

DECEMBER 2007

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. Mobility of an electron is

- (A) maximum flow of electrons per unit field.
- (B) average field applied per unit drift velocity.
- (C) average drift velocity per unit field.
- (D) average conductivity per unit field.

b. The correct order of the co-ordination number in simple cubic, body centered cubic and face centered cubic of unit cell is

- (A) 6, 8, 12.
- (B) 8, 12, 12.
- (C) 12, 8, 12.
- (D) 6, 8, 8.

c. At absolute zero temperature, the probability of finding an electron at an energy level E is zero when

- (A) $E < E_F$
- (B) $E > E_f$
- (C) $E = \frac{E_f}{2}$
- (D) None

d. Piezoelectric effect is the production of electricity by

- (A) chemical effect. (B) temperature.
(C) applying pressure. (D) humidity.
- e. A ferromagnetic material is one in which neighbouring atomic magnetic moments are
- (A) predominantly parallel in small regions of material.
(B) predominantly parallel and unequal in small regions of material.
(C) predominantly equal and parallel through out the material.
(D) predominantly unequal and parallel throughout the material.
- f. In an intrinsic semiconductor, there are
- (A) no mobile holes.
(B) no free electrons.
(C) neither free electrons nor mobile holes.
(D) equal number of free electrons and mobile holes.
- g. Which one of the following is not the advantage of ion-implantation over diffusion doping
- (A) it is a low temperature process.
(B) point imperfections are not produced.
(C) shallow doping is possible.
(D) gettering is possible.
- h. The hardness of quenched Martensite
- (A) increases with increasing carbon percentage.
(B) decreases as carbon percentage increases.
(C) first increases and then remains almost constant as the carbon percentage increases.
(D) first increases and then decreases as carbon percentage increases.
- i. The preheating of parts to be welded and slow cooling of the welded structure will reduce
- (A) cracking and incomplete fusion
(B) cracking and residual stress.
(C) residual stress and incomplete penetration.
(D) cracking and underfill.
- j. The degree of freedom when ice water and water vapour coexist in equilibrium is

- (A) zero
(C) triple point
- (B) one
(D) minus one

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

- Q.2** a. Distinguish the following with suitable examples:-
- (i) Ionic and covalent types of bonding.
 - (ii) Lattice and cohesive energy.
 - (iii) Ionisation energy and electron affinity. **(3+3+3)**
- b. Establish the relation between lattice constant (a) of a cubic crystal and the density of the crystal material. Determine the size of the largest spherical impurity atom that will fit into the voids of the FCC structure. **(4+3)**
- Q.3** a. What is meant by crystal imperfections? Classify them in the order of their geometry. Explain the difference between edge and screw dislocations. What is a Burger's vector? **(2+2+4+1)**
- b. What is the phase rule and what does it indicate? Using Gibb's phase rule show that eutectoid reaction is non-variant. **(2+2+3)**
- Q.4** a. Explain with suitable diagrams the atomic model of diffusion. How does drift current differ from diffusion current? What is Einstein's relationship? **(4+4+2)**
- b. Explain with suitable plots the probability of occupancy of energy level E by an electron with
- (i) $E < E_F$
 - (ii) $E = \frac{E_F}{2}$
 - (iii) $E > E_f$
- Also draw a plot between number of electrons and the energy. **(6)**

Q.5 a. Mark the Fermi level in energy band diagram for

- (i) an intrinsic semiconductor.
- (ii) n-type semiconductor.
- (iii) p-type semiconductor.

Show that the density of electrons in the conduction band of an n-type semiconductor is proportional to the square root of donor concentration. **(3+5)**

b. What is Hall effect? Briefly discuss the physical origin and uses of Hall effect? What are the uses of this effect? **(3+3+2)**

Q.6 a. Explain the following:

- (i) polarizability.
- (ii) dipole relaxation.
- (iii) loss angle.
- (iv) dielectric breakdown.

Summarize the various factors contributing to breakdown in dielectrics. **(8+2)**

b. What are the chief characteristics of ferro-electric materials? How do you establish the existence of ferro-electricity in a material? **(3+3)**

Q.7 a. Draw the B-H curve for a ferro-magnetic material and identify the retentivity and the coercive field on the curve. What is the energy loss per cycle? How are ferrites superior to ferro-magnetic materials? **(4+2+3)**

b. Explain clearly the difference between hard and soft magnetic materials. Explain why Fe-Si alloys are used for power transformers whereas Ni-Fe alloys are used for pulse transformers. **(3+4)**

Q.8 a. Explain the various steps required in the fabrication of an integrated circuit. What are the important functions of oxide layer in an integrated circuit? **(6+3)**

b. Differentiate between soldering and brazing processes. What are the metallurgical factors which affect the quality of a welded joint? **(5+2)**

Q.9 Write notes on any **TWO** of the following:-

- (i) Annealing and normalizing processes.
- (ii) Extrusion process.
- (iii) Properties of filament and contact materials.
- (iv) Free electron theory of metals. **(8+8 = 16)**