

Metallurgical Engineering

DEGREE STANDARD

PHYSICAL AND MECHANICAL METALLURGY

UNIT I

1. Elements of Materials Science:

Atomic binding, elementary crystallography, single crystals and polycrystals, grain boundaries, point defects and line defects. Binary equilibrium diagram, Gibbs' phase rule, solid solutions and intermediate phases, transformations during cooling of pure metal and typical alloys.

2. Materials testing:

Tension test, stress - strain curve, elastic and plastic deformation, strength, ductility and toughness, Hardness, impact, fatigue and creep testing.

3. Mechanical behaviour:

Slip and twinning, critical resolved shear stress. Elementary dislocation theory, edge and screw dislocations, stress fields around dislocations, dislocation interactions, application to plastic deformation, work hardening, recovery, recrystallization and grain growth. Strengthening mechanisms. Ductile and brittle fracture, elementary fracture mechanics. Fatigue and creep behaviour, mechanisms and methods of improvement.

4. Heat treatment of ferrous alloys:

Iron - carbon diagram, steels and cast irons, hypo - and hyper - eutectoid steels. Decomposition of austenite on continuous cooling, effect of cooling rate, eutectoid and martensitic reactions. Isothermal transformation of austenite, formation of bainite, ttt and oct diagrams, concept of hardenability. Tempering of martensite. Common heat treatments of steel - annealing, normalising, hardening, tempering, case - hardening. Types of cast iron and their heat treatment.

5. Classification of steels:

Effect of alloying elements in steel, low - alloy and high - alloy steels.

6. Phase transformations:

Principles of solidification, elementary ideas and diffusion, diffusion - based solid - state transformations, including precipitation from solid solution, age - hardening.

7. Important non-ferrous alloys:

Physical metallurgy of aluminium, copper, nickel, magnesium, titanium and zinc alloys, useful alloys based on these for industrial application.

8. Metallurgical characterisation techniques:

Microscopic examination, X-ray diffraction, introduction to transmission electron microscopy, and scanning electron microscopy.

PAPER -II

CHEMICAL AND INDUSTRIAL METALLURGY

UNIT 2

1. PRINCIPLES OF EXTRACTIVE METALLURGY

Thermodynamic principles metal extraction, physio-chemical aspects of pyrometallurgy, hydrometallurgy and electrometallurgy, principles of metal refining

2. PRODUCTION OF IRON:

Raw materials and their beneficiation, description of the blast furnace and its accessories, blast furnace reactions, direct and indirect reductions, recent trends in blast furnace technology. Other methods of iron - making - electric and low - shaft practices. Iron - making under Indian conditions.

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3. PRODUCTION OF STEEL:

Bessemer, open - hearth and L _ D processes, steel - making reactions, control of composition, dephosphorization, desulphurization and deoxidation reactions, electric furnace steel - making, production of alloy steels, recent developments in refining steels.

4. NON - FERROUS EXTRACTION:

Ores and their availability in India, raw material beneficiation, principles of extraction of copper, zinc aluminium, magnesium, nickel and titanium. Extraction of uranium, thorium and zirconium.

5. METAL JOINING:

Common welding processes including manual metal arc, submerged arc and gas - shielded welding. Weld thermal cycle and metallurgical principles in the welding of steels, stainless steels and aluminium alloys. Brazing and soldering. Welding defects and remedies.

6. METAL CASTING:

Structure of ingots and castings, moulding processes, principles of gating and risering, segregation and other defects, remedies.

7. METAL FORMING:

Fundamental aspect of plasticity cold, warm and hot working basic aspects of rolling, forging, extrusion, wire - drawing and sheet metal working, forming defects and remedies.

8. POWDER METALLURGY:

Powder production processes, characteristics of powders, pressing and sintering, advantages and applications of powder metallurgy.

9. NON -DESTRUCTIVE TESTING AND FAILURE ANALYSIS:

Principles of dye - penetrant, magnetic particle, ultra sonic and radiographic inspection, failures in engineering components and methods of analysis.

10. CORROSION:

Forms of corrosion, corrosion testing procedures, measures for minimizing corrosion like inhibition, anodic and cathodic protection and surface treatment.