## **JUNE 2007**

Code: AE-04

**Subject: MATERIALS AND PROCESSES** 

Time: 3 Hours Max. Marks: 100

NOTE: There are 9 Questions in all.

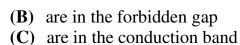
- Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.
- Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.
- Any required data not explicitly given, may be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



**(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 coexisting 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?

- 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)