

Engineering materials

ME303

Contacts : 3L Contact week/ semester = 12 minimum

Credits : 3

Module 1

Introduction: Material Science its importance in engineering; Classification of Materials metals, polymers, ceramics, composites; Advanced materials semiconductors, smart materials, nano-materials; Review atomic structure, Atomic bonding in solids bonding forces and energies; ionic/covalent/metallic bonding. [2]

Module 2

Crystal Structure: Fundamental concepts; Unit cells; seven crystal systems; single crystal, polycrystalline and non-crystalline materials; Metallic crystal structures FCC, atomic packing factor, BCC & HCP structures. [2]

Module 3

Imperfections in Metals: Point defects due to vacancy & impurities, alloys, solid solutions; Dislocations linear defects, interfacial defects, grain boundaries. [2]

Module 4

Phase Diagrams: Definition and basic concepts; solubility limit; Phase equilibria, one-component phase diagram, binary phase diagram, interpretation of phase diagrams. [3]

Module 5

Iron-carbon System: allotropy of iron, iron-iron carbide phase diagram, properties and uses of plain carbon steel [2]

Module 6

Classification of Metals and Alloys- compositions, general properties and uses:

6.1 Ferrous alloys: Classification low carbon steels, medium carbon steels, high carbon steels, stainless steels, alloy steels, tool and die steel, cast irons.

6.2 Non-ferrous alloys: Copper & Copper alloys; Aluminum alloys; Zinc alloys; Nickel alloys; Lead & Tin alloys; [6]

Module 7

Mechanical Properties of Materials: Elastic properties of materials tensile and compressive stress and strain, stress-strain behaviour, modulus of elasticity (Young's modulus), yield strength, tensile strength, plastic deformation, true stress and strain; Ductility; Resilience; Toughness, impact tests; Hardness- Brinell, Rockwell and Vickers hardness and their testing procedures, correlation between hardness and tensile strength; Fatigue strength; Effect of temperature on tensile strength & impact properties, creep failure. [6]

Module 8

Heat Treatment: Definition and purposes; Heat treatment processes for steels Hardening, structural change during heating and cooling, factors affecting hardening; Tempering; Austempering; Normalizing; Annealing full annealing, spheroidising annealing, stress-relieving, recrystallisation annealing; Precipitation or Age Hardening of non-ferrous alloys. [4]

Module 9

Polymers & Elastomers: Definition; How polymers are made - polymerization; Polymer molecular structures; Thermoplastics & Thermosets; Special characteristics like low sp. gravity, optical, electrical & thermal property, decorative color, easy formability, low corrosion etc; Uses of polymers and elastomers. [2]

Module 10

Ceramic Materials: What is ceramics; common ceramic materials and their characteristics; How ceramics are made sintering and vitrification process; Ceramic structures; Properties and applications. [2]

Module 11

Composite materials: What is composites; Polymers matrix and their applications; Metal matrix and ceramic matrix composites and their applications; How composites are made. [2]

Module 12

Corrosion and Degradation of Engineering Materials: Definition; Types of corrosion uniform, pitting, crevice, galvanic, stress corrosion cracking and erosion; Corrosion control material selection, environment control, proper design. [2]

Module 13

Materials Selection Methodology: Selection of material based on required properties, availability and cost of material, environmental issues. [1]

Note for Teachers:

1. Stress should be given to clarify different concepts.
2. Industrial examples must be cited regarding use of various materials and the specific properties involved for selection of these materials.

Note for examination paper setter:

1. Question should be set covering all the 13 topics of the syllabus.
2. Marks of questions from each topic should be proportionate to the recommended contact hours allotted, as far as possible.

Books Recommended

1. Materials Science and Engineering by W.D. Callister and adapted by R. Balasubramaniam, Willey India, 2010 Ed.
2. Engineering Materials: properties and selection by Budinski & Budinski, 9th Ed., Prentice Hall India
3. Engineering Materials and Metallurgy by R.Srinivasan, 2nd Ed., Tata McGraw Hill.
4. Materials & Processes in Manufacturing by E.P.Degarmo and adapted by Black & Kosher, 10th Ed., Wiley India.
5. Materials Science and Engineering by V.Raghavan, 5th Ed., Prentice Hall India.