

JUNE 2008

Code: AE04

Subject: MATERIALS AND PROCESSES

Time: 3 Hours

Max. Marks: 100

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x10)

a. Missing of one cation and one anion in an ionic crystal (having charge neutrality) is called

- (A) Frenkel imperfections.
- (B) Compositional imperfections.
- (C) Electronic imperfections.
- (D) Schottky imperfections.

b. The steady state conditions in diffusion are governed by

- (A) Fick's second law.
- (B) Fick's first law.
- (C) both (A) and (B).
- (D) Maxwell-Boltzmann's law.

c. The probability of occupancy of electrons above Fermi level at $T=0^\circ\text{K}$ is

- (A) 0%.
- (B) 25%.
- (C) 50%.
- (D) 100%.

d. In a ferroelectric material, the spontaneous polarization vanishes above

- (A) Transition temperature.
- (B) Debye temperature.
- (C) Fermi temperature.
- (D) Curie temperature.

e. P-type and N-type extrinsic semiconductors are formed by adding impurities of valency

- (A) 5 and 3 respectively.
 (B) 5 and 4 respectively.
 (C) 3 and 5 respectively.
 (D) 3 and 4 respectively.
- f. Hard magnetic material is characterized by
- (A) high coercive force and high residual magnetic induction.
 (B) high coercive force and low residual magnetic induction.
 (C) low coercive force and high residual magnetic induction.
 (D) Only low coercive force.
- g. Electromigration in metallization refers to the diffusion (under the influence of current) of
- (A) Al. (B) Cu in Al-Cu alloy.
 (C) Si. (D) Na.
- h. Annealing is generally done to impart
- (A) hardness to the material.
 (B) softness to the material.
 (C) brittleness to the material.
 (D) High resistivity to the material.
- i. Aluminium is not good for die casting because
- (A) it is light and strong.
 (B) it takes longer time to cool.
 (C) it tends to react chemically with the die surface.
 (D) its melting point is high and it expands on solidification.
- j. The $\{\bar{1}\bar{1}\}$ plane is parallel to
- (A) (111) (B) $\{\bar{1}\bar{1}\}$
 (C) $\{1\bar{1}\}$ (D) $\{\bar{1}1\}$

**Answer any FIVE Questions out of EIGHT Questions.
 Each question carries 16 marks.**

- Q.2** a. Explain with suitable examples the ionic, covalent and chemical type of bonding in solids. What is the nature of bonds in NaCl and silicon? (6+2)
- b. What are the similarities and differences of primitive cells and unit cells? What do you understand by Miller indices of a crystal plane? Derive an expression for the interplaner spacing for planes of (hkl) type in the case of a cubic structure. (3+2+3)
- Q.3** a. What is meant by point defects in crystal lattice? What are different types of point defects? How are they caused? (2+4+2)
- b. What is the importance of lever rule? Which information of a phase diagram can be known from the lever rule? Show that for correct mass balance, the relative amounts of two co-existing phases or microconstituents must be given by the lever rule. (2+2+4)
- Q.4** a. State Fick's law of diffusion. Explain it in respect of non-steady-state flow. Discuss the doping applications of Fick's law describing non-steady-state flow. (2+4+2)
- b. What is density of energy states? Draw a plot between density of states and the energy of electrons. Explain why nichrome is used as a heating element instead of copper. (2+2+4)
- Q.5** a. How are p-type and n-type semiconductor obtained? Show that the Fermi energy in an intrinsic semiconductor lies approximately half way between the top of valence band and the bottom of conduction band. When does intrinsic semiconductor become an extrinsic semiconductor? Explain. (2+4+2)
- b. Explain with diagrams forward and reverse biasing of a p-n junction. What is meant by avalanche breakdown? How a semiconductor diode can be used as a rectifier? (2+2+4)
- Q.6** a. Explain the different types of polarization mechanisms in dielectrics. What is complex dielectric constant? How does it vary with frequency of the applied field? Explain local electric field. (3+2+3+2)

b. Describe various properties and applications of mica and transformer oil. (3+3)

Q.7 a. Explain the mechanism of ferromagnetism. On the basis of this explanation how will you explain hysteresis and Curie point? Describe the experimental evidence to demonstrate the existence of ferromagnetic domains. (2+4+2)

b. What are ferrites? Give an account of the applications of ferrites for high frequency transformers and computer memory cores, pointing out their advantages over a ferromagnetic material. (2+6)

Q.8 a. Differentiate between “chemical vapour deposition” and “lithography” in the fabrication of ICs. How does addition of copper help in reducing electromigration in the process of metallization? (6+3)

b. What are the various purposes of casting, forging and rolling? Explain with suitable examples. (7)

Q.9 a. How does “holding or soaking” time affect the properties of steel during heat treatment process?
What are the objectives of annealing? (5+4)

b. What are major differences in the processes and purposes of hardening (by quenching) and tempering? Explain (7)