II YEAR-I Semester

ME3T4 METALLURGY & MATERIALS SCIENCE Credits: 3

Lecture: 3 periods/week **Internal assessment: 30marks**
Tutorial: 1 period/week **Semester end examination: 70 marks**

Course Objectives:

- This course provides students an understanding of basic structure and crystal arrangement of materials, the phase diagrams, advantages of heat treatment and the method of heat treatment processes, powder metallurgy processes, the need and application of composite materials.

Course Outcomes:

Upon completion of this course the student will be able to:

1. Identify the properties of metals with respect to crystal structure and grain size
2. Interpret the phase diagrams of materials
3. Classify and Distinguish different types of cast irons, steels and non ferrous alloys
4. Describe the concept of heat treatment of steels & strengthening mechanisms
5. Explain the powder metallurgy process, types and manufacturing of composite materials

UNIT 1

INTRODUCTION:

Introduction to metallurgy, Mechanical properties of materials

CRYSTALLOGRAPHY:

Classification of crystals – Bravais lattices – Miller Indices – Packing factor in cubic systems – coordination number – crystal imperfections – crystal deformation –Slip and Twinning.

STRUCTURE OF METALS:

Crystallization of metals, Effect of grain size on properties of metals, Determination of grain size

UNIT 2

CONSTITUTION OF ALLOYS:

Types of solid solution- substitutional and interstitial solid solutions, Hume rothery rules for solid solution

PHASE DIAGRAMS:

Phase, Phase equilibrium, Gibbs Phase rule – one component system, two component system, Construction of binary phase diagram, isomorphous, eutectic, eutectoid, peritectic and peritectoid systems, Fe-Fe3C equilibrium diagram

UNIT 3

STEELS AND CAST IRONS: Classification of steels-Plain carbon steels, Stainless steels, Tool steels, Structure and properties of White Cast iron, Malleable Cast iron, Grey cast iron, Spheroidal graphite cast iron.

NON-FERROUS METALS AND ALLOYS: Structure and properties of Copper and its alloys, Aluminium and its alloys.

UNIT 4

HEAT TREATMENT PROCESSES: Annealing, Normalizing, Hardening, Tempering, TTT diagram of eutectoid steel, Austempering, Martempering, Flame hardening, Induction hardening ,carburizing, cyaniding, nitriding, Hardenability concept and experimental determination using jominy end quench test.

STRENGTHENING MECHANISMS: Grain Refinement, Strain hardening, solid solution strengthening, dispersion strengthening

UNIT 5

POWDER METALLURGY: Powder metallurgy process, Preparation of powders, Characteristics of metal powders, Mixing, Compacting, Sintering, Applications of powder metallurgy.

COMPOSITE MATERIALS: Classification of composites, particle reinforced materials, fiber reinforced composite materials and metal matrix composites,

Manufacture of composites: Hand layup, Spray–up, Vacuum–bag molding, Pressure–bag molding, Thermal expansion molding, Autoclave molding, pultrusion

Learning Resources

Text books:

1. Sidney H. Avener, "Introduction to Physical Metallurgy", Tata McGraw Hill - 2nd edition - 1997.
2. V.D. Kodgire, "Material Science and Metallurgy", Everest Publishing House - 25th Edition – 2009.

Reference books:

1. Donald R. Askeland, "Essential of Materials Science and Engineering", Thomson Learning, 5th Edition - 2006.
2. B.K.Agarwal, "Introduction to Engineering Materials", Tata McGraw Hill-1stEdition.
3. V. Raghavan, "Material Science and Engineering",-PHI Learning - 5th Edition.
4. R.K.Rajput, "Engineering Materials and Metallurgy", - S.Chand - 1st Edition-2011
5. William D. Callister , "Materials Science and Engineering", John Wiley & Sons Inc-2010.