

# AMIETE – ET (OLD SCHEME)

Code: AE04  
Time: 3 Hours

Subject: MATERIALS AND PROCESS  
Max. Marks: 100

**DECEMBER 2010**

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: (2 × 10)**

a. Covalent bonds in solids are formed by

- (A) Electrical dipoles. (B) Sharing of electrons.  
(C) Transfer of electrons. (D) Gravitational forces.

b. A plane in a unit cell is described by its Miller indices (632). The plane intersects  $x$ ,  $y$ ,  $z$  respectively at points whose distances from origin are

- (A) 6, 3 and 2 units (B)  $1/3$ ,  $2/3$  and 1 units  
(C)  $1/3$ ,  $1/2$  and  $1/1$  units (D)  $1/6$ ,  $1/3$  and  $1/2$  units

c. The unit of diffusion coefficient is

- (A)  $m^2 s^{-1}$ . (B)  $m^2 s^{-1}$   
(C)  $m^2 s^{-2}$  (D)  $m^2 s^2$

d. In a single component system, the maximum number of phases that can coexist in equilibrium are

- (A) 5 (B) 7  
(C) 3 (D) 2

e. If the mobility of electrons in a metal increases, the resistivity

- (A) Decreases  
(B) increases.  
(C) First decreases and then increases  
(D) First increases and then decreases

f. Burger's vector of an edge dislocation is

- (A) Parallel to dislocation line  
(B) Perpendicular to dislocation line  
(C) At any angle with dislocation line including 0 and 90°  
(D) None of the above

- g. In photoelectric effect the number of electrons emitted is proportional to
- (A) work function of cathode
  - (B) velocity of incident beam
  - (C) frequency of incident beam
  - (D) intensity of incident beam
- h. The fastest cooling rate is achieved when steel is quenched in
- (A) air
  - (B) oil
  - (C) water
  - (D) brine water
- i. The temperature below which certain materials are ferromagnetic and above which they are paramagnetic is called
- (A) Neel temperature
  - (B) Curie temperature
  - (C) Weiss temperature
  - (D) None of these
- j. A Zener diode is used as
- (A) a coupler
  - (B) a rectifier
  - (C) an amplifier
  - (D) a voltage regulator

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

- Q.2** a. Increasing the temperature of a semiconductor breaks covalent bonds. For each broken bond, two electrons become free to move and transfer electrical charge.
- (i) What fraction of valence electrons are free to move and
  - (ii) What fraction of the covalent bonds must be broken in order that  $5 \times 10^{15}$  electrons conduct electrical charge in 50 gm of silicon? (8)
- b. Calculate the atomic radius in cm for the following:
- (i) BCC metal with  $a_0 = 0.3294$  nm and one atom per lattice point.
  - (ii) FCC metal with  $a_0 = 4.0862$  and one atom per lattice point. (8)
- Q.3** a. Explain phase rule and what does it indicate? Show that eutectoid reaction is non-variant. (8)
- b. What are crystal imperfections? Discuss Burger's vector. (8)
- Q.4** a. Explain with suitable diagrams the atomic model of diffusion. How does drift current differ from diffusion current? What is Einstein's relation? (8)
- b. Iron is often coated with a thin layer of zinc if it is to be used outside. Explain why? What are the precautions which should be considered while handling or recycling this product? (8)

- Q.5** a. What material can be used for the electrical contacts in an electronic switching device which opens and closes frequently and forcefully? What properties should the contact material possess? Would  $\text{Al}_2\text{O}_3$  be a good choice? Explain. (8)
- b. Discuss, briefly, various properties and applications of dielectric materials. (8)
- Q.6** a. In a semiconductor the effective mass of an electron is  $0.07 m_0$  and that of a hole is  $0.4 m_0$ , where  $m_0$  is the free electron mass. Assuming that the average relaxation time for the holes is half that for the electrons, calculate the mobility of the holes when the mobility of the electrons is  $0.8 \text{ m}^2 \text{ volt}^{-1} \text{ s}^{-1}$  (8)
- b. State and explain Hall effect. What are its applications? (8)
- Q.7** a. Discuss properties and applications of following  
(i) Bakelite. (ii) Mica. (8)
- b. The density of nickel is  $8.90 \times 10^3 \text{ kg/m}^3$ . Avogadro's number is  $6.023 \times 10^{23}$  atoms/mol. Atomic weight of Ni is 58.71 gm/mol. Calculate (i) the saturation magnetization (ii) the saturation flux density. (8)
- Q.8** a. Explain why ferromagnetic materials can be permanently magnetized whereas paramagnetic ones cannot? (8)
- b. In the context of processing of electronic materials, explain oxidation, diffusion and metallization. (8)
- Q.9** a. Explain the term 'welding'. Describe the process of extrusion giving its advantages. (8)
- b. Briefly describe the process and purpose of the following heat treatment operations  
(i) Hardening.  
(ii) Tempering (8)