JUNE 2007

Code: AE-04
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. A Ge atom contains

(A) four protons **(B)** four valence electrons
(C) six valence electrons **(D)** only two electron orbits

b. The energy required to break a covalent bond in a semiconductor

(A) is equal to 1 eV
(B) is equal to the width of the forbidden gap
(C) is greater in Ge than in Si
(D) is the same in Ge and Si

c. The property of a material by which it can be drawn into wires is known as

(A) ductility **(B)** elasticity
(C) softness **(D)** tempering

d. An electron in the conduction band

(A) is located near the top of the crystal
(B) has no charge
(C) has a higher energy than an electron in the valence band
(D) is bound to its parent atom

e. At 0° K, all the valence electrons in an intrinsic semiconductor

(A) are in the valence band

(B) are in the forbidden gap
(C) are in the conduction band
(D) are free electrons

f. Malleability of a metal is the

(A) ability to withstand compressive stresses
(B) ability to withstand deformation under shear
(C) property by which a material can be cold-worked
(D) ability to undergo permanent deformation

g. Insulating material used in spark plug is

(A) rubber **(B)** porcelain
(C) mica **(D)** Polysterene

h. Which of the following has piezoelectric properties:

(A) corundum
(B) neoprene
(C) quartz
(D) glass

i. For metallization, the property <u>not desirable</u> is

(A) reproducibility
(B) quick dissipation of heat
(C) low thermal conductivity
(D) high melting point

j. If P is the number of phases, F is the degrees of freedom, and C is the number of components in a system, then, according to phase rule

(A) $P + F = C - 2$ **(B)** $P + C = F - 2$
(C) $P + F = C + 2$ **(D)** $P + C = F + 2$

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

Q.2 a. Draw sketches illustrating a (100) plane, a (110) plane, and a (111) plane in a cubic unit cell. How many equivalent {100} planes are there in a cubic crystal? **(8)**

b. Calcium has a face-centred cubic structure with an ionic radius of 1.06 Å. Calculate the interplanar separation for (111) planes. **(8)**

Q.3 a. Explain the electric polarization and the electric susceptibility in the context of dielectrics. **(8)**

b. A conductor is charged by repeated contacts with a metal plate which, after each contact, is recharged to a quantity of charge Q. If q is the charge of the conductor after the first operation, what is the ultimate charge on the conductor? **(8)**

Q.4 a. Briefly discuss the classification of magnetic materials. Give examples. **(8)**

b. Describe Ferrites for high frequency transformers and computer memory cores. **(8)**

Q.5 a. Obtain a relationship between the conductivity and mobility of charge carriers in a semi-conducting specimen. Explain the temperature dependence of conductivity. **(8)**

b. Show that for correct mass balance, the relative amounts of two co-existing phases or microconstituents must be given by the lever principle. **(8)**

Q.6 a. Explain, giving examples, the formation of co-valent, metallic and ionic bonds in crystals. **(8)**

b. What are the important crystal imperfections? Explain the geometry of edge and screw dislocations. Give suitable sketches. **(8)**

Q.7 a. In the context of processing of electronic materials, explain oxidation, diffusion and metallisation. **(8)**

b. Outline a procedure for photolithography in the fabrication of electronic devices. What are the limitations of this procedure? **(8)**

Q.8 a. Explain the term 'welding'. Brief explain the distinguishing features of the following methods of 'welding': (i) pressure welding; (ii) fusion welding; (iii) electric arc welding. **(8)**

b. Give two iron bars, identical in appearance, one magnetized, the other not. Explain how to distinguish them without using external magnetic fields. You are allowed to measure forces. **(8)**

Q.9 a. With the help of a suitable diagram showing the relative orientations of magnetic induction, current densities and electric fields in a semiconducting specimen, derive an expression for the Hall constant, the Hall angle and the Hall mobility. **(8)**

b. Write short notes on the following:

(i) Atomic model of diffusion,

(ii) The Einstein relation **(8)**