

**ENGINEERING MATERIALS  
(MECH 2104)**

**Time Allotted : 3 hrs**

**Full Marks : 70**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and  
any 5 (five) from Group B to E, taking at least one from each group.*

*Candidates are required to give answer in their own words as far as practicable.*

**Group - A  
(Multiple Choice Type Questions)**

- Choose the correct alternative for the following: **10 × 1 = 10**
  - Number of atoms present per unit cell of a HCP crystal is  
(a) 1 (b) 6 (c) 4 (d) 2.
  - Atomic packing factor of a face centered cube is equal to  
(a) 0.64 (b) 0.54 (c) 0.74 (d) 0.84.
  - In a tensile test, at yield point  
(a) tensile stress increases rapidly with increase in strain  
(b) tensile stress decreases rapidly with increase in strain  
(c) tensile stress increases in linear proportion to the strain  
(d) tensile stress decreases in linear proportion to the strain.
  - Polymers are \_\_\_\_\_ in nature.  
(a) organic (b) inorganic  
(c) both (a) & (b) (d) composite.
  - Thermal expansion of materials arises from  
(a) strong bonds  
(b) weak bonds  
(c) thermal vibrations  
(d) asymmetry of potential energy.
  - Strain hardening improves  
(a) static tensile strength (b) steady state creep rate  
(c) fatigue life (d) none of these.
  - A Binary eutectic alloy (metal) of eutectic composition will solidify at  
(a) a fixed temperature  
(b) varying temperature  
(c) a solidification temperature of one of the metals  
(d) none of these.

- Austenite has a maximum solubility of carbon in iron of  
(a) 0.76% at 727°C (b) 1.41% at 923°C  
(c) 2.14% at 1147°C (d) 4.30% at 1229°C.
- Grey cast iron has good bearing properties because its microstructure has presence of  
(a) martensite (b) cementite  
(c) graphite (d) none of these.
- Austenite in steel when rapidly cooled (quenched) from recrystallisation temperature forms  
(a) pearlite (b) bainite  
(c) martensite (d) none of these.

**Group - B**

- Prove that Atomic packing factor (APF) of an HCP unit cell is 74%.  
(Given:  $c/a = \sqrt{8/3}$ , where c is the height of the unit cell and a is the edge length of the unit cell.)
  - Explain with neat sketches the mechanism for 'dislocation' and 'twinning' as related to plastic deformation.
  - With proper sketch, explain schottky defect & frenkel defect in a lattice.

**4 + 4 + 4 = 12**
- What is Miller Indices? Give the comparison between ionic bond and covalent bond.
  - Draw the phase diagram for the binary isomorphous alloy of Cu and Ni showing the regions of (i) liquid phase (ii)  $\alpha$ -solid phase (iii)  $\alpha$ -solid + liquid phase. The melting temperatures for pure Cu and Ni are 1085°C and 1453°C respectively.
  - An alloy of 35% (Wt) Ni and 65% (Wt) Cu at 1250°C temperature is in ( $\alpha$ -solid + liquid) phase. The same temperature line in the phase diagram intersects the liquidus and solidus at 31.5% (Wt) Ni and 42.5% (Wt) Ni respectively. Determine the weight proportion of  $\alpha$ -solid present in the melt at 1250°C.

**(2 + 2) + 4 + 4 = 12**

**Group - C**

- Name the different allotropic forms of Iron (Fe) stating their crystal structure and temperature range.

- (b) Describe the transformation that occurs during equilibrium cooling of steel with 0.76%C present from 900°C to normal temperature. Also show the microstructure obtained.
- (c) Write down the carbon % present in Low carbon steel, Medium carbon steel, High carbon steel and Cast Iron. Explain how Cast Iron differs from steel in respect to microstructure. What is Austenitic Stainless steel?

$$2 + (4 + 1) + (2 + 2 + 1) = 12$$

5. (a) Name three different Cu-Alloys mentioning their compositions and uses.
- (b) Give composition of a Wrought Al-Alloy mentioning its use.
- (c) Explain Full Annealing and Normalising process as applied to low carbon and medium carbon steels. What is quench hardening and tempering of high carbon steel?

$$3 + 2 + (4 + 3) = 12$$

#### Group - D

6. (a) Mention the factors that affect the selection of materials for Engineering Purposes.
- (b) Differentiate between true strain and engineering strain. The engineering stress and strain at fracture were found to be 450 MPa and 0.63 respectively. Determine true stress and true strain.

$$6 + (4 + 2) = 12$$

7. (a) Define Brinell hardness number and from the definition, show that Brinell hardness number N is given by:  $N = 191 / 10 \cdot \sqrt{(100 - d^2)}$  for a load of 3000 kgf, where D is the diameter of steel ball and d is the diameter of impression. What would be the corresponding formula for 10 mm diameter ball and 500 kgf load?
- (b) Define Young's modulus and Poisson's ratio. The Young's modulus and Poisson's ratio of a material are 210 GN/m<sup>2</sup> and 0.3 respectively. Determine the shear modulus of the material.

$$6 + (4 + 2) = 12$$

#### Group - E

8. (a) Define corrosion and explain the different mechanisms of corrosion.

- (b) Discuss any two major type of corrosion.

$$6 + 6 = 12$$

9. (a) What are ceramic materials? State advantages of ceramic materials.
- (b) Describe properties and the importance of plastics in engineering applications.

$$(2 + 4) + 6 = 12$$