Metallurgical Engineering
Syllabus

Thermodynamics and Rate processes : Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria , Ellingham and phase stability diagrams, thermodynamics of surfaces, interfaces and defects, adsorption and segregation; basic kinetic laws, order of reactions, rate constants and rate limiting steps; principles of electro chemistry- single electrode potential, electro – chemical cells and polarizations, aqueous corrosion and protection of metals, oxidation and high teparature corrosion- characterization and control; heat transfer – conduction, convection and heat transfer coefficient relations, radiation, mass transfer – diffusion and Fick's laws.

Extractive Metallurgy: Minerals of economic importance, comminution techniques, size classification, Flotation, gravity and other methods of mineral processing; agglomeration, pyrometallurgy, hydrometallurgy and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals – aluminum, copper, Zinc, lead, magnesium, nickel, titanium and other rare metals;

Iron and Steel making – principles, role, structure and properties of slags, metallurgical coke, blast furnace, direct reduction processes, primary and secondary steel making, ladle metallurgy operations including deoxidation, desulphurization, inert gas rinsing and vacuum reactors; secondary refining processes including AOD, VAD, VOD, VAR and ESR;ingot and continuous casting; stainless steel making, furnaces and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, ceramics and polymers, structure of surfaces and interfaces, nano-crystalline and amorphous structures; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, cast iron and aluminum alloys;

surface treatments; recovery, recrystalization and grain growth; industrially important ferrous and non-ferrous alloys.

Elements of X-ray and electron diffraction: principles of scanning and transmission electron microscopy; industrial ceramics; polymers and composites-classification, production, properties and applications.

Mechanical Metallurgy: Elasticity, yield criteria and plasticity; defects in crystals; elements of dislocation theory – types of dislocations, slip and twinning, source and multiplication of dislocations, stress fields around dislocations, partial dislocations, dislocation interactions and reactions; strenghthening mechanisms; tensile, fatigue and creep behaviour; super – plasticity fracture – Griffith theory, concepts of linear elastic and elasto – plastic fracture mechanics, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing – tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness, NDT using dye penetrant, ultrasonic, radiography, eddy current, acoustic emission and magnetic particle methods.

Manufacturing Processes : Metal casting – patterns and moulds including mould design involving feeding, gating and risering, melting, casting practices in sand casting, permanent mould casting, investment casting and sheel moulding, casting defects and repair; hot, warm and cold working of metals, Metal forming – fundamentals of metal forming processes of rolling, forging, extrusion, wire drawing and sheet metal forming, defects in forming;

Metal joining – soldering, brazing and welding, common welding processes of shielded metal arc welding, gas metal arc welding, gas tungsten arc welding and submerged arc welding; welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welded joints; powder metallurgy-powder production, characterization of powders, consolidation/compaction, sintering and finishing operations.