

PHYSICAL METALLURGY (4-0) CREDITS: 04**Module-1 (14 Hours)**

Crystallography: Crystalline and amorphous structures, Elements of crystal symmetry, symmetry elements and axes, two, three, four and six fold symmetry, review of atomic bonding in materials, common crystal systems, crystal structure of metals, representation of planes and directions in crystals, atomic packing in crystals, calculation of packing density, voids in common crystal structures and imperfection in crystals. Metallography: Metallurgical microscope, Specimen preparation, Techniques for microscopic observation. High temperature microscopy, Quantitative metallographic.

Module-II (14 Hours)

Thermodynamics of phase change: Equilibrium, phase stability, evolution of phase diagrams, chemical potential gradient, Atomic model of diffusion, solid solution, Theories of alloying, Hume-Rothery rules, Single component systems, P-T diagrams, Allotropy. Free energy- composition diagram, Binary equilibrium diagrams (Isomorphous, eutectic, eutectoid, monotectic, peritectic, peritectoid, Syntectic systems), Gibbs phase rule, Tie line, Lever rule. Common alloy systems (Pb-Sn, Cu-Zn, Al-Si etc) Ternary system: Ternary phase diagrams, representation, isothermal and vertical sections, Ternary isomorphous and eutectic systems, Tie lines, Two phase, Three phase and four phase equilibrium, Gibb's triangle representation.

Module-III (14 Hours)

Fe-C system: Effects of alloying elements, Formation of Austenite, Decomposition of Austenite, Pearlitic, Bainitic and Martensitic phase transformations, TTT and CCT diagrams, Hardenability, Critical diameter, Jominy end quench Test, Tempering of steel, Temper brittleness, Thermomechanical Treatment, Ausforming, Maraging steels, Processing- structure property relationship in multiphase alloys (steels and cast irons), Rapid solidification processing, Metallic Glasses, Single crystal processing. Nano crystalline materials.

Books for reference:

1. Reedhill R.E., Physical Metallurgy Principles, Affiliated East West Press.
2. R.W.Cahn and Peter Haasen, Physical Metallurgy.
3. Avner S.H., Introduction to Physical Metallurgy, Tata McGraw Hill.
4. Porter D.A. & Easterling K.E., Phase Transformations in Metals and Alloys.
5. Kakani S.L. and Kakani A., Materials Science, New Age International.
6. Clarke & Varney, Introduction to Physical Metallurgy.