Unit I

Chapter 1 : Crystal Structures and Deformation of Materials 1-1 to 1-61

Syllabus : Crystal Structures : Study of Crystal structures BCC, FCC, HCP and lattice parameters and properties, Miller indices, Crystal imperfections, and Diffusion Mechanisms.

Material Properties : Mechanical (Impact, hardness, etc.), Electrical, optical and Magnetic properties.

Deformation of Materials : Elastic deformation, Plastic deformation: slip, twinning, work hardening, baushinger effect, recovery, re-crystallization and grain growth, Fracture: Types of fractures (brittle, ductile), Creep & Fatigue failures.

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Unit II

Chapter 2 : Material Testing and Characterization Techniques 2-1 to 2-61

Syllabus : Destructive Testing : Impact test, Cupping test and Hardness test
Non-Destructive Testing : Eddy current test, Sonic & Ultrasonic testing, X-ray Radiography testing (Principle and Applications only)
Microscopic Techniques : Sample Preparation and etching procedure, optical microscopy, Electronic microscopy – only SEM, TEM and X-ray diffraction (Principle and Applications only)
Macroscopy : Sulphur printing, flow line observation, spark test

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Unit III

Chapter 3 : Phase Diagrams and Iron-Carbon Diagram **3-1 to 3-52**

Syllabus : Solid solutions : Introduction, Types, Hume Rothery rule for substitutional solid solutions,

Solidification : Nucleation & crystal growth, solidification of pure metals, solidification of alloys.

Phase Diagrams : Cooling curves, types of phase diagrams, Gibbs phase rules

Iron-Carbon Diagram: Iron-carbon equilibrium diagrams in detail with emphasis in the invariant reactions.

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Unit IV

Chapter 4 : Heat Treatments **4-1 to 4-53**

Syllabus : Austenite transformation in steel : Time temperature transformation diagrams, continuous cooling transformation diagrams. Retained austenite and its effect, Steps in Heat treatment and Cooling Medium.

Heat Treatment Processes : Introduction, Annealing (Full annealing, Process annealing, Spheroidise annealing, isothermal annealing, stress relief annealing), Normalising, Hardening, Tempering, Austempering, Martempering, Sub-Zero Treatment, Hardenability.

Surface Hardening : Classification, Flame hardening, Induction hardening, Carburising, Nitriding, Carbonitriding

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Unit V

Chapter 5 : Ferrous Materials **5-1 to 5-43**

Syllabus : Carbon Steel : Classification, types & their composition, properties and Industrial application

Alloy Steels : Classification of alloy steels & Effect of alloying elements, examples of alloy steels, (Stainless steel, Tool steel) sensitization of stainless steel

Designation of carbon steel and alloy steels as per IS, AISI, SAE Standards

Cast Iron : Classification, types and their composition, properties and Industrial application of (White CI, Gray CI, SG CI, Malleable Cast and alloy Cast Iron) Microstructure and property relationship of various ferrous Materials

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Unit VI

Chapter 6 : Non-Ferrous Materials 6-1 to 6-26

Syllabus : Classification of Non-Ferrous Metals : Study of Non-ferrous alloys with Designation, Composition, Microstructure **Mechanical and other properties for Industrial Applications :** Copper and its Alloys (Gilding Metal, Cartridge Brass, Muntz Metal, Tin Bronze, Beryllium Bronze), Aluminium and its Alloy (LM5, Duralumin, Y-Alloy, Hinduminum), Nickel and its Alloys (Invar, Inconel), Cobalt and its Alloys (Stellite Alloys, Alnico), Titanium and its Alloys (α Alloys, α-β Alloys), Bearing Alloys (Classification, lead based alloys, tin based alloys), Age Hardening, Microstructure and Property relationship of various Non-ferrous Materials

Recent Material used in Additive Manufacturing : Properties, Composition and Application only

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