

**MATERIAL SCIENCE AND ENGINEERING**

*Time : Three hours*

*Maximum marks : 100*

*Answer FIVE questions, taking ANY TWO from Group A,  
ANY TWO from Group B and ALL from Group C.*

*All parts of a question (a, b, etc) should be  
answered at one place.*

*Answer should be brief and to-the-point and be supple-  
mented with neat sketches. Unnecessary long answers  
may result in loss of marks.*

*Any missing data or wrong data may be assumed suitably  
giving proper justification.*

*Figures on the right-hand side margin indicate full marks.*

**Group A**

1. (a) Explain semiconductor, intrinsic and extrinsic semiconductors. 6
- (b) Mention four strengthening mechanisms of metals and alloys, and explain any one of them. 4
- (c) Why are metals mostly ductile and ceramics brittle at room temperature? 10
2. (a) What are the invariant points (degrees of freedom = 0) in a binary phase diagram with eutectic? 3
- (b) Explain the terms isomorphous, eutectic, peritectic and eutectoid systems. 8

- (c) Explain how will you determine the elastic and plastic components of strain from a schematic stress-strain curve, showing loading and unloading in plastic strain range. 3
- (d) Define the following terms : 3 × 2
- Yield strength
  - Tensile strength
  - Poisson's ratio.
3. (a) Explain the mechanism of creep. 8
- (b) Distinguish between ductile and brittle fracture. 4
- (c) What do you mean by normalizing and tempering, and indicate how those heat treatments affect the properties of steel? 4
- (d) A sodium silicate glass has no surface defects as etching has removed them, but has cracks inside from  $2\ \mu\text{m}$  to  $5\ \mu\text{m}$  in length. Calculate the surface energy of glass if fracture strength =  $100\ \text{MNm}^{-2}$ ; Young's modulus =  $70\ \text{GNm}^{-2}$ . 4
4. (a) Write a note on viscoelastic properties of materials, showing schematic plots of variation of stress with strain and strain with time. 6
- (b) Differentiate between edge and screw dislocation. 4
- (c) Explain cold working, warm working and hot working. 6
- (d) What is Bauschinger effect? 4

### Group B

5. (a) Discuss the mechanism of age hardening of Al alloys. 5
- (b) How is hardenability test carried out? 5
- (c) Discuss the heat transfer characteristics during quenching, and its effect on mechanical properties. 5
- (d) Discuss the nitriding process. 5
6. (a) What are the effects of high temperature on mechanical properties of metals. 3
- (b) What will be your considerations for choice of an alloy for high temperature applications. 4
- (c) A continuous and aligned glass fiber reinforced composite consists of 40 vol% of glass fibres having a modulus of elasticity 69 GPa and 60 vol% of a polyester resin that, when hardened, displays a modulus of 3.4 GPa. Calculate the modulus of elasticity of this composite in the longitudinal directions. 7
- (d) Discuss zone theory of solids and explain zones in conductors and insulators. 6
7. (a) A transformer core is wound with a coil carrying an alternating current at a frequency of 50 Hz. Assuming the magnetization to be uniform throughout core volume of  $0.02\ \text{m}^3$ , calculate the hysteresis loss. The hysteresis loop has an area of 80,000 units, when the axes are drawn in units of  $10^{-4}\ \text{Wbm}^{-2}$  and  $10^{-2}\ \text{Am}^{-1}$ . 6
- (b) Distinguish between soft and hard magnets. 4

- (c) Write the peritectic, eutectic and eutectrial reaction of Fe-Fe<sub>3</sub>C phase diagram. 5
- (d) Discuss the cooling process of 0.6% C steel from 1500 °C to room temperature. 5
8. (a) Give some applications of polyethylene, nylons and polyester. 4
- (b) What is polymerisation? With the help of suitable examples, compare and contrast the processes of addition polymerisation and condensation polymerization. 6
- (c) Name two commonly used thermosetting polymers and their applications. 5
- (d) Why are fiber glass reinforced composites used extensively? 5

#### Group C

9. Answer the following questions : 2 × 10
- (a) What is Bergers vector?
- (b) State Fick's second law of diffusion.
- (c) Differentiate between interstitial and vacancy diffusion.
- (d) What is work hardening?
- (e) Explain the reason for cracking of brass.
- (f) How is martensite formed in steel?

- (g) If you subject a refractory lining to thermal gradient (heating at one end and cooling at other), how will high or low coefficient of thermal expansion and thermal conductivity affect its longevity?
- (h) Give two examples of soft magnetic materials.
- (i) How do you determine the temperature for hot working of a metal?
- (j) Give two applications of nano materials.