Phase Transformations & Heat Treatment Credits: 4

Unit-1: INTRODUCTION TO PHASE TRANSFORMATIONS AND DIFFUSION

Introduction and classification of phase transformations, equilibrium in homogeneous systems and heterogeneous systems, Fick's laws of diffusion, solution of Fick's second law and its applications, atomic model of diffusion and role of crystal defects, temperature dependence of diffusion coefficient, Kirkendall effect, High diffusion paths.

Unit-2: SOLIDIFICATION

Principles of solidification, nucleation in pure metals, homogeneous nucleation, heterogeneous nucleation, growth of a pure solid, alloy solidification, solidification of single phase alloys, eutectic solidification, cellular and dendrite growth, solidification of castings and ingots, freezing of ingots, nucleation and grain size , segregation, directional solidification, growth of single crystals, evolution of microstructures in pure metals and alloys.

Unit-3: DIFFUSIONAL PHASE TRANSFORMATIONS IN SOLIDS

Precipitation from solid solution: types of precipitation reactions, crystallographic description of precipitates, precipitation sequence and age hardening, spinodal decomposition. Iron-carbon alloy system: iron-carbon diagram, nucleation and growth of Pearlite, cooling of hypoeutectoid, eutectoid, and hypereutectoid steels, development of microstructures in cast irons, Order-disorder Transformation: Examples of ordered structures, long and short-range order, detection of super lattices, influence of ordering on properties.

Unit -4: DIFFUSIONLESS PHASE TRANSFORMATIONS

Martensitic Transformations: General characteristics of martensitic reactions, similarity to deformation twinning, bain distortion, crystallography and kinetics of martensitic transformations.

Unit-5: HEAT TREATMENT OF FERROUS ALLOYS

Annealing, normalizing, hardening and tempering of steels; Isothermal and continuous cooling transformation diagrams; Influence of alloying elements on transformation characteristics; Hardenability, Principles of alloying; Introduction to important alloy steels like stainless steels, tool steels, maraging steels, high strength low alloy steels, etc; Surface hardening of steels; Cast irons types, heat treatment and properties.

Unit-6: HEAT TREATMENT OF NON-FERROUS ALLOYS

Classification, important alloy types, and heat treatment of aluminium alloys, titanium alloys, copper base alloys, super alloys, shape memory alloys, etc.

TEXT BOOK;

1. Phase Transformations in Metals and Alloys – David A. Porter, K. E. Easterling and Md. Y. Sherif, 3rd edition, 2009
2. Heat Treatment Principle and Techniques-T.V. Rajan, C.P. Sharma, Ashok Sharma, 2nd edition, 2011
3. Heat Treatment of Metals – Prof. Vijendra singh, 2nd edition, 2006
4. Physical Metallurgy Principles – Robert E. Reed hill, Reza Abbaschian, Lara Abbaschian, 4th edition, 2009.

REFERENCES;

1. Heat treating, ASM Metals Handbook, Volume 4

2. Physical Metallurgy for Engineers - D.S. Clark and W.R.Varney, 3rd edition,1955

3. Physical Metallurgy – R W Cahn and Peter Haasen, 1983