PHASE TRANSFORMATION AND HEAT TREATMENT

Course Type	Course Code	Name of Course	L	T	P	Credit
DC	FMC206	Phase transformation and heat treatment	3	0	0	9

Course Objective
Principles of phase transformation and heat treatment with emphasis on steels and non-ferrous alloys
Learning Outcomes
• Crystal structure in metals. • Thermodynamics and kinetics of solid-liquid and solid-solid phase transformations. • Phase diagrams and microstructure evolution in solid-liquid and solid-solid transformations. • Heat treatment techniques in for modification of mechanical properties Fe-C systems (steels) and non-ferrous metals.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Types of bonding; lattice and unit cell; crystal systems and Bravais lattices; atomic packing; voids; Miller indices	3	Introduction to atomic bonding and crystal structure
2	Gibbs free energy vs. composition diagram; types of binary phase diagrams; Lever's rule; phase rule	4	Phase diagrams in metallic systems
3	Thermodynamics of solidification; nucleation and growth; pure metal solidification; alloy Solidification: redistribution of solute during solidification; constitutional under-cooling; dendrites growth; structure of casting and ingots; types of casting	6	Thermodynamics, microstructure, and applications of solid to liquid transformation
4	Solid state phase transformation: nucleation and growth; overall transformation rate	3	Thermodynamics and kinetics of solid state phase transformation
5	Iron-carbon alloy system: iron-Fe_3C diagram; nucleation and growth of pearlite; cooling of hypo-eutectoid; eutectoid; and hyper-eutectoid steels; types and microstructure of cast iron	3	Phase diagram and microstructure in iron-carbon alloy system
6	JMKA (Avrami) kinetics; TTT and CCT Diagrams; bainitic transformation; martensitic transformation	4	Kinetics of solid-state transformation in iron-carbon system
7	Annealing; normalizing; hardening; tempering; recovery/recrystallization/grain growth; hardenability of steels (Jominy end quench method)	3	Heat treatment processes of steel
8	Role of alloying elements in steels	2	Effect of alloying elements on phase transformation in steels.
9	Thermomechanical treatment of steels: controlled rolling; hot-cold rolling; ausforming; isoforming	3	Thermomechanical treatment of steels
10	Heat treatment of aluminium alloys: designations; aluminium alloy series; heat treatable and non-heat treatable alloys; precipitation and sequence; effect of deformation and temperature; heat treatment of titanium and magnesium alloys; heat treatment of titanium and magnesium alloys	6	Fundamentals of heat treatment of non-ferrous alloys
11	Carburizing; nitriding; carbonitriding; laser surface cladding; flame hardening; induction hardening	3	Surface hardening methods
12	Batch Furnaces; continuous furnaces; salt bath furnaces; Temperature measurement and control: calibration; thermocouples and pyrometers	2	Furnace and controls used in heat treatment
	Total	42	

Text Books:

S. No.	Resource/Book Name	Author(s)/Editor(s)	Publisher
1	Physical Metallurgy Principles	Reza Abbaschian, Lara Abbaschian, Ribert E. Reed-Hill	Fourth Edition, Cengage Learning
2	Materials Science and Engineering	W.D. Callister	John Wiley & Sons, New York, USA
3	Heat Treatment: Principles and Techniques	T. V. Rajan, C. P. Sharma, Ashok Sharma	Prentice Hall

Reference Books:

S. No.	Resource/Book Name	Author(s)/Editor(s)	Publisher
1	Phase Transformations in Metals and Alloys	David A. Porter, Kenneth E. Easterling, Mohamed Y Sherif	CRC Press
2	Introduction to Physical Metallurgy	Sidney H Avner	Mc Graw Hill Education
3	Phase Transformations and Heat Treatments of Steels	Ray Bankim Chandra	CRC Press