MATERIAL SCIENCE AND ENGINEERING

(Common to Mechanical Engineering and Mechanical Engineering (Robotics))

Course Code: 20ME11

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3	0	0	3

Course Outcomes: At the end of the course, the student will be able to
CO1: Explain crystal systems and mechanisms of plastic deformation
CO2: Apply phase diagrams for the study of alloys
CO3: Select ferrous materials for engineering applications
CO4: Outline nonferrous and polymeric materials for engineering applications.
CO5: Select ceramic materials and composite materials for engineering applications

UNIT- I **10 Lectures**

Structure of Metals: Bravais lattice systems, packing factor and density calculations of BCC, FCC and HCP, Miller indices, crystallization of metals, effect of grain boundaries on properties of metals, crystal imperfections.
Mechanical Behavior of Materials: Plastic deformation- slip and twinning, fracture, fatigue, creep.

Learning Outcomes: At the end of this unit, the student will be able to

1. discuss the importance of lattice parameters (L2)
2. describe properties of metals related to grain structure (L2)
3. differentiate among various kinds of crystal imperfections (L2)

UNIT- II **10 Lectures**

Constitution Of Alloys: Intermediate alloy phases, types of solid solutions, Hume -Rothery rules. Phase rule, construction of equilibrium diagrams, lever rule.
Phase Diagrams: Isomorphous system, eutectic, peritectic, reactions, reactions in solid state: allotropy, eutectoid and peritectoid reactions.

Learning Outcomes: At the end of this unit, the student will be able to

1. differentiate between substitutional and interstitial solid solutions (L2)
2. describe various invariant reactions occurring on phase diagrams (L2)
3. predict microstructures using phase diagrams (L3)

UNIT- III **10 Lectures**

Metallurgy of Iron and Steel: Fe-Fe_3C equilibrium diagram, micro constituents in steels, classification, structure and properties of plain carbon steels and cast irons.
Heat Treatment of Steels: Annealing, normalizing, TTT diagram, hardening, tempering, surface hardening methods, alloy steels, tool steels, HSS, stainless steels, cryogenic heat treatment of tools

Learning Outcomes: At the end of this unit, the student will be able to

1. illustrate Fe-Fe_3C phase diagram(L3)
2. describe the properties and applications of steels and cast irons (L2)
3. explain the heat treatment of steels (L2)

UNIT- IV **10 Lectures**

Non-ferrous Metals and Alloys: Structure and properties of copper and its alloys, aluminum and its alloys, titanium and its alloys.

Polymeric Materials: Polymerization, classification of polymers, structure and properties of polymeric materials and their applications.

Learning Outcomes: At the end of this unit, the student will be able to

1. describe the properties and applications of copper, aluminum and titanium based alloys (L2)
2. differentiate between thermoplastics and thermosets (L2)
3. discuss the applications of plastics (L2)

UNIT- V **10 Lectures**

Ceramic Materials: Ceramics, abrasive materials, Nano- materials: definition, properties and applications.

Composite Materials: Classification of composite materials, particle reinforced materials, fiber reinforced materials, metal ceramic and polymeric matrix composites and C-C composites, properties and applications.

Learning outcomes: At the end of this unit, the student will be able to

1. explain ceramic, abrasive and nano materials (L2)
2. differentiate various types of composite materials (L2)
3. describe the applications of ceramic, abrasive, nano and composite materials (L2)

Text Books:

1. S. H. Avner, *Introduction to Physical Metallurgy*, 2nd Edition, Tata McGraw- Hill, 2017. (Units I,II and III)
2. Kalpakjian S and Schmid S. R, *Manufacturing Engineering and Technology*, *7*th Edition, Pearson Publishers, 2018. (Units IV and V)

Reference Books:

1. Kodgire VD and Kodgire SV, *Material Science and Metallurgy for Engineers*, 35th Edition Everest Publishing House, 2018.
2. V.Raghavan, *Materials Science & Engineering: A First Course*, 2nd Edition Pearson Education, 2015.
3. Callistar, *Metallurgy and Materials Science*, 2nd Edition, Wiley India, 2010.
4. L.H.Van Vlack, *Elements of Material Science and Engineering*, 6th Edition, Pearson Education, 2008.

Web Resources

https://nptel.ac.in/courses/113/107/113107078/

https://nptel.ac.in/courses/113/102/113102080/