MTPC2005 PHASE TRANSFORMATION AND HEAT TREATMENT OF METALS (3-0-0)

Course Objective:

1. To provide students with a comprehensive understanding of the thermodynamic and kinetic principles governing phase transformations in materials, including nucleation, growth, and the role of phase diagrams in predicting microstructural evolution.
2. To equip students with the knowledge and practical skills required to design and apply heat treatment techniques, such as annealing, quenching, tempering, and surface hardening, to achieve desired mechanical and microstructural properties in metals and alloys.

Module I (6 Hrs)

Introduction: Definition and types of Phase transformations, Free Energy for Ideal solution and regular solution, free energy composition diagrams, Spinodal decomposition, Miscibility gap; Ternary Phase Diagram.

Module-II (6 Hrs)

Order-disorder Transformation examples of ordered structures, long range and short range order. influence of ordering on properties. Crystal interfaces and microstructure. Microstructure evolution including recrystallization and grain growth.

Module III (6 Hrs)

Review of Iron-carbon alloy system, Graphitization, Importance of Austenite Grain size. Formation of Austenite, Pearlitic, Bainitic and Martensitic Transformations (Mechanisms, Kinetics and Morphologies)

Module IV (6 Hrs)

Heat treatment of steels: TTT and CCT diagrams, conventional heat treatment processes – annealing, normalizing, hardening and tempering. Hardenability, Factors influencing hardenability, Methodology.

Module V (6 Hrs)

Surface heat Treatment Process: Heat treatment of non-ferrous alloys (Al-Cu, brass, Ti alloys, Ni alloys), Heat treatment of special steel(maraging steel, HSLA)

Course Outcome:

CO1: Students will be able to explain the fundamental concepts of phase transformations, interpret free energy diagrams, and analyze spinodal decomposition, miscibility gaps, and ternary phase diagrams.

CO2: Students will understand order-disorder transformations, evaluate their influence on material properties, and analyze microstructure evolution processes such as recrystallization and grain growth.

CO3: Students will demonstrate the ability to analyze the iron-carbon system, understand graphitization, and describe pearlitic, bainitic, and martensitic transformations in terms of mechanisms, kinetics, and morphologies.

CO4: Students will gain the skills to interpret TTT and CCT diagrams, design conventional heat treatment processes, and evaluate factors influencing the hardenability of steels.

CO5: Students will be able to apply surface heat treatment processes, understand heat treatment techniques for non-ferrous alloys, and analyze the treatment of special steels like maraging steel and HSLA.

Text Books:

1. "Phase Transformations in Metals and Alloys" by David A. Porter, Kenneth E. Easterling, and Mohamed Sherif
2. "Heat Treatment: Principles and Techniques" by T.V. Rajan, C.P. Sharma, and Ashok Sharma

Reference Books:

1. "Physical Metallurgy Principles" by Robert E. Reed-Hill and Reza Abbaschian
2. "Introduction to Materials Science for Engineers" by James F. Shackelford
3. “Solid State Phase Transformations” by Raghavan, PHI