

DECEMBER 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. The number of nearest neighbours for a body centred (BCC) lattice is
- (A) 4. (B) 8.
(C) 10. (D) 16.
- b. The IC-chips used in computers are made of
- (A) pure gold.
(B) pure silicon.
(C) silicon having desired impurities.
(D) germanium having silicon and arsenic as impurities.
- c. Plastic pipes for domestic use are made of
- (A) PVF. (B) Teflon.
(C) Bakelite. (D) PVC.
- d. At 0°K, all valence electrons in an intrinsic semiconductor are
- (A) free electrons. (B) in the valence band.
(C) in the forbidden gap. (D) in the conduction band.
- e. Which of the following materials has maximum magnetic permeability?
- (A) 4% silicon steel. (B) pure iron.
(C) grain-oriented Si – Fe. (D) cast iron.

- f. The minority carrier concentration in semiconductors is largely a function of
- (A) the breakdown voltage. (B) temperature.
 (C) forward biasing voltage. (D) reverse biasing voltage.
- g. Which of the following is minimized by laminating the core of a transformer?
- (A) hysteresis loss (B) eddy current loss
 (C) heat loss (D) all of them
- h. The degree of freedom when ice, water and water vapour co-exist in equilibrium is
- (A) 1 (B) 0
 (C) 2 (D) -1
- i. Diamagnetic materials are
- (A) only slightly magnetized.
 (B) magnetized in one direction only.
 (C) magnetized with eddy currents only.
 (D) magnetized in a direction opposite to that of the applied field.
- j. Which of the following is an amorphous material?
- (A) glass (B) zinc
 (C) silver (D) mercury

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

Q.2 a. Give examples for materials that bond in (i) ionic (ii) covalent
 (iii) metallic way of bonding. Explain how the properties of these
 materials depend on the type of
 bond. (8)

b. Explain line and surface imperfections found in solid materials with
 suitable sketches. (8)

Q.3 a. Name the materials which are used in the making of
 (i) elements for dielectric heaters.

- (ii) resistors for loading rheostats.
- (iii) resistors for precision instruments.
- (iv) elements of a filament lamp. (8)

b. Give a short explanation of the classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service. (8)

Q.4 a. (i) Explain laws of diffusion.

(ii) Explain atomic model of diffusion. (8)

b. Distinguish between ferromagnetism and ferrimagnetism. Explain domain structure and hysteresis loop for a soft magnetic material used in electrical machines. (8)

Q.5 a. Explain 'chemical vapour deposition', 'implantation', 'metallization' in the context of processing of electronic materials. (8)

b. The magnetic field strength in a piece of copper is 10^6 A/m . If the magnetic susceptibility of copper is 0.5×10^{-5} unit, find the flux density and the magnetization in copper. $\mu_0 = 1.257 \times 10^{-6}$ henry / m. (8)

Q.6 a. Describe direct and indirect extrusion process with sketches. (8)

b. What is polarizability? What do you mean by local electric field? Examine the physical processes which give rise to different types of polarizations. (8)

Q.7 a. What is heat treatment? Explain hardening and tempering. (8)

b. Give an outline of the various steps taken during the process of photolithography. Discuss the fabrication of photo-masks employed for making micron-range devices. (8)

Q.8 a. The intrinsic resistivity of germanium at 300°K is 47 ohm-cm. What is the intrinsic carrier concentration? Given the electron mobility, $\mu_n = 3900\text{cm}^2$ per volt-sec; the hole mobility, $\mu_p = 1900\text{cm}^2$ per volt-sec, and the electronic charge, $e = 1.6 \times 10^{-19}$ coulomb. (8)

b. State and explain Hall effect. Describe an experimental set up to determine Hall coefficient and Hall mobility. (8)

Q.9 a. (i) What is phase rule? Explain phase, component and degree of freedom.

(ii) Explain zone refining. Give its important applications. (8)

b. Write notes on any **TWO** of the following:

(i) Rolling.

(ii) Annealing and Normalizing.

(iii) Characteristics of a p-n-p junction transistor. (8)