GUJARAT TECHNOLOGICAL UNIVERSITY

B. E. SEMESTER: VI

Metallurgical Engineering

Subject Name: **Physical Metallurgy – I**
Subject Code: **162101**

Teaching Scheme				Evaluation Scheme		
Theory	**Tutorial**	**Practical**	**Total**	**University Exam (Theory) (E)**	**Mid Sem Exam (Theory) (M)**	**Practical (I)**
4	2	2	8	70	30	50

Sr. No	Course Content	Total Hrs.
1.	**Introduction** Introduction to phys met, Crystal and crystal systems, miller indices planes and direction	06
2.	**Solidification of Metals & Alloys** Nucleation and growth phenomena, Constitutional supercooling, Eutectic solidification. Rules of formation of various types of solid solutions, Primary & Intermediate phases and their formation, Intermetallic compounds	08
3.	**Phase Diagram** Concepts of alloy system and explanation of terms like system, component, phase, micro constituent and degree of freedom, structural constituent of an alloy, phase rule and phase equilibria, equilibrium diagrams and their classification based on solubility of components in liquid and solid states, cooling curves, morphology and distribution of phases, effect of non-equilibrium cooling on morphology. Eutectic, peritectic, monotectic, eutectoid and peritectoid reactions, binary equilibrium diagrams involving isomorphous systems and various reactions, common binary systems viz. Cu-Ni, Al-Si, Cu-Sn, Al-Cu, Pb-Sn, Cu-Zn. Lever rule. Ternary diagrams-simple systems, Analytical problems for this unit	14
4.	**Iron-Carbon system** Allotropic changes, Iron-Iron carbide equilibrium diagram, Phases, Invariant reactions, Critical temperatures, Plain carbon steels, Slow cooling of steels, Effect of alloying elements, Effect of impurities, Property variation with microstructure, Classification of steels, Specification of steels, Physical significance of grain size: Grain size effects, Grain size designation, Grain size measurement, Corresponding standards. ASTM 112-96	12

5.	**Steels** Classification of steels, Plain carbon steels, Advantages and limitations of plain carbon steels, Effect of impurity elements on the properties of steels, Alloy steels, Purpose of alloying of steel, Functions of alloying elements in steel, Effects of alloying elements on the properties of steels, Properties and applications of various alloy steels such as stainless steels, Systems for designation of steel, Coding of steel as per Indian Standard (IS) and American Standard	14
6.	**Cast irons** Classification according to graphite morphology and matrix structure, Gray, White, Ductile, Malleable, Mottled and Compacted graphite cast irons, Their properties and applications, Indian Standards applicable to cast irons	10
7.	**Metallography** Microscopic examination, Polishing techniques for different metals and alloys, Etching and Mounting techniques, electrolytic polishing Metallurgical microscope, Macroscopic & Microscopic examination methods, Non metallic inclusions, ASTM E3-01: ASTM Designation for preparation of metallography specimen. ASTM E1558-99: electrolytic polishing, ASTM E45-05: Inclusion rating	08

Text Book:

1. Physical Metallurgy Principles - R.E. Reed Hill [East - West]

Reference Books:

1. Principles of Metallographic Laboratory Practice - G.E. Kehl and H.Davis[Mc.Hill]
2. Phase Diagrams in Metallurgy - F.N.Rhines.
3. Engineering Physical Metallurgy - Y.Lakhtin[MIR Publications]
4. Physical Metallurgy Vol I-I.A.Gulyaev[MIR Publications]
5. Physical Metallurgy for Engineers-D.S.Clark and W.R. Varney[CBS]
6. Modern Physical Metallurgy - R.E.Smallman[ELBS]
7. Heat Treatment Principles and Techniques - T.V.Rajan, C.P.Sharma and A. Sharma [Prentice Hall]
8. Physical Metallurgy – Peter Hansen, Cambridge University Press
9. Introduction to Physical Metallurgy, Sidney H. Avner, McGraw Hill Book Co. 11.
10. Metallography Techniques: principles and practice, Vander Voort, George F., McGraw-Hill Book, 1984, New York