoly; Marginal theory of distribution; Wages; Rent; Interest; Profit.

Macro: Social accounting, National income, methods of measuring national income; Theory of employment, Keynesian system - critique, relevance, multiple and accelerator; Trade cycles; Inflation and monetary policy; Labor relations; Economic systems; Economics of development and welfare; Role of government

ME215 Engineering Thermodynamics

(3-1-0) 4 Credits

Introduction, Thermodynamic equilibrium; Quasi-static process; Zeroth law and reference points in thermometry; Work and heat transfer; First law for a closed system; Steady flow energy equation; Second law: Kelvin-Planck and Clausius statements; Causes of irreversibility; Carnot's theorem; Absolute temperature scale; Inequality of Clausius; Entropy principle; Entropy transfer and entropy generation; Quality of energy; Energy principle; Guoy-Stodale theorem; Properties of a pure substance; p-v, p-T, T-s and h-s diagrams; Properties of gases and gas mixtures, Equations of state; Law of corresponding states; Maxwell's equations; Joule-Kelvin effect; Clausius-Clapeyron equation; Rankine cycle; Reheat and regenerative cycles; Cogeneration systems; Air standard cycles; Otto, Diesel, Dual, Stirling and Ericsson cycles; Brayton cycle and gas turbine plant.

ME216 Environmental Pollution and Control

(3-0-2) 4 Credits

Historical perspective. Human respiratory system; effects of pollutants on human health. Classification and sources of pollutants. CO, CO₂, O₂, N₂ cycles, sources and sinks. Reactions of pollutants in the atmosphere, and their effects; smokes, smog, fog, acid rain and ozone layer. Global warming and its effects. Regulatory laws and standards. Atmospheric lapse rate, inversions and heat balance. Atmospheric diffusion of pollutants, transport, transformation and deposition.

Air sampling and pollutant measurement methods, principles and instruments. Ambient air quality and emission standards. Control principles: removal of gaseous pollutants by absorption, adsorption, chemical reaction and other methods. Selective catalytic reduction of NO_x, Particulate emission control; settling chambers, cyclone separation, wet collectors, fabric filters and electrostatic precipitators. Clean coal technology and shifted emphasis on non-carbon sources of energy.

Semester-IV

ME221 Heat and Mass Transfer

(3-1-0) 4 Credits

Conduction: Mechanism; Fourier's general conduction equation in 3D; 1D steady state conduction with heat generation: composite plane wall and cylinders, thermal resistance network, critical thickness of insulation; extended surface heat transfer. 2D steady state conduction: solution for simple boundary conditions. Unsteady heat conduction: lumped parameter system, semi-infinite wall with convection boundary condition. Use of Heisler charts.

Convection: Review of hydrodynamic equations of boundary layer theory. Convection boundary layers: velocity and thermal boundary layers. Laminar boundary layer analysis on flat plate. Fully developed heat transfer through smooth pipes. Relation between fluid friction and heat transfer. Turbulent boundary layer; forced convection correlations. Free convection: laminar free convection on a vertical flat plate; empirical correlations

Boiling and condensation: mechanism, different regimes of boiling, boiling curves and correlations, laminar film condensation on a vertical plate

Heat exchangers: types, analysis: LMTD, effectiveness-NTU method.

Radiation: physical mechanism; radiation properties. Black body radiation, gray body; spectral dependence of radiation properties, Kirchoff's law. Wien's displacement law. View factor; radiation exchange between infinite planes, and between gray bodies; Radiation shields; re-radiating surface and 3-surface enclosures, network representation.

Mass transfer: Fick's law, similarity with convection and correlations.

ME222 Metal Casting and Welding Technology

(4-0-2) 5 Credits

Metal Casting: Introduction. Pattern materials and pattern allowances. Types of patterns and core boxes. Base sands and their characteristics. Clay bonded sand systems and practices. Additives and washes. Inorganic and organic binder based processes. Melting furnaces for different types of metals and alloys. Cupola melting and melt control. Introduction to gating and feeding. Fettling and salvaging of castings. Casting defects and remedies.

Welding: Introduction to welding. Different processes, Weldability. Bonding in liquid and solid states. Welding of various metals and alloys. Physical and metallurgical characteristics of weldments.

ME223 Kinematics and Dynamics of

(3-1-0) 4 Credits

Machines

Kinematic pairs, diagram and inversion. Mobility and range of movements. Displacement, velocity and acceleration analysis of planar linkages. Dimensional synthesis for motion, function and path generation. Cam profile synthesis. Gears dynamic force analysis, flywheel, inertia forces and their balancing for rotating and reciprocating machines. Hydrodynamic and boundary lubrication in journal and thrust bearings.

ME224 Scientific Computation

(3-0-2) 4 Credits

Errors in computation, instability. Nonlinear equation in one variable: direct and iterative methods, order of convergence. Iterative methods for systems of nonlinear equations. Linear systems of equations direct and iterative methods, rate of convergence of iterative methods, ill-conditionedness of systems and condition numbers.

Interpolation: Lagrange, Newton divided difference formula, Newton's interpolations, errors in interpolation, Gauss, Stirling, Bessels, splines.

Approximation: Least square and uniform approximations.

Differentiation: differentiation using interpolation formulas.

Integration: Integration using interpolation: Newton-Cotes formulas, Gauss quadrature rules.

Ordinary differential equations: Taylor, Euler and Runge-Kutta formulas, multi-step methods.

Computer implementation of various methods.

ME225 Metal Forming Technology

(3-0-2) 4 Credits

Mechanical behavior of metals in elastic and plastic deformation, stress-strain relationships. Yield criteria. Application to tensile testing. Concept of flow stress by true stress-strain curves, Fundamentals of metalworking, Strain rate and temperature in metal working. Hot deformation, cold working and annealing. Analysis of bulk forming processes like forging, rolling, extrusion, wire drawing by slab method. Technology and practice of these processes, Sheet metal forming processes.

ME226 Control Theory and Applications

(3-1-0) 4 Credits

Introduction to automatic controls. Modeling of flow, heat transfer and electrical, pneumatic and vibration systems. Block diagram and transfer function. Modeling of continuous systems. Extraction of reduced order models. Transient and frequency response evaluation using Laplace transform. Characteristics of hydraulic controller, pneumatic, electronic controller, Electro-hydraulic and electro-pneumatic controllers. PID control. Stability. Gain and phase margins. Control system design using root and compensation. Applications. Sequence control, Logic diagram. Introduction to digital control, Implementation using computers.

Semester-V

ME311 Operations Research I

(3-1-0) 4 Credits

Behavioral versus quantitative decision making - Role of models - Linear programming, graphical and simplex procedure - Sensitivity analysis - Transportation and assignment problems - Application of linear programming in business and other systems - Integer linear programming - Cutting plane algorithm and branch and bound methods - Introduction to queuing: Single and multiple server models, finite population models, queuing costs and applications.

ME312 Design of Machine Elements

(3-0-2) 4 Credits

Mechanical engineering design vis-à-vis Solid mechanics - Factor of safety - Standards and design equations - Selection of materials and processes - Standard numbering system, including BIS designations of materials - Application of theories of failure to design - Design procedure and its application to static strength.

Design of mechanical elements: Design of screws, fasteners and connections - Design of axles, shafts, etc. - Bearing selection - Mechanical springs.

Design of Power Transmission Elements: Belt and Pulleys, Chain Drives, Clutches Brakes, Couplings and flywheels; Gears etc.

Fatigue Design: Introduction to design for fatigue strength - Endurance and modifying factors - Surface strength - Design procedure of fatigue failure with applications to design of bolts and springs subjected to fatigue loading.

ME313 Principles of Metal Cutting

(3-0-2) 4 Credits

Introduction to machine tools and machining operations - Mechanics of metal machining - Cutting forces, friction, cutting fluids and surface finish, lubrication, temperatures and heat transfer and its measurement - Tool life and tool wear aspects - Theoretical models of shear angle solution - Basic concepts of cost and economics of metal cutting operations - Tool nomenclature - Tool materials: HSS, carbides and coated carbides, ceramics and cermets, etc. - Chip control and design for machining.

ME314 Machine Tools

(3-0-2) 4 Credits

Lathes: Classification of lathes - Spindle and feed drive mechanisms - Typical operations on lathes - Cutting speeds and feeds - Work holding and tool holding devices - Cutting tools - Semi automatic and automatic lathes - **Drilling machines:** Classification and specifications - Work and tool holding devices - Types of drills - Speeds and feeds - Reamers and taps - **Shapers:** Classification and specifications - Quick return mechanism - Automatic feed - Typical operations on shapers - **Planers:** Classifications - Drives for speed and feed - Automatic feed - **Milling machines:** Types and specifications - Various milling attachments - Typical operations on milling machines - Milling cutters - **Boring machines:** Types and classifications - Boring on typical components such as axle housing, tailstock, headstock, etc. - Boring fixtures - Boring mills: Setup and operation - Jig boring with examples - **Broaching**

machines: Classification - Broach tool construction and geometry - Types of broaches - Examples of work done - Internal, external, spline, key-way and surface broaching - **Gear cutting machines:** Comparison of forming and generating processes - Working principles of gear hobbing and gear shaping machines - Cutters for gear shaping and gear hobbing - Bevel gear generator - Gear finishing methods: Gear shaving, gear grinding and gear lapping - **Grinding machines:** Theory of grinding - Wheel abrasives: Grade, grain, structure and designation of grinding wheels - Types of grinding machines: Cylindrical, surface, centreless and cutter grinders - Lapping, honing and super finishing methods - Deburring process.

ME315 Engineering Metrology

(3-0-2) 4 Credits

Introduction: Principles of dimensional and form measurements. Basic standards of length and angle. Industrial standards. Errors in measurement.

Linear and angular measurements: Vernier caliper, Micrometer, Dial indicator, Slip gauges, Angle gauges, Height gauges, Height gauges, Sine bar and Interferometers.

Comparators: Mechanical, Pneumatic, Electrical, Electronic and Optical Comparators Description, merits and demerits.

Projectors and microscopes: Abbe's comparator, Autocollimator, Tool maker's microscope, Alignment telescope - Applications.

Limits, Fits and Tolerances: Basic principles – Terminologies used – Maximum and least material conditions – Disposition of tolerances and deviations.

Gauges: Types of gauges. Taylor's principle, Design of gauges.

Metrology of Gears and Screw Thread: Measurement of various errors in gears – various instruments – Constant chord method – Base tangent method. Measurement of screw thread using 2- and 3- wire methods. Best size wire. Compensation for errors in these methods.

Surface Measurement: Various parameters – Analysis and evaluation on these parameters – Surface measuring instruments.

Interferometers: Types of light sources and interferometers, Types of scales and gratings, Optical flats, Use of different interferometers for calibration of height standards etc.

Coordinate Measuring Machines: CMMs, Applications, Types, Constructions, Probing, Hard probing and soft probing, Construction and working principle of touch trigger probe, Alignment, Programming, Types of errors.

ME316 Computer Graphics

(3-0-2) 4 Credits

Overview of graphics Systems: Points and lines, Line drawing algorithms - DDA and Bresenham line algorithms, Circle and ellipse generating algorithms, Conic sections, Primitives and functions. 2D transformation and their matrix representations. 3D concepts and object representation: 3D transformations. 3D display methods. Polygon surfaces, Curved lines and surfaces, Spline representations, Cubic spline interpolation methods, Bezier curves and surfaces, B-splines and NURBS. Implementations using C++ language.

Types of production; Jobbing, batch and mass production; Flexible systems of manufacture; Selection of production planning and control; Preplanning, demand forecasting; routing and scheduling techniques. Inventory control. Work study concepts and techniques; Activity sampling; Job design including ergonomic considerations. Planning of facilities and plant layout, Elementary concept of line balancing. Project network and scheduling techniques, Value engineering and value analysis concepts. Use of computers in industrial engineering.

**ME325 Manufacturing Systems (3-1-0) 4 Credits
Engineering**

Introduction of group technology, coding and classifications - Selection of coding systems - Examples of coding systems - Benefits of group technology - Cell formation approaches: Rank order clustering algorithm, Cluster identification algorithm, Similarity coefficient-based methods, Mathematical programming based methods, and graph theoretic methods - Layout planning in cellular manufacturing - Flexible Manufacturing Systems
Introduction to process planning - Process planning in integrating CAD/CAM - Approaches to process planning: mutual, variant, generative and feature based - Some examples of process planning systems - Introduction to Just-in-Time manufacturing systems - Describing three Ms, Pull vs. Push, Types of Kanbans and Kanban planning and control models - Basic of concurrent engineering - Understanding interactions between design and manufacturing - Serial engineering vs. Concurrent engineering - Benefits of concurrent engineering.

ME326 Technology of Special Foundry Processes (3-0-2) 4 Credits

Process details and analysis of die casting, centrifugal casting and continuous casting - Griffin process - Investment casting - Lost foam casting and Related Processes - Sodium silicate based sand systems - Fluid sand process - Shell sand, Oil sand, Hot box, Cold box, SO₂ and other no-bake organic binder processes - Rheocasting and thixocasting - Counter gravity casting - Layered manufacturing of pattern and mould.

Semester-VII

ME411 Quality Assurance and Reliability (3-0-0) 3 Credits

Probability and Statistics; Product Tolerances, Tolerance Analysis and Allocation. Process Capability, Statistical Process control, Economics of quality Control. Acceptance Sampling Plans and selection. Taguchi Techniques. Product Reliability, Reliability Achievement, Reliability Testing, Reliability Evaluation. System Reliability Assessment. Quality Circles, ISO9000, Quality Audits.

ME412 Forging Die Design and Manufacture (3-0-2) 4 Credits

Job analysis, designer's drawing, standards for forging tolerances and allowances, forging drawing - Preliminary die design considerations like parting line position, rib and web dimensions, draft angle, fillet and corner radii, etc. - Design of flash and gutter, preform

design, insert design, finishers blocker design consideration - Design of upsetting and piercing tools - Design of trimming and punching die and tools - Estimation of forging load and energy - Computer aided design of forging dies - Automation in forge shops - Materials and properties of forging dies - Heat treatment of dies and tools - Problems of die wear, estimation and remedial measures - Recent development in technology of die forging - Economy of die design.

ME413 Machine Tools Design

(3-0-2) 4 Credits

Introduction to machine tool drives and mechanisms - General principles of machine tool design - Selection of electric motor - Mechanical transmission and its elements - Devices for intermittent motion - Regulation of speed and feed rates: Stepped regulation of speed - Design of speed and feed boxes - Classification of speed and feed boxes - Design of machine tool structures: Basic design principles - Process capability of machine tools - Static compliance and overall compliance of machine tools - Design of beds, columns, housings, bases and tables - Design of cross rails, arms, saddles and carriages - Design of rams - Design of guide ways: Slide ways and their design - Stick slip phenomenon in slide ways - Design of hydrodynamic slide ways - Design of hydrostatic slide ways - Design of antifriction guide ways - Design of spindles and spindle supports: Antifriction bearings - Preloading of antifriction bearings - Sliding bearings - Sleeve bearings - Hydrodynamic journal bearings - Vibrations in machine tools: Effects of vibrations - Sources of vibrations - Analysis of single degree of freedom system - Chatter theory - Regenerative principle - Elimination of vibrations: Damping.

ME414 Materials Management

(3-0-0) 3 Credits

Introduction - Relevance of materials management - Need for integrated approach - Deterministic models: EOQ, EPQ, discount, backlogging, multi-item models, etc. - Sensitivity analysis, basic systems of inventory management, inventory costing - Aggregate inventory models, stochastic inventory models, service levels, single period model, etc. - Role of uncertainty - Selective inventory control - Material planning, forecasting, warehousing, storage etc. - Documentation for purchasing, etc. - MRP: Concepts, logic, computerized models, implementation issues and case studies - JIT: Philosophy, logic, applications and implementation - Vendor selection and evaluation - Vendor relations, consolidation of vendor base, single sourcing - Information systems for materials - Documentation, e-procurement and internet based purchasing - E-commerce and materials management - Organizational issues and evaluation of materials function.

ME416 Colloquium

(0-2-0) 2 Credits

Introduction to planning, preparing and making presentations – preparation of slides, time management, communication aspects, etc. Making a presentation on practical training with response sheet for testing audience. Reading an assigned project report, making a presentation with audience response sheet and a critique on writing style, completeness and

editorial get-up. Performing patent searches on the project work and making a presentation. Preparing posters on practical training and presenting these at a poster session.

ELECTIVES

Elective I (3-0-0) 3 credits

Introduction to Sociology

Sociology of architecture, society, groups and sub-groups, group formation and dynamics, culture, elements of culture, cultural systems and sub-systems, lag, institutions, social, political and economic; formal organization and bureaucracy, stratification, status and role, Social policy and planning.

Industrial Psychology

Scope of scientific Psychology and Industrial Psychology.

Basic process: Perception.

Training and learning: Human variables, selection and placement: Intelligence, MA & IQ measurement.

Personality: Development, approaches, assessment and tests.

Selection and placement: Job analysis, interviewing, psychological tests, decision making process.

Motivation and work: Needs, hierarchy of needs, leadership supervision.

Ergonomics: Three processes

Work space and Human Factors in job design: Working environment, noise, atmospheric conditions and illumination.

Management Concepts and Techniques - An Introduction

Introduction to management theory: The system approach to management - Systems methodology - Management style - Managers and their external environment - Introduction to planning: Nature and scope of planning - Type of planning - Long and short term plans - Decision making: Systems approach to decision making.

Organizing: Basic departmentation - Line and staff authority relationships - Functions of leadership - Nature of leadership - Control: The system and process of control - Control techniques - Control of overall performance.

Introduction to functional areas of management: Operation management, financial management, marketing management, human resource management and organization management.

Elective II (3-0-2/3-1-0) 4 Credits

Material Handling Systems and Equipment

Introduction to various mechanical handling systems and equipment for handling unit load and bulk materials, namely pulley blocks, winches, electric hoists, EOT cranes, belt conveyor, bucket elevator, screw conveyor and pneumatic conveyor, etc. - Dynamic analysis, design procedures of their components, common mechanisms involved and their industrial applications - Programmable and flexible load handling devices.

Automobile Engineering

Introduction: History and development of vehicles - General classification of vehicles - Layout of a passenger car - Major parts.

Vehicle construction: Chassis, sub-frame, engine mounting, suspension systems, mounting of fuel tanks, radiator and exhaust systems.

Power unit: Principles of petrol and diesel engine operation - Engine parts and their functional aspects - Multi cylinder engines and power balance - Rotary Wankel engine - Gas turbines for automotive applications - Engine trouble shooting and repairs.

Fuel system: Combustion and engine fuels - Petrol pump - Carburetor: Types and functions, troubleshooting and servicing of carburetors - Diesel pumps and fuel injectors: Operation and troubleshooting intake and exhaust systems.

Cooling and lubrication systems: Air and water cooling systems - Radiator construction and maintenance - Cooling system faults and remedies - Types and methods of lubrication of various parts.

Power transmission system: Clutches: Construction and functional aspects of various types - Fluid flywheels - Gear box types - Gear selection arrangements, overdrives, automatic gear boxes, torque converters, lubrication and fault diagnostics - Propeller shaft: types - Differential: Floating of axles, double axle drives and maintenance.

Steering and suspension systems: Steering systems: Types and details - Ackerman principle of correct steering linkages - Toe-in Toe-out - Camber angle - Castor angle - Power steering - Suspension systems: Independent suspension coil spring - Leaf springs and torsion bars, shock absorbers, wheels and wheel alignment - Faults and remedies in steering and suspension systems.

Brakes, wheels and tyres: Drum brake and disc brakes - Friction materials - Hydraulic and air brake systems - Power brakes - Brake defects and maintenance - Construction of wheels and tyres - Tyre removal and fitting - Balancing of wheels.

Electrical systems: Ignition systems: Starter motor circuits, dynamo charging circuits, lighting circuits and battery regulators - Troubleshooting and remedies.

Garage equipment and organization: Equipments for repair and service station - Testing equipments - Garage organization and management.

Geometrical Modeling for Manufacturing

Geometric representation of curves, surfaces and solids - Machining of freeform surfaces from geometric models - Geometric modeling for die and mold design - Geometric model driven process simulation and process planning - Use of geometric models in inspection of curved geometries and reverse engineering - Realization of freeform solids by layered manufacturing - Computational geometry for manufacturing and inspection.

Advanced Numerical Modeling

Finite difference discretization: Truncation error, stability, consistency and convergence - Lax equivalence theorem (statement only) - Finite difference treatment of second order nonlinear partial differential equations of elliptic type, irregular boundary shapes and body

fitted grid generation - Convergence: Acceleration of convergence, approximate factorization method and multi grid methods - Second order equations of parabolic type : ADI method and implicit schemes - Solution of hyperbolic system of conservation law computation of discontinuous solution - Introduction to finite volume method with simple examples.

Advanced Welding Technology

Review of major welding processes - Heat flow in welding - Welding stresses and distortion - Weldability of specific materials - Cracks in welds - Weldability tests - Weld defects - Weld inspection, repair and maintenance - Weld design based on static, fatigue loading and fracture toughness.

Elective III (3-0-2 /3-1-0) 4 Credits

Manufacture of Plastics and Ceramic Products

Plastics: General properties of engineering plastics - Structural features - Behavior of reinforced plastics and common fabrication techniques - Common fabrication processes and their analysis (extrusion, injection molding, thermoforming, etc.) - Flow analysis of polymer melt - Typical defects in plastic components and their prevention.

Ceramics: Classification of ceramics - Historical development - Technologic and economic significance - Structural features - Physical properties - Engineering processing: the sintering process, powder pressing and sintering fabrication processes - Sintering defects - Slip casting - Ceramic injection molding - Tape casting - Refractory - Single crystal processing.

Facility Layout and Design

Nature and scope of facility design - Facility design and facility layout - Facility location: Location factors and location analysis with fixed costs - Continuous facility location - Facility layout: objectives, facility layout models, visual aids, optimal and heuristic procedures and computerized layout planning - Production line: Mass production management - Design and operation of single-model and mixed-model lines - Buffer stocks - Material handling: definitions, objectives, principles of material handling and material handling equipment selection.

Rapid Prototyping and Reverse Engineering

Basic principles and classification of RP processes - Industrial RP systems, like Stereolithography, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, 3D Printing, Ballistic Particle Modeling, etc. - Role of RP and rapid tooling in product development - Process planning for RP - STL file generation - Defects in STL files and repairing algorithms - Slicing and various slicing procedures - Accuracy issues in rapid prototyping - Strength of RP parts - Surface roughness problem in RP - Part deposition, orientation and issues like accuracy, surface finish, build time, support structure, cost, etc. - Rapid tooling techniques, such as laminated metallic tooling and direct metal laser sintering - Introduction to reverse engineering - Integration of reverse engineering and RP.

Operational Research II

Nonlinear programming: Kuhn-Tucker conditions, constrained and unconstrained optimization and search techniques - Use of NLP computer software packages.

Dynamic programming: Principle of optimality, stage coach problems and recursive relationship - Applications to assignment problem, Knapsack problem and production-inventory problems.

Probabilistic OR models: Markov chains, Queuing theory, Poisson and non-Poisson queues, Priority discipline models and Computer packages for solving queuing problems.

Heat Treatment Technology

Alloying behavior of iron and decomposition of austenite - Diffusionless and diffusion controlled transformations, pearlitic, bainitic and martensitic transformations - Concept of hardness and hardenability, mass effect, etc. - Surface and volume hardening, tempering, annealing and normalizing - Heat treatment of alloy steel castings and forgings, stainless steels, Hadfield steels and spring steels - Heat treatment of cast iron, malleable iron and SG iron - Heat treatment of non-ferrous metals and alloys - Theory of age hardening - Heat treatment of Brasses, Bronzes, Al and Mg alloys.

Elective IV (3-0-2/3-1-0) 4 Credits

Project Management

Nature of projects: project as non-repetitive unit production system and as agent of change - Project identification considering objectives and SWOT analysis - Screening of project ideas - Technical, market, financial, socioeconomic and ecological appraisal of a project - Work break down structure and network development - Basic scheduling - Critical path and four kinds of floats - Scheduling under probabilistic durations - Time cost tradeoffs - Project monitoring: PERT/Cost - Organizational aspects, computer packages and project completion.

Knowledge Management for Competitiveness

Knowledge management (KM): Introduction, definitions, industrial relevance - Evolving industrial competition (multi-attributed competition) - Complex and dynamic systems - Growing need for knowledge and its effective management - Role of IT, KM and CRM - KM technical concepts: Data vs. information vs. knowledge - The knowledge edge - Knowledge engineering - KM framework (process steps) - Aligning KM with manufacturing strategy, business strategy, etc. - Design and deployment of KM in industrial enterprises (KM team, KM system analysis, developing effective systems, knowledge audit) - IT based tools (role of simulation, intelligent systems) - KM challenges and opportunities - Managing innovations - Performance measurement - KM and competitiveness link - Applications and cases.

Supply Chain Management

Introduction and overview of supply chain management - Inbound and outbound logistics - Supply chain as a source of competitive advantage - Inbound logistics: Buyer-vendor

coordination, 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.

Industrial Tribology

Importance of lubrication, mechanisms and regimes of lubrication - Viscosity and its measurement - Bearing varieties and selection - Hydrodynamic lubrication - Journal and thrust bearings - Lubricants - Bearing materials - Rolling bearings

Methoding of Castings

Principles of fluid flow: Types and design of gating system - Use of ceramic filters in gating system - Principles of solidification and heat transfer - Design of risers - Improving risering efficiency - Insulating and exothermic sleeves.

Introduction to design of castings - Selection of parting line - Design and construction of pattern and core box

Computer simulation of casting processes: Prediction of mould filling, solidification, residual stress and microstructure evolution and their role in design of casting, gating and risering.

Elective V (3-0-2 /3-1-0) 4 Credits

Total Quality Management

Evolution of quality paradigms - Customer orientation - Quality philosophies - TQM in manufacturing and services - Tools and improvement cycle (PDCA) - Life cycle approach to quality costs - Prevention, appraisal and failure costs - Organizational, communicational and team requirements - Quality circles - Seven QC tools and their applications - Quality function deployment - Statistical process control - Process capability - Total productive maintenance - Importance of standardization (national and international) - Quality systems - Quality manuals - Quality information systems and documentation - Auditing - Basics of ISO-9000 and ISO 14000: Relevance and misconceptions - Six-sigma philosophy - Quality strategy and policy - Implementation barriers to TQM practices.

Design for Manufacturing and Assembly

An overview of three stages of product design, generating and evaluating conceptual alternatives from manufacturability point of view, selection of materials and processes - Evaluating part configurations for manufacturability - Evaluating parametric mechanical engineering designs for manufacturability - DFM analysis for various manufacturing

processes - Product design for manual assembly - Product design for high-speed automatic assembly - Product design for robot assembly.

Micro and Nano Manufacturing

An overview of micro and nano mechanical systems and their applications in mechanical engineering - MEMS micro fabrication methods - Silicon micromachining methods - Laser micromachining methods - Mechanical micromachining techniques - Nano manufacturing methods - CAD/CAM tools for micro and nano manufacturing processes.

Concurrent Engineering

Concurrent engineering - meaning and need - Review of engineering problem solving methods - Description of methods of analysis, decision making, creativity and information processing and their role in engineering - Discussion of emerging engineering strategies of total design - Design for manufacturing and assembly - Quality function deployment - Constraint networks - Integrating concurrent approaches with those of conventional - Implementation of concurrent engineering in industrial environment, especially those of IT and high speed computation.

Design and Manufacturing of Composites

FRP composites, fiber types, fiber forms and properties, matrices type and properties, lamina, laminate, orthotropy, anisotropy, composites - macro and micro-mechanical analysis and properties, Failure theories - Tsai-Hill, Tsai-Wu, Primary and secondary manufacturing - Lay-up, Autoclave molding filament winding, Pultrusion, Compression molding, RTM, RIM, SRIM, machining, drilling, routing etc., design, structural and testing, applications. Metal matrix composites and ceramic matrix composites - Manufacturing routes and applications.

Elective VI (3-0-2/3-1-0) 4 Credits

Fluid Power Control

Fundamental concepts of fluid power transmission, drives and controls - Oil hydraulics: Properties of conventional fluid - Power pack, valves, positive displacement pumps and motors, electro-hydraulic valves (servo and proportional control), symbols, circuit and systems - Pneumatics: Compressible fluid properties; components, symbols, circuit and applications - Fluid power and control in automation: Fluid logic, applications - Special topics on fluid power and control applications.

Mechatronics

Introduction to mechatronic systems and components - Principle of basic electronics - Microprocessors and their applications - Integrated circuits, sensors, actuators, and other electrical/electronic hardware in mechatronic systems.

Principles of electronic/system communication: Interfacing, DA and AD converters, software and hardware principles and tools to build mechatronic systems - Selection of mechatronic

systems, namely, sensors like encoders and resolvers - Stepper and servomotors - Solenoid like actuators - Transmission elements like ball screw and controllers - Analysis and synthesis of mechatronic systems with applications to robotics, CNC systems and others.

Non Destructive Testing

Scope of non-destructive evaluation; Liquid-penetrant and magnetic particle inspection techniques; X-ray and gamma-ray radiography; Ultrasonic inspection:- principle of wave propagation through solids, surface waves, pulse echo technique, A,B,C scan; Eddy current testing; Image sensing through welding arc; Thermal imaging; Image reconstruction; Inspection of typical components:- castings, forgings, welded components, brazed and adhesive bonded assemblies.

Evolutionary Computing

Genetic algorithms: Introduction, mathematical foundation, computer implementation, applications.

Neural networks: Introduction, multi-layer networks, recurrent networks, learning paradigms.

Fuzzy analysis: Introduction to fuzzy set theory, mathematical foundation, applications.

Chaos: complexity and simplicity, evolution of possibilities, simple models of chaos, deterministic chaos, self-organization.

Evolutionary computing: Hybrid intelligent system, evolutionary dynamics, evolutionary engineering and its application.

Laser Applications in Manufacturing

Common industrial lasers and their output characteristics: CO₂, Ruby, Nd-YAG, Nd-glass, excimer & He-Ne. Overview of laser Applications: Laser application in various fields, advantages & disadvantages, economics. Laser processing fundamentals: beam characteristics, absorption characteristics of materials, heat flow theory and metallurgical considerations. Cutting and drilling: Process characteristics, material removal modes, development of theoretical models and practical performance. Welding: Process mechanisms like keyhole & plasma, development of theoretical models, operating characteristics and process variation. Surface modification: heat treatment, rapid solidification, alloying and cladding, surface texturing, development of theoretical models, LCVD, LPVD. Introduction to interferometry: working principles of Michelson interferometer and Fabry-Perot interferometer and elementary holography. Special topics: detection and measurement of radiation, laser safety.