

Time: 3 Hours

DECEMBER 2013

Max. Marks: 160

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

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.
- The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.
- 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 the best alternative in the following: (2 × 10)

a. The number of atoms present in the unit cell of HCP structure is

- (A) 2 (B) 4
(C) 6 (D) 7

b. Piezoelectric effect is the production of electricity by

- (A) chemical effect (B) pressure
(C) varying field (D) temperature

c. Ferroelectric materials are characterised by

- (A) Very high degree of polarisation
(B) A sharp dependence of polarisation on temperature
(C) Non-linear dependence of the charge Q on the applied voltage
(D) All of these

d. Al has a ccp arrangement of atoms. The radius of Al = 1.423 \AA (= 143.2pm and atomic weight = 26.98). The lattice parameter of the unit cell is

- (A) 4.050 \AA (B) 5.040 \AA
(C) 1.423 \AA (D) 2.698 \AA

e. If P is the number of phases, F is the degree 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) $P + C = F + 2$

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- f. Number of Terminals in a JFET are
- (A) Two (B) Three
(C) Four (D) Five
- g. Missing of one cation and one anion in an ionic crystal (having charge neutrality) is called
- (A) Frenkel imperfections
(B) Compositional imperfections
(C) Electronic imperfections
(D) Schottky imperfections
- h. Insulating material used in spark plug is
- (A) rubber (B) porcelain
(C) mica (D) polysterene
- i. Aluminium is not good for die casting because
- (A) it is light and strong
(B) it takes longer time to cool
(C) it tends to react chemically with the die surface
(D) its melting point is high and it expands on solidification
- j. Barrier potential in a P-N junction is caused by
- (A) Thermally generated electrons and holes.
(B) Diffusion of majority carriers across the junction.
(C) Migration of minority carriers across the junction.
(D) Flow of drift current.

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

- Q.2** a. Define atomic packing. Show that the atomic packing factor for FCC and HCP metals are the same (8)
- b. Obtain the miller indices of a plane which intercepts at a , $b/2$, $3c$ in a cubic unit cell. Draw a neat diagram showing the plane, (where a, b, c are lattice parameters.) (8)
- Q.3** a. What are different types of point defects and how are they caused? (8)
- b. Explain in detail the ionic and metallic bonds observed in materials with an example. (8)

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- Q.4** a. The Fermi level for potassium is 2.1eV. Calculate the velocity of the electron at the Fermi level. Show that the probability of occupancy of energy level E by an electron is 50% for $E = E_F$ at temperature ($T \neq 0^\circ\text{K}$). (8)
- b. How do temperature and impurities affect electrical resistivity of metals. (4+4)
- Q.5** a. What is piezoelectricity? What are the different applications in which piezoelectricity is used. Describe materials that show piezoelectricity. (8)
- b. Explain the properties of common dielectric materials. Write the application area of these dielectric materials. (8)
- Q.6** a. Qualitatively explain, the domain theory of ferromagnetic materials. Explain how are the domains formed and are affected by temperature changes? (8)
- b. Explain the significance of hysteresis. Sketch a neat representation of hysteresis loop for a –
- (i) Transformer core.
 - (ii) Strong electromagnet.
 - (iii) Magnetic tape. (8)
- Q.7** a. With respect to semiconducting materials explain with suitable diagrams the atomic model of diffusion. How does drift current differ from diffusion current? What is Einstein's relationship? (8)
- b. 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 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 $0.8\text{m}^2 \text{ volt}^{-1} \text{ sec}^{-1}$ (8)
- Q.8** a. Explain the term 'depletion layer' across a p-n junction in a semiconducting device. Discuss how P-N junction functions as a rectifier. (8)
- b. Discuss the properties and application area of the following materials-
- (i) Ceramic
 - (ii) Mica (4+4)
- Q.9** a. For an n- channel silicon FET with $a = 3 \times 10^{-4} \text{ cm}$ (effective channel width) and $N_D = 10^{15} \text{ electron /cm}^3$. Find:
- (1) pinch of voltage
 - (2) the channel half width for $V_{GS} = 1/2 V_P$ and $I_D = 0$. (8)
- b. Write short notes on : (8)
- 1. Grown junction
 - 2. Zone refining.

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