MSE-228 Physical Metallurgy

Credit Hours: 3-0

Pre-requisites: Nil

Course Description

The course primarily focusses on the knowledge that links the structure of materials with their properties. The role of processing in developing various types of structures will be discussed. This understanding will also help in alloy designing for various applications and interpreting the behaviour of materials under different conditions.:

Course Contents

- Introduction to Physical Metallurgy; structure properties relationship.
- Diffusion in solids, Driving Force for diffusion, Fick's first and second laws of diffusion. Interfaces: Structure and types of interfaces, Nucleation and Growth: Nucleation of precipitates from a supersaturated matrix, driving force for nucleation. Diffusion and diffusion less transformations.
- Solidification (Homogeneous and Heterogeneous); Nucleation and growth; Grain-boundaries and grain structure; Role of Metallurgical microscope in the analysis of microstructure; theory of etching and concept of grain boundary energy.
- Solid solutions; limits of solid solubility; Phase diagrams, different types of binary phase diagrams: Isomorphous system, Eutectic and eutectoid reactions, coherent/in-coherent precipitates, Peritectic and peritectoid reactions; Ordered and disordered solutions.
- Iron-Iron carbide system, microstructure and properties of plain carbon steels and cast-irons; microstructure of common copper-base and aluminium-base alloys.

Weekly Plan

Week	Topics
1	Introduction to Physical Metallurgy; structure properties relationship, Diffusion in solids
2	Driving Force for diffusion, Fick's first and second laws of diffusion.
3	Interfaces: Structure and types of interfaces
4	Nucleation and Growth: Nucleation of precipitates from a supersaturated matrix, driving force for nucleation
5	Diffusion and diffusion less transformations
6	Solidification (Homogeneous and Heterogeneous)

7	Nucleation and growth; Grain-boundaries and grain structure;
8	Role of Metallurgical microscope in the analysis of microstructure; theory of etching and concept of grain boundary energy.
9	**Mid-Semester Exams**
10	Solid solutions; limits of solid solubility
11	Phase diagrams, different types of binary phase diagrams:
12	Isomorphous system, Eutectic and eutectoid reactions
13	Coherent and in-coherent precipitates
14	Peritectic and peritectoid reactions; Ordered and disordered solutions
15	Iron-Iron carbide system, microstructure and properties of plain carbon steels and Cast irons.
16	Microstructure of common copper-base and aluminium-base alloys.
17-18	**End Semester Exams**

Course Outcome

At the end of the course the students are expected to have learned the following:

- Variables influencing development of a particular microstructure in alloys.
- A critical awareness of the relevance of key areas, e.g. diffusion, interfaces, phase diagrams, processing and exploiting real alloys.

Suggested Books

- *Introduction To Physical Metallurgy* by S.H. Avner, 2nd Edition, McGraw-Hill Book Company (1997).
- *Materials Science and Engineering: An Introduction* by D. G. Rethwisch and W. D. Callister Jr., 10th Edition, Wiley (2018).
- *Physical Metallurgy Principles* by D. Laughlin, K. Hono. 5th Edition, Elsevier (2014).
- *Physical Metallurgy: Principles and Design* by G. N. Haidemenopoulos, 1st ed. CRC Press (2018).
- *Physical Metallurgy Principles* by R. Abbaschian, L. Abbaschian, R. E. Reed-Hill. 4th ed. Cengage Learning (2010).
- *Physical Metallurgy: Metals, Alloys, Phase Transformations* by V. M. Schastlivtsev, V. I. Zel'dovich. De Gruyter GmbH (2022).