UNDERGRADUATE COURSE DESCRIPTIONS

Physical Properties of Materials I
Atomic structure of metals; atomic binding; metal structure; crystal defects; classification of alloys; phase diagrams; solid solution, eutectic, peritectic, monotectic, eutectoid, ...; iron-carbon diagram; TTT diagrams; precipitation hardening, ternary diagrams.
Prerequisite: Physical Chemistry of Materials

Physical Properties of Materials II
Kinetics of phase transfor- mation in the solid state, diffusion, nucleation, annealing, recrystallization grain growth, diffusional transformation in steels, martensitic transformation.
Prerequisite: Physical Properties of Materials I

Mechanical Properties of Materials I
Behavior of metals under simple and combined stress systems, elements of theory of elasticity, plastic deformation, elements of theory of dislocations, strengthening mechanisms.
Prerequisite: Physical Properties of Materials I

Modern Techniques in Materials Analysis
Essential techniques for materials characterization, Techniques suitable for elemental and phase analysis like AA, XRD, XRF, EDS, ICP - OES, SEM, and TEM.
Prerequisite: Physical Properties of Materials II

Principles of Metals Extraction I (Pyrometallurgy)
Principles of calcination and roasting, reduction of metals oxides, volatile metals, matte smelting and converting, metallotermic reduction, refining processes (fire refining , steelmaking, desulfurization, deoxidation, zone refining, vacuum refining, metal-metal separation), problems.
Prerequisite: Materials Thermodynamics I, Ore Dressing

Steelmaking
Principle reactions of steelmaking, gases and non metallic inclusions in steel, deoxidation, charge materials and refractories, oxygen steelmaking processes (LD, LDAC, Kaldo,...), electric furnace steelmaking, quality steelmaking.
Prerequisite: Ironmaking I

Metals Extraction I (Iron & Steel Manufacture)
Principles reactions of ironmaking, iron ores, charge materials, agglomeration (sintering, pelletizing), coking, manufacture of pig iron in the blast furnace, direct reduction process, principles reactions of steelmaking, steelmaking processes.
Prerequisite: Materials Thermodynamics I

Corrosion and Oxidation
Definition, classification, anodic and cathodic reactions, various type of corrosion, corrosion tests, materials selection, cathodic and anodic protections, inhibitors, polarization, electrochemical techniques.

Corrosion Laboratory
Galvanic couples, oxygen concentration cell, electrochemical methods, practical cathodic protection method, coatings on steels using electroplating and electroless plating processes.
Prerequisite: Corrosion and Oxidation

Heat Treatment
Iron-Carbon equilibrium diagram, effects of alloying elements and cooling rate on microstructure, pearlite, bainite and martensite transformations, TTT and CCT diagrams; homogenizing, annealing, normalizing, partial annealing, hardening and tempering; hardenability; case hardening; industrial problems.
Prerequisite: Physical Properties of Materials II

Non-Ferrous Alloys
Review of failure mechanisms and strengthening mechanisms; structure, properties, metallurgical processing and applications of non-ferrous alloys including light metals, copper, zinc and their alloys, low-melting, solders and bearing metals, precious metals, refractory metals and superalloys.
Prerequisite: Physical Properties of Materials II

Nondestructive Testing
Discussion of various inspection techniques, e.g. Liquid-penetrant, magnetic-particles, Eddy-current, radiographic (X-and Gama Ray), electron and neutron radiographic, ultrasonic, thermal, optical and acoustical holography.
Prerequisite: Senior year standing.

Metal Forming
Stress and strain, principal stresses and yielding criteria, metalworking theory, effect of temperature and strain rate on workability, metalworking, processes: cold and hot rolling, drawing, extrusion, forging, sheet metal working,
Prerequisite: Mechanical Properties of Materials

Materials Thermodynamics I
Review of thermodynamics laws and functions, reactions involving pure condensed phases and gaseous phase, phase equilibria in a one-component system, solution thermodynamics, free energy-composition and phase diagrams of binary systems, electrochemical systems.
Prerequisite: Physical Chemistry of Materials

Ironmaking II
Physical chemistry of Direct Reduction (thermodynamics and kinetics), Reducing gas production (Catalytic Reforming, Partial Oxidation), Direct reduction Processes, Use of DRI in Electric Arc Furnaces.
Prerequisite: Iron Making I

Principles of Metals Extraction II (Pyrometallurgy)
Electro- chemistry of aqueous solutions, thermodynamics of aqueous solutions, chemistry of leaching processes, leaching methods, recovery of metals from leach solutions: cementation, electrowining, solvent extraction and ion exchange.
Prerequisite: Principles of Physical Metallurgy

Physical Chemistry of Materials
Behavior of gases: equation of state of ideal and real gases, heat capacity of an ideal gas, mixtures of ideal gases. The first law of thermodynamics : intensive and extensive properties, internal energy and the first law of thermodynamics, chemical equilibrium, enthalpy of formation and the Hess law, heat of reactions, the second law of thermodynamics, the statistical interpretation of entropy.
Prerequisite: Calculus, General Chemistry

Production of Non-Ferrous Metals
Pyrometallurgy : production of copper; roasting of sulphide concentrates, chemistry of roasting, matte smelting, industrial furnaces for matter smelting, converting of coppermatte,

continuous methods, anod refining, electric refining of copper, production of zinc, lead, tin, aluminium, and magnesium, pyrometallurgical processes for production of above metals.
Prerequisite: Principles of Extractive Metallurgy II (Pyrometallurgy)

Metals Extraction II (Non-Ferrous Metals Manufacture)
Principles of pyrometallurgical processes : thermodynamics and kinetics of roasting, calcination, smelting, converting, and refining, production of copper, zinc, lead, and aluminum via pyrometallurgical processes, principle of pyrometallurgy : production of non-ferrous metals by pyrometallurgy.

Crystallography
Bonding, crystal systems, Bravais lattice, elements of crystal symmetry, reciprocal lattice, stereographic projection, elements of X-ray crystallography.
Prerequisite: General Chemistry

Refractories
Crystal structure of ceramics, silicate structures, ceramic raw materials and phase diagrams, processing-properties and applications of ceramics, different kinds of refractories, their shapes and testing methods.

Materials Science
Relationship between structure, properties, and processing methods, evaluation of mechanical properties of materials (mechanical Testings), diffusion, defects, phase diagrams, heat-treatment of alloys, corrosion, ceramics, polymers, composites.
Prerequisite: General Chemistry

Kinetics in Materials Engineering
The concept of kinetic, a comparison between kinetics and thermodynamics, chemical kinetic : the rate of reactions, rate laws, the order or reactions, theories of reaction rates (collision and activated complex), The effect of temperature, pressure, concentration and catalyst on the rates of reactions. Transport Kinetic: A review on mass transfer in metallurgical reactions (diffusion and convection).

Computer Application in Materials Engineering
Computer Hardware & Software, Application programs, Fundamentals of Modelling, Geometric modelling (CAD), Numerical modelling: FDM, FEM, BEM, MC, CA, Computer Simulation of Metallurgical Processes (Casting and solidification of metals, Heat treatment, Phase transformation, Welding and joining, Metal forming, Electromagnetic processes, Failure analysis, Artificial Intelligence …), Computer-aided Experimental Systems, Data acquisition, Phase & stability diagrams, Thermal analysis, Metallography, Mechanical tests.
Prerequisite: Computer Programming