GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. SEMESTER: VII

METALLURGY ENGINEERING

Subject Name: **Physical Metallurgy - II**
Subject Code: **172101**

Teaching Scheme				Evaluation Scheme			
Theory	Tutorial	Practical	Total	University Exam (E)		Mid Sem Exam (Theory) (M)	Practical (Internal)
				Theory	Practical		
3	1	2	6	70	30	30	20

Sr. No	Course Content	Total Hrs.
1.	**Principles of heat treatment of steels:** Phase Transformation on heating, Forming of austenite, Kinetics of formation of austenite, Nucleation sites in eutectoid steels, Austenitic grain size, Grain growth, Determination of austenitic grain size, Importance of austenitic grain size	6
2.	**TTT (Time Temperature Transformation) and CCT (Continuous Cooling Transformation) diagrams:** Method of plotting, Types of TTT diagram, Critical cooling rate, Effect of alloying elements on TTT diagram, Applications, Continuous cooling transformation diagram.	5
3.	**Pearlitic transformation:** Mechanism of transformation, Kinetics of transformation, Hull-Mehl model of pearlitic transformation, Effect of alloying elements on transformation, Interlameller spacing, Bainitic transformation: Characteristics, Mechanism of transformation, Bainitic structure.	5
4.	**Martensitic transformation:** Diffusionless transformation, Mechanism of transformation, Kinetics of transformation, M_s - M_f temperatures, Athermal and isothermal martensites, Effect of applied stress on transformation, Habit planes, Bain distortion model / crystallographic theory of martensitic transformation, Retained austenite, Martensitic transformation in non-ferous systems such as Fe-Ni and Cu-Al systems.	6

5.	**Hardenability:** Significance, Measurement Grossman method, Critical and ideal critical diameter, Jominy End Quench method, Use / Significance of Hardenability data, Effect of grain size and composition, Residual stresses, Quench cracking. ASTM A255-02: Hardneability, Factors affecting hardenability, Quenchants: Characteristics of quenchants, Different quenching media, Synthetic quenchants, Mechanism of quenching.	6
6.	**Heat treatment processes:** Stress relieving, Annealing – full annealing, partial annealing, bright annealing, diffusion annealing, recrystallization annealing, Spheroidizing, Normalizing, Hardening and Tempering, Hardening of typical steels, cast irons and non-ferrous alloys.	6
7.	**Surface hardening of metals:** Principles involved in induction and flame hardening methods and application of selective hardening, Laser hardening, Case carburizing (solid, liquid and gaseous), Cyaniding, Carbonitriding, Nitriding, Plasma nitriding etc., Depth of penetration - its measurement and relation with time and temperature.	6
8.	**Special methods of heat treatment:** Austempering, Martempering, Ausforming, Patenting, Sub-zero treatment etc., Thermo-Mechanical treatments.	3
9.	Heat treatment of carbon steels, alloy steels, tools and dies steels, stainless steels (with reference to carbide precipitation and sigma phase formation) and cast irons – specific examples, Heat treatment of aluminium alloys, titanium alloys and copper alloys, Concept of age-hardening.	6
10.	Design for heat treatment, Heat treatment furnaces- their temperature and atmosphere control, Defects in heat treated parts, Causes for the defects in heat-treated parts and remedies.	5

Text Books:

1. Heat Treatment (Principles and Techniques) by T. V. Rajan, C. P. Sharma and A. Sharma, PHI
2. Physical Metallurgy for Engineers by D. S. Clark and W. R. Varney, East-West press

Reference Books:

1. Introduction to Physical Metallurgy by S. H. Avner, Tata Mc-Graw Hill
2. Engineering Physical Metallurgy and Heat Treatment by Yu. M. Lakhtin, MIR Publishers
3. Material Science and Metallurgy for Engineers by V D Kodgire and S V Kodgire, Everest Publishing House

4. Heat Treatment of Metals by Vijendra Singh
5. Physical Metallurgy (Principles and Practice) by V. Raghvan, PHI
6. Heat Treatment of Metals by Zakharov
7. ASM Handbook on Heat Treating, Vol. 4
8. Handbook of Heat Treatment by K. H. Prabhudev, Tata Mc-Graw Hill.