# SYLLABUS
Manufacturing and Process Engineering  
(Dept. Metallurgy & Materials Engg & Dept. of Production Engg)

1st Year

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DETAILED SYLLYABUS

ENGINEERING MATHEMATICS I (First Semester)
(Calendar, Linear Algebra and Numerical Method)

Module I (10 Hours)
Open sets, closed sets, Limit points of a set, Limits, Continuous functions, the derivative, Increasing and decreasing functions, Darboux’s theorem, Rolle’s theorem, Lagrange’s mean value theorem, Cauchy’s mean value theorem, Extremum values; Riemann integral: Definition and existence of the integral, Integral as a limit of sums, some integrable functions, Fundamental theorem of calculus, Mean value theorems for integral calculus.

Module II (10 Hours)

Module III (10 Hours)
Eigenvalues, Eigenvectors, Some Applications of Eigenvalue Problems, Symmetric, Skew-Symmetric, and Orthogonal Matrices, Eigenbases, Diagonalization, Quadratic Forms, Complex Matrices and Forms, Inclusion of Matrix Eigenvalues, Power Method for Eigenvalues.

Module IV (10 Hours)
Numerical methods in general, Introduction, Solution of Equations by Iteration, Interpolation, Numerical Integration and Differentiation

Text Books:
1. S.C. Malik and S. Arora, Mathematical Analysis, New Age International
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd

Chapters: S.C. Malik - 2(2.1-2.3), 5(5.1-5.3), 6(6.1, 6.3-6.7), 7(7.1), 9(9.1, 9.6, 9.7, 9.9, 9.10)
E. Kreyszig - 7(7.1-7.5, 7.7, 7.8, 7.9), 8, 20 (20.7, 20.8), 19(19.1, 19.2, 19.3, 19.5)

Reference Books:
ENGINEERING PHYSICS (First Semester)

Module I (10 Hours)

Waves and acoustics:
Waves: Elementary idea, Wave equation, Progressive and stationary waves.
Acoustics: Introduction, Classification of sound, Characteristics of Musical Sounds, Weber-Fechner Law, Reverberation, Sabines’s formula, Absorption coefficient and measurement, Acoustic quieting and some common methods of quieting

Module II (12 Hours)

Electromagnetism: Introduction to Vector Products, Gradient, Divergence, Curl of Vector fields, Gauss divergence theorem. Stoke’s theorem, Green’s theorem (statement only), Maxwell’s electromagnetic equations in differential form and in integral form.
Quantum mechanics: Need for Quantum Physics, Basic postulates of quantum mechanics, Wave function properties, Probability density, Normalization of the wave function, Operators, eigenfunction and eigenvalue, expectation value, Schrödinger wave equation (time dependent and time independent), Application of Schrodinger’s equation (particle in one dimensional box)

Module II (10 Hours)

Dielectric Properties: Introduction, Dielectric constant, Dielectric Polarization (Polarizability), Different types of Polarizations in Dielectrics (Electronic, Ionic, Orientational and space charge polarization, Internal fields (no derivation), Clausius-Mosotti equation, Dielectric Loss, Break down and Strength, Applications of Dielectric materials
Magnetic Properties: Introduction, Basic definitions, Bohr magneton, Classification of magnetic materials-Dia, Para, Ferro, Anti-ferro and Ferri magnetism, Hysteresis curve- Soft and Hard magnetic materials, Applications of magnetic materials
Superconductivity: General Properties, Meisener effect, isotope effect, Energy gap in superconductors, Coherence length, Critical magnetic field, Flux quantization Penetration depth, DC and AC Josephson effects Type-I and Type-II superconductors, BCS Theory, Londons equations, Applications of superconductors

Module IV (8 Hours)

Introduction, Classification, Physical characteristics and applications (fundamental)

Books Recommended:
1. Fundamental of Physics: Jearl Walker, David Halliday, Robert Resnick
2. Optics – Ajoy Ghatak
3. Concepts of Modern Physics – A. Beiser
4. Electricity & Magnetism – D. Griffiths
5. Quantum Mechanics – M. Das and P.K Jena
ENGINEERING CHEMISTRY (First Semester)

Module I (10 Hours)

Water Treatment: Hardness, Scale & Sludge, Caustic embrittlement, Priming & Foaming, softening methods, Drinking water, Desalination of Brackish water, Chemical analysis of water.

Module II (10 Hours)

General Metallurgy: Ores & minerals, Ore dressing, Extraction and purification of metals

Corrosion and its control: Introduction, Types of corrosion, Prevention methods, Metallic Coatings, Electro plating, paints and varnishes

Module III (10 Hours)

Thermodynamics of Chemical Processes: Concept of Entropy, Chemical Potential, Equilibrium Conditions for Closed Systems, Phase and Reaction Equilibria, Maxwell Relations


Module IV (10 Hours)

Electrochemistry: Electrode Potentials and its Relevance to Oxidation and Reduction, Measurement of EMF, Determination of pH, Hydrogen, Glass, Quinhydrone Electrodes, Dry Cells, Fuel Cells and Storage Battery

Engineering application of materials: Nanomaterials

Reference Books:
PHYSICAL METALLURGY (First Semester)

Module I (10 Hours)
Introduction, Atomic structure of materials, Symmetry aspects in crystals, Crystal systems, crystal planes and directions, atomic packing efficiency, voids in common crystal systems, Solidification of pure metal, Homogeneous and heterogeneous nucleation processes, cooling curve, concept of supercooling, microstructures of pure metals, solidification of metal in ingot mould. Crystal imperfections,

Module II (10 Hours)
Mechanical properties of metals, concept of plastic deformation of metals, CRSS, Slip and twinning Concept of cold working: Recovery; Recrystallization and grain growth; Hotworking. Concept of equilibrium, Concept of alloy formation, types of alloys, solid solutions, factors governing solid solubility; Unary phase diagram, phase rule, binary phase diagrams: Isomorphous, Eutectic, Peritectic, Eutectoid,Peritectoid, Monotectic and Monotectoid system.

Module III (10 Hours)
Lever rule and its application, interpretation of solidification behavior and microstructure of different alloys belonging to those systems, effect of non-equilibrium cooling, coring and homogenization. Allotropic transformations, order disorder transformations, Iron cementite and iron- graphite phase diagrams, microstructure and properties of different alloys (both steels and cast irons),

Module IV (10 Hours)
Concept of heat treatment of steels i.e., annealing, normalizing, hardening and tempering; Microstructural effects brought about by these processes and their influences on mechanical properties. Effect of common alloying elements on the Fe-Fe₃C and Fe-C diagrams, concept to hardenability, factors affecting hardenability. Alloy steels- Stainless steels. Physical metallurgy of nonferrous alloys Cu-Al, Bronze, Brass.

Text Books:
1. Introduction to physical metallurgy – Sydney Avner
2. Fundamentals of materials science and engineering W. Callister
FUEL, FURNACES AND REFRACTORIES (First Semester)

Module I (10 Hours)
Introduction of fossil fuels and their world-wide reserves; Primary and secondary fuels, Coking and non-coking coals, Characterization of coal properties (caking and swelling indices, calorific value, proximate and ultimate analyses, etc.); Coal carbonization and effects of different parameters; Properties of coke, char and graphite. Selection of coal for sponge iron making and thermal power plants. Alternative sources of energy (viz. ferro-coke, formed coke, charcoal, solar, wind, tidal, etc.) and their suitability for metallurgical and power industries.

Module II (10 Hours)
Classification of refractories, raw materials, manufacture, testing and properties of heavy and special refractories, silica, silicousaluminosilicate, high alumina, magnetisite, chrome, chrome-magnesite, dolomite, forsterite, chemically bonded basic, carbon and insulating refractories and special purpose oxides, carbide nitride refractories. Binary phase diagrams of Al₂O₃-SiO₂, CaO-MgO, Cr₂O₃-MgO and MgO-SiO₂ systems. Refractory mortars and cements, Refractory castables, selection of refractories for coke oven, iron blast furnace, copper convertor, soaking reheating furnaces and heat treatment furnaces, electric arc furnaces.

Module III (7 Hours)
Classification of furnaces: basis and uses. Mechanism of combustion, ignition temperature. Flames: Flame propagation, flame speed and inflammability limits, types of flames; premixed and diffusion flames and their characteristics.

Module IV (13 Hours)

Text Books:
1. Fuels, Furnaces and Refractories by J.D. Gilchrist.
2. Fuels, Furnaces and Refractories by O. P. Gupta.
ENGINEERING MATHEMATICS II (Second Semester)
(Multivariable Calculus and Special Functions)

Module I (10 Hours)

Module II (10 Hours)
Fourier series and integral, Even and odd function, Half range series, Dirichlet criterion, Parseval’s identity, Functions with arbitrary period.

Module III (10 Hours)
Orthogonal curvilinear coordinates, Jacobians, gradient, divergence, curl and Laplacian in curvilinear coordinates, Special curvilinear coordinates.

Module IV (10 Hours)
Gama function, The Beta function – Dirichlet integral, Other special functions– Error function, exponential integral, Sine and cosine integrals, Bessel's Equation, Bessel Functions, Bessel Functions of the Second Kind, Legendre's Equation, Legendre Polynomials.

Text Books:
1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt. Ltd
   Chapters: 5(5.3, 5.5, 5.6), 9(9.4, 9.7, 9.8, 9.9), 10.1-10.4, 10.8, 11(11.1-11.3, 11.6, 11.7), A3.4, A3.1

Reference Books:
1. S.C. Mallik and S. Arora, Mathematical Analysis, New Age International
HEAT TREATMENT (Second Semester)

Module I (10 Hours)

Module II (10 Hours)

Module III (10 Hours)

Module IV (10 Hours)
Heat treatments of general engineering steels: Spring, Bearing steels, Tool steels, HSLA steel and Maraging steels, Dual phase steels and Stainless steels, Heat treatment cast irons, Heat Treatments of Non-ferrous alloys: Al-alloys, Brass, Bronze, and Ti-alloys, Superalloys

Text Books:
METALLURGICAL THERMODYNAMICS & KINETICS (Second Semester)

Module I (10 Hours)
Importance of Thermodynamics, Definition of Thermodynamics; concept of state and path functions, Equation of states, thermodynamic processes, first law of thermodynamics, Phase diagram of a single component system, Internal energy, heat capacity, enthalpy. Second law of thermodynamics, entropy, and entropy changes for various processes.

Module II (10 Hours)
Free energy and its significance, free energy change as a function of temperature, reversible and irreversible process, criteria of equilibrium, auxiliary functions, combined statements, Maxwell’s relations, transformation formula, Gibbs-Helmoltz equation, Concept of standard state.

Module III (10 Hours)
Fugacity, activity, equilibrium constant, Concept of Third law of thermodynamics, temperature dependence of entropy, statistical interpretation of entropy, relation between $C_p$ and $C_v$, consequences of third law, Ellingham – Richardson diagrams. Solutions: partial molal quantities, ideal and non-ideal solutions, Roul't's law; Henry’s law, Gibbs – Duhem equation, regular solution, Chemical potential.

Module IV (10 Hours)

Text Books:
1. Introduction to the Thermodynamics of Materials by D.R. Gaskell; Taylor and Francis.
2. Textbook of Materials and Metallurgical Thermodynamics by A. Ghosh; Prentice Hall of India Pvt. Ltd.
ENGINEERING ECONOMICS & COSTING (Second Semester)

Module I (10 Hours)

Module II (10 Hours)

Module III (10 Hours)

Module IV (10 Hours)

Text Books:
MINERAL PROCESSING (Second Semester)

Module I (10 Hours)

Module II (10 Hours)
Size separation: Sieving and screening, laboratory sizing and its importance, representation and interpretation of size analysis data, industrial screening. Classification: Movement of solids in fluids, free setting and hindered settling of particles, different types of classifiers, e.g. sizing and sorting classifiers used in mineral industry.

Module III (10 Hours)

Module IV (10 Hours)
Agglomeration techniques: Sintering, palletizing, briquetting and their applications in ferrous and non-ferrous metal industries, testing of agglomerates. Important mineral deposits in India.

Text Books:
1. Principle of Mineral Dressing by A. M. Gaudin
2. Mineral Processing Technology by Berry A. Willis
BASIC MANUFACTURING PROCESSES *(Third Semester)*

**Module – I (10 Hours)**
Manufacturing process: Definition, Classification of manufacturing process, Sand Casting: Pattern – materials, allowances, types, molding types, molding procedure, molding and properties, testing of molding sand, cores, core materials, properties of core making. Melting and founding of cast iron, degasification, design of casting and risering, pouring and feeding of casting, casting defects and inspection.

**Module II (10 Hours)**

**Module – III (10 Hours)**

**Module – IV (10 Hours)**
Metal Forming Process:
Extrusion: Classification, Advantages, Limitations and applications
Wire Drawing: Classification, Advantages, Limitations and applications
Rolling: Cold and Hot Rolling processes, Classification, Advantages, Limitations and applications
Sheet Metal Working: Deep drawing process

**TEXT BOOK(S):**

**REFERENCE(S):**
PRINCIPLE OF EXTRACTIVE METALLURGY (Third Semester)

Module I (10 hours)
Overview of Extractive Metallurgy processes; Pyro-metallurgy, Hydrometallurgy and Electrometallurgy; Thermodynamic and Kinetic Principles of metal extraction; Ellingham diagrams, Calcinations; Roasting; Predominance Area Diagram, Roasting Practices, Smelting, Formation and function of slag and their calculations; Metallo-themnic reduction of oxides, Smelting Furnaces, Matte Smelting, Pyro metallurgical processes using vacuum.

Module II (12 hours)
Hydrometallurgy: Leaching; Theory of Leaching; Role of oxygen in leaching operation; Bacterial and microbial leaching; Contact reduction of metals in aqueous solutions; Gaseous reduction of metals in aqueous solutions; Ion exchange, Solvent Extraction and Electrolysis.

Module III (8 hours)
Electrometallurgy: laws of electrolysis, electrolyte Structure of solvent media; Electrolysis of aqueous solution; Electrolysis of fused salts; Cell design; Electro-plating.

Module IV (10 hours)
Halide Metallurgy and Halogenisation; Basic approaches of refining, preparation of pure compounds; Purification of crude metals produced in bulk; Numerical problems relevant to Pyro, Hydro and Electrometallurgical processes.

Text Books:
IRON & STEEL MAKING (Third Semester)

Module I (8 Hours)
History of Iron making in India, Indian and other resources of raw materials required for iron making, coke making. Blast furnace plant and -Modern blast furnace, plant layout, Details of construction of blast furnace and its main accessories; gas cleaning system, hot blast generation. Blast furnace refractories and blast furnace cooling system

Module II (10 Hours)
Agglomeration of iron ore fines, sintering and pelletisation, evaluation of properties of blast furnace, burden materials and application to blast furnace performance. Blast furnace plant operation, blowing in, blowing out and banking of blast furnace, role of burden charging and distribution in iron extraction, irregularities in Blast furnace operation and their remedies. Blast furnace products their quality control and disposal, coke rate and fuel efficiency of B.F. operations.

Module III (12 Hours)
Modern trends in Blast furnace practice—Production of super flux sinter, pellets, super flux and cold bonded pellets. Auxiliary fuel injection in the blast furnace. High temp.blast, humidified and oxy generated blast, high top pressure, Desulphurization of hot metal. Chemical processes in Blast Furnace, Reactions in Tuyere, hearth and bosh zone. Reduction and coke gasification, Reactions in stack and exit gases. Thermodynamics of Blast furnace process requirement in Blast furnace, temp. profile in the furnace. Free energy and equilibrium consideration in Blast furnace a brief discussion on blast furnace stoichiometry and enthalpy balance

Module IV (10 Hours)
Alternate route for iron making charcoal blast furnace, low shaft furnace and electro thermal processes of iron making. Direct reduction processes, their classification, choice of DR process. Introduction to Production of Ferro-alloys. Production of various ferro-alloys Fe-Mn, Fe-V, Fe-Cr etc. uses of ferro-alloys in iron and steel industry

Text Books:
1. Modern Iron Making - Dr. R.H. Tupkary
2. Principles of Blast Furnace iron making - Dr. A K Biswas
PHASE TRANSFORMATIONS IN METALS & ALLOYS (Third Semester)

Module I (12 Hours)
Classification of phase transformations. Thermodynamics and Kinetics: Introduction, Equilibrium, Gibbs free energy change with single component system, Thermodynamic parameters in binary system, Binary phase diagrams, Free energy Vs Composition phase diagrams.

Module II (8 Hours)
Crystal interfaces: Interfacial free energy, Boundaries in single phase solids, Bond breaking model, Interphase interfaces in solids: interface coherency, interfacial energy effects, misfit strain effects.
Nucleation and growth: Homogeneous nucleation, homogeneous nucleation rate, Heterogeneous nucleation, Heterogeneous nucleation rate, Growth of a pure solid,

Module III (15 Hours)
Diffusional transformations in solids: Overall transformation kinetics: TTT diagrams, Precipitation in age hardening alloys, Particle coarsening, Spinodal decomposition, Ferrite: nucleation and growth, Pearlitic transformation: mechanism, nucleation and growth, Bainitic transformation: mechanism, nucleation and growth, Effect of alloying elements on hardenability, CCT diagrams, massive transformations, ordering transformations

Module IV (5 Hours)
Diffusionless transformations: Martensitic transformations: characteristics, crystallography, theories of Martensitic nucleation, martensite growth. Recovery, Recrystallization and grain growth.

Text Books:
1. Phase transformations in metals and alloys by D.A.Porter, K.E.Easterling and Sharif, CRC press
2. Phase transformation in materials by Romesh C Sharma, CBS publishers & Distributors
THEORY OF METAL FORMING (Fourth Semester)

Module I (10 Hours)

Review of two dimensional stress and strain, state of stress in three dimensions, Stress tensor, Invariants, Mohr’s circle for 3-dimensional state of stress, strain at a point- Mohr’s circle for strain, Hydrostatic & Deviatory components of stress, Elastic stress-strain relations.

Module II (10 Hours)

Elements of theory of plasticity; Flow curve, True stress & true strain, Yield criteria for ductile metals, Von Misses & Teresa yield criteria, combined stress tests. The yield locus, Anisotropy in yielding, Yield surface, levy-Misses, Prandtl-Reuss Stress-Strain relation, Classification of forming processes variables in metal forming and their optimization.

Module III (10 Hours)


Module IV (10 Hours)

Analysis of metal forming processes (only limited portion), forging: Load calculation in plane strain forging, Rolling: Forces & geometrical relationship in rolling, Rolling load and torque in cold rolling, Von-Karman work equation,

Text Books:
NON-FERROUS EXTRACTIVE METALLURGY (Fourth Semester)

Module I (10 Hours)
General principles of extraction of metals from oxides and sulphides; Mineral resources of non – ferrous metals in India; their production, consumption and demand; Future of non – ferrous metal industries in India; Thermodynamic considerations and process selection in pyro-metallurgical extraction of metals. Aluminium: Bayer’s process and factors affecting its operation; Hall – Heroult process: principle & practices, use of electrodes, anode effect; Refining of Aluminium; Alternative methods of Alumina and Aluminium production.

Module II (12 Hours)
Extraction of metals from Sulphide ores (Cu, Ni, Pb and Zn) Matte smelting; Converting; Refining; by-products recovery; recent developments; Continues copper production processes, hydrometallurgy of copper.

Module III (8 Hours)
Extraction of metals from oxide ores (Sn, Mg), and extraction of metals through halide route (Ti and Zr). Extraction of metals like (U,Nb, etc)

Module IV (10 Hours)
Electro winning and Electro refining of metals:
a) From aqueous salts (Cu, Ni, Au, and Ag)
b) From fused salts (Al and Mg)
Environmental pollution and its address related to various metal extraction processes in general.

Text Books:
ORGANISATIONAL BEHAVIOUR (Fourth Semester)

Module I (10 Hours)

OB: Learning objectives, Definition & Meaning, why to study OB, An OB model, New challenges for OB Manager
LEARNING: Nature of learning, how learning occurs, Learning & OB
Case Study Analysis

Module II (10 Hours)

PERSONALITY: Meaning & Definition, Determinants of Personality, Personality Traits, Personality & OB
PERCEPTION: Meaning & Definition, Perceptual process, Importance of Perception in OB
MOTIVATION: Nature & Importance, Herzberg’s Two Factor theory, Maslow’s Need Hierarchy theory, Alderfer’s ERG theory
Case Study Analysis

Module III (10 Hours)

COMMUNICATION: Importance, Types, Barriers to communication, Communication as a tool for improving Interpersonal Effectiveness
GROUPS IN ORGANISATION: Nature, Types, why do people join groups, Group Cohesiveness & Group Decision Making- managerial Implications, Effective Team Building
LEADERSHIP: Leadership & management, Theories of leadership- Trait theory, Behavioural Theory, Contingency Theory, Leadership & Followership, how to be an Effective Leader
CONFLICT: Nature of Conflict & Conflict Resolution
TRANSACTIONAL ANALYSIS: An Introduction to Transactional Analysis
Case Study Analysis

Module IV (10 Hours)

ORGANISATIONAL CULTURE: Meaning & Definition, Culture & Organizational Effectiveness
HUMAN RESOURCE MANAGEMENT: Introduction to HRM, Selection, Orientation, Training & Development, Performance Appraisal, Incentives
ORGANISATIONAL CHANGE: Importance of Change, Planned Change & OB Techniques
INTERNATIONAL OB: An Introduction to Individual & Interpersonal Behavior in Global Perspectives
Case Study Analysis
MATERIALS CHARACTERIZATION (Fourth Semester)

Module I (10 Hours)
Introduction to materials characterization & its importance, Fundamentals of Crystallography, levels of characterization (macro, meso and micro), Resolution, depth of field/focus, aberrations (spherical, chromatic and astigmatism) and its remedial measures. Optical microscopy (OM) – Microscope construction and working, reflected/transmitted light microscope, theoretical and practical resolution of optical microscope, numerical aperture, principle of image formation, effective/empty magnification, Types of illumination - bright field, dark field, polarized light and phase contrast, applications of each type of illumination. Sample preparation for optical microscopy, features of an image

Module II (12 Hours)
Introduction to scanning electron microscope (SEM), working and construction, advantages/disadvantages as compared to OM, types of electron gun and comparison between them. Electron - specimen interaction, imaging modes (secondary and backscattered), effect of spot size, apertures, accelerating voltage on SEM image, Everhart-Thornley detector, Robinson detector, solid state segmented detector, atomic number and topological contrast. Chemical analysis using SEM, EDS/WDS working principle, construction, resolution of EDS/WDS detector, advantages/disadvantages.

Module III (8 Hours)

Module IV (10 Hours)
Thermal analysis techniques & its Importance, principles and applications of differential thermal analysis (DSC), differential scanning calorimetry (DSC) and thermogravimetric analysis (TGA). Brief idea of TEM: principle of operation, application. Introduction to advanced microscopic techniques.

Text Books:
2. Electron Microscopy and Microanalysis, Goodhew, Humphreys and Beanland, Taylor and Francis, New York, 2001
HYDRO AND ELECTRO METALLURGY (*Fifth Semester*)

*Module I (10 Hours)*

Introduction: Justification of Hydrometallurgical selection of solvent processing, Eh-Pt diagrams Principles underlying hydrometallurgical processes, various commercial hydrometallurgical processes. Criteria for selection of solvents, Types of Solvents.

*Module II (10 Hours)*

Thermodynamics & kinetics of hydrometallurgical processes, Unit operations in hydrometallurgical processing, Thickness & filters, counter current decantation. Applications of hydrometallurgy to Copper, Zinc, Precious metals etc.

*Module III (10 Hours)*


*Module IV (10 Hours)*


**Text Books:**

2. E. Jackson, Hydrometallurgical Processing & Reclamation, John Wicky & Sons.
DEFORMATION THEORY OF METALS (Fifth Semester)

Module I (10 Hours)
Introduction: Scope of the subject, elastic, plastic and visco-elastic deformation. Deformation behavior: Tensile and compression testing, effect of temperature and strain rate Continuum mechanics: Concepts of stress and strain in 3D stress and strain tensor, principal stresses and strains and principal axes, mean stress, stress deviator, maximum shear, equilibrium of stresses, equations of compatibility.

Module II (10 Hours)

Module III (10 Hours)
Microscopic basis of plastic deformation: Elements of dislocation theory, movement of dislocation, elastic properties of dislocation, intersection of dislocation, dislocation reactions in different crystal structures, origin and multiplication of dislocations. Plastic deformation of single crystals: Critical resolved shear stress, deformation by twinning, deformation band and kink band, strain hardening of single crystal; stress-strain curves of fcc, bcc and hcp materials

Module IV (10 Hours)
Plastic deformation of polycrystalline materials: Role of grain boundaries in deformation, strengthening by grain boundaries, yield point phenomenon, strain ageing, strengthening by solutes, precipitates, dispersoids and fibres. Deformation in non-metallic materials: structure and deformation of polymers, concept Super lattice dislocations in inter metallics, and concept of charge associated with dislocations in ceramics.

Text Books:
TRANSPORT PHENOMENA (Fifth Semester)

Module I (10 Hours)

Module II (10 Hours)
Heat Transfer I: Steady state and Transient conduction in solids. One dimensional steady state problems of heat flow through composite walls, Cylinder and Spheres. Unsteady conduction in one dimensional system.Use of Heisler charts and applications. Convective heat transfer, equation of energy, free and forced convections.

Module III (10 Hours)

Module IV (10 Hours)
Mass Transfer and Kinetics: Importance in Heterogeneous metallurgical systems of reactions. Steady state one dimensional mass diffusion of component through stationary media. Convective mass transfer in fluids, concept of concentration boundary layer, Mass transfer coefficient.Heterogeneous reactions of metallurgical importance, their rate controlling steps. Discussion of the following examples from metallurgical systems: Nucleation and growth and bubble formation phenomenon, Interfacial reaction, Carbon gasification by CO2, slag-metal reaction at the interface, Topo-chemical model of gas-solid reaction

Text Books:
NON-CONVENTIONNAL MACHINING (Fifth Semester)

Module-I (10 Hours)

Module-II (10 Hours)

Module-III (10 Hours)
Electro Discharge Machining: mechanism of material removal, Basic EDM circuitry and principles of operation, Analysis of relaxation circuits, Concepts of critical resistance, Machining accuracy and surface finish, Tool Material, Dielectric fluid, Application limitation.


Module-IV (10 Hours)

Text Books:
1. Modern machines process- P.C.Pandey and H.S.Shan. TMH
TESTING OF MATERIALS (Sixth Semester)

Module I (10 Hours)
Engineering materials and their applications, testing of materials: Types of testing systems, significance of measurement of properties and test conditions, interpretation of test results, Tensile Testing: significance of measured parameters, necking, stress distribution, ductility measurement,

Module II (10 Hours)
Effect of gauge length, effect of strain rate and temperature on flow properties, Machine stiffness in tensile testing system, measuring instrument computerization, Torsion Test: Mechanical properties in torsion. torsion vs tension test.

Module III (10 Hours)

Module IV (10 Hours)
Fatigue Tests: Stress cycles, SN curve, effect of stress concentration, size and surface conditions on fatigue, Creep, Stress rupture tests, Creep curve and its analysis, Non-destructive Testing: Visual, magnetic, radiographic, ultrasonic, electromagnetic, penetrant tests, their applications in quality control and inspection.

Text Books:
1. Mechanical Metallurgy George E. Dieter
2. Materials Testing by S. Bhargava
Module I (10 Hours)
Introduction, importance of corrosion study, corrosion as non equilibrium process, corrosion rate expressions, electrochemical principles of corrosion-cell analogy, concept of single electrode potential, reference electrodes, e.m.f. and galvanic series-their uses in corrosion studies, polarization, passivity.

Module II (10 Hours)
Different forms of corrosion-uniform attack, galvanic, crevice, pitting, intergranular, stress corrosion cracking -their characteristic features, causes and remedial measures. Principles of corrosion prevention-material selection control of environment including inhibitors

Module III (10 Hours)
Cathodic and anodic protection, coatings and design considerations. Corrosion testing methods. Introduction to high temperature corrosion, Pilling- Bedworth ratio, oxidation kinetics, oxide defect structures

Module IV (10 Hours)
Considerations in high temperature alloy design, prevention of high temperature corrosion -use of coatings. Hydrogen Damage-Sources, Types of damage, Mechanisms and preventive methods, Liquid metal attack -liquid metal embrittlement, preventive measures

Text Books:
PRODUCTION & OPERATION MANAGEMENT (Sixth Semester)

Module I (10 Hours)
Operations function in an organization, Manufacturing vs. Service operation. Design in products, services & processes, new product design, Product life cycle, Design for services, Services process technology. Value Engineering, Standardization, Make or buy Decision. Process technology: project, job shop, batch, assembly line, continuous manufacturing, Process technology life cycle, Process technology trends, CAD, CAM, GT, FMS and CIM.

Module II (10 Hours)

Module III (10 Hours)
Facility location: Factor influencing plant & warehouse location, impact of location on cost & revenue. Facility location procedure & models; qualitative models, Breakeven analysis, Single facility location model, Multi facility location model, Minimax location, Total & partial covering model. Plant Layout: layout types; Process layout, Product layout, Fixed position layout, planning, tools and techniques of plant layout, travel chart, Systematic layout planning, CORELAP, ALDEP and CRAFT.

Module IV (10 Hours)

Text Books:
2. Production and Operations Management- R. Panneerselvam, PHI.
COMPUTER INTEGRATED MANUFACTURING (Seventh Semester)

Module-I (10 Hours)
Introduction: The meaning and origin of CIM, The changing manufacturing and management scenario, External communication, Islands of automation and software, Dedicated and open systems, Manufacturing automation protocol, Product related activities of a company, Marketing engineering, Production planning, Plant operations, Physical distribution, Business and financial management. Computer Aided Process planning: Role of process planning in CAD/CAM integration, Approaches to computer aided process planning- Variant approach and Generative approaches, CAPP and CMPP process planning systems.

Module-II (10 Hours)
Shop Floor Control and FMS: Shop floor control-phases, Factory data collection system, Automatic identification methods- Bar code technology, Automated data collection system, FMS-components of FMS - types -FMS workstation, Material handling and storage systems, FMS layout, Computer control systems-application and benefits.

Module-III (10 Hours)
CIM Implementation: CIM and company strategy, System modeling tools-IDEF models, Activity cycle diagram, CIM open system architecture (CIMOSA), Manufacturing enterprise wheel, CIM architecture, Product data management, CIM implementation software. Data Communication: Communication fundamentals, Local area networks, Topology, LAN implementations, Network management and installations.

Module-IV (10 Hours)

Text Books:
POWDER METALLURGY AND COMPOSITE MATERIALS  (Seventh Semester)

Module I (10 Hours)
Introduction to powder metallurgy, Metal and alloy powder production, chemical, physical and mechanical methods of production, metal powder characterization introduction, chemical composition, particle size, surface area, densit , compressibility, strength .

Module II (8 Hours)
Powder compaction, Sintering introduction, Introduction to Composites: Matrices, Reinforcements: galss fibre, carbon fibre, whiskers, Fundamental concept of reinforcement, review of current developments; Basic mechanics of reinforcement, stiffness of parallel arrays of fibers in a matrix,

Module III (12 Hours)
Polymer Matrix Composites (PMCs): processing of thermoplastic and thermoset matrix composite, structural defect and mechanical properties, application .Metal Matrix Composites (MMCs):Aluminum alloy, copper alloy, titanium alloys, solid state processing, in situ processing, high temperature properties and strength, applications .

Module IV (10 Hours)
Ceramic Matrix Composites (CMCs):cold pressing and sintering, hot pressing, self propagating high temperature synthesis, thermal shock resistance properties, crack deflection and toughness. Nano composites: polymer clay nano composite, self healing and self reinforced composite, bio composite, hybrid composite.

Text Books:
1  Powder metallurgy technology by G. S. Upadhyaya
2  Composite materials science and engineering by K. Chawla
SURFACE ENGINEERING (Seventh Semester)

**Module I (10 Hours)**

Introduction, Surface dependent engineering properties, viz., Friction and wear, corrosion, fatigue, etc.; common surface initiated engineering failures; mechanism of surface degradation; importance and necessity of surface engineering; classification and scope of surface engineering in metals, ceramics, polymers and composites, tailoring of surfaces of advanced materials.

**Module II (10 Hours)**

Surface protection (Physical); surface modification (Chemical) techniques: classification, principles, methods, and technology. Conventional surface engineering methods: carburising, nitriding, cyaniding, diffusion coating, hot dipping, galvanizing etc.

**Module III (8 Hours)**

Electrochemistry and electro-deposition; scope and application of conventional surface engineering techniques in engineering materials; advantages and limitations of conventional processes

**Module IV (12 Hours)**

Recent trend in surface engineering: physical/chemical vapor deposition; plasma spray coating; plasma assisted ion implantation. Surface modification by directed energy beams like ion, electron and laser beams; energy transfer, novelty of the directed energy beams assisted surface modification techniques.

**Text Books:**

CASTING & SOLIDIFICATION OF MATERIALS (Seventh Semester)

Module I (10 Hours)
Introduction: Casting as a process of Manufacturing. Moulding Processes, Equipments and Mechanization: Different types of Moulds, Moulding Materials and Moulding processes, Pattern and other mould making equipments, Different types of binders and their uses in mould and core makings.

Module II (10 Hours)
Melting of Metals and Alloys for casting: Brief mention of various melting units, melting and post melting treatments, melting practices as adopted for a few metals and alloys such as CI, Al, Cu, steels, cast irons.

Module III (10 Hours)
Solidification of Metals and Alloys: Nucleation, Growth, Role of alloy constitution, Thermal conditions and inherent nucleation and growth conditions in the liquid melt, Time of solidification and Chowrinov rule, concept of directionality in solidification Significance and practical control of cast structure
Principles of Gating and Risering: Feeding characteristics of alloys, Types of Gates and Risers, gating ratio.

Module IV (10 Hours)
Special casting Methods: Investment casting, Die casting, Centrifugal casting, Full mould casting, Vacuum sealed casting. Casting Defects: A detailed analysis of casting defects Their causes and prescription of remedial measures

Text Books:
1. P. R. Beeley, Foundry Technology, Newnes-Butterworths, 2001
STRENGTH OF MATERIALS (Eighth Semesters)

Module-I (10 Hours)
Analysis of axially loaded members: Composite bars in tension and compression-temperature stresses in composite rods-statically indeterminate problem. 2D Stress system, Principal Planes, Principal stress, Mohr’s stress circle, Members in biaxial state of stress: Stresses in thin cylinders, thin spherical shells under internal pressure-wire winding of thin cylinders. Strain & deformation: Two dimensional state of strain, Principal Strains, Calculation of principal stresses from principal strains, Strain measurement.

Module-II (10 Hours)

Module-III (10 Hours)
Torsion in solid and hollow circular shafts, Twisting moment, strength of solid and hollow circular shafts, Strength of shafts in combined bending and twisting, Close-coiled helical springs. Deflection of Beams: Slope and deflection of beams by integration method and area-moment method.

Module-IV (10 Hours)
Buckling of columns: Euler’s theory for initially straight columns with various end conditions. Theories of failure: maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, Maximum strain energy theory and maximum distortion energy theory.

Text Book(s):
AUTOMATION AND NUMERICAL CONTROL MACHINES (Eight Semester)

Module-I (10Hours)

Module-II (10Hours)

Module-III (10Hours)
Numerical Control: Components of NC system, NC procedure, NC co-ordinate system, motion control, applications, NC part programming-manual part programming, computer assisted part programming, ATP language-macro statements, programming with interactive graphics, NC part programming using CAD/CAM. Writing simple part programme. Computer control in NC: Problems with conventional NC. Controller technology, CNC, DNC Adaptive Control

Module-IV (10Hours)
Automated material handling: Type of equipment, Principles of material handling, Conveyor system Group Technology cell formation: Part classification & coding, Computer Aided Process Planning (CAPP) - Retrieval & Generative type process planning system.

Text Books:
1. Automation, Production System and CIM- M.P.Groover, PHI.
2. CAD/CAM- Groover & Zimmers, PHI.
ADVANCED MATERIALS (Eighth Semester)

Module I (10 Hours)
Electronic Polymers, Organic electronics, Melanin, Organic semiconductor, Printed electronics, Organic LED. Nanostructures, Nanomaterials, Nanocomposites. Biomaterials: Metallic biomaterials like 316L stainless steel, Co-Cr Alloys, Titanium Ti6Al4V.,

Module II (10 Hours)

Module III (10 Hours)

Module IV (10 Hours)

Text Books: