



- N. B. : (1) Question No. 1 is compulsory.  
(2) Attempt any **three** questions from Question No. 2 to 6.  
(3) Use **suitable data** wherever **required**.  
(4) **Figures** to the **right** indicate the **full** marks.

1. Attempt any **five** of the following :—

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- Identify the type of lattice and number of atoms per unit cell for CsCl and BaTiO<sub>3</sub> (above 120°C) crystal structure.
- Fermi Energy for Silver is 5.5 eV. Find out the energy for which the probability of occupancy at 300 K is 0.9.
- Explain the formation of depletion region in an unbiased p-n junction.
- Write three distinct differences between ionic and orientational polarization.
- Draw the variation of permeability against external magnetic field for a paramagnetic and ferromagnetic material (below Curie temperature).
- Mention only one solution for each of the following acoustical problems in a hall (i) echo (ii) dead spot and (iii) inadequate loudness.
- What is piezoelectric effect? Why ferro-electrics are preferred than quartz for the production of ultrasonic waves?

2+1

2. (a) What is effective mass? Why the effective mass of holes is more than the effective mass of electrons?

2+2

Draw the diagrams only (fully labelled and self explanatory) to show the variation of Fermi energy with (i) temperature and (ii) impurity concentration at high level, for an n-type semiconductor.

2+2

(b) Define space lattice and basis. A metal crystallizes with a density of 2.7 gm/cc and has a packing fraction of 0.74. Determine the mass of one atom if the nearest neighbour distance is 2.86 Å.

1+1+5

3. (a) Explain the variation in magnetic induction with magnetic field for a ferromagnetic material, using the domain theory and with the help of a graph. A magnetic field of 1800 Amp/m produces a magnetic flux of  $3 \times 10^{-4}$  Wb in an iron bar of cross-sectional area 0.2 cm<sup>2</sup>. Calculate the susceptibility and the permeability.

3+5

(b) How the variation in glancing angle is achieved while determining the crystal structure using (i) rotating crystal method and (ii) powder method?

3+4

Calculate Bragg angle if (200) planes of a BCC crystal with lattice parameter 2.814 Å give second order reflection with X-rays of wavelength 0.71 Å.

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4. (a) Calculate the critical radius ratio of an ionic crystal in ligancy 4 configuration. 5
- (b) Determine the concentration of conduction electron in a sample of Silicon if one in every million Silicon atom is replaced by a Phosphorous atom. Assume every Phosphorous atom to be singly ionized. Si has a molar mass of 0.028 kg/mole and density of 2300 kg/m<sup>3</sup>. 5
- (c) If a gas contains  $1.2 \times 10^{27}$  atoms/m<sup>3</sup> and radius of atom is 0.53 Å, then calculate electronic polarizability and dielectric constant. Find the capacitance of a parallel plate capacitor having this gas inside, with plate area 1 cm<sup>2</sup> and plate separation 0.12 cm. 5
5. (a) Find Miller Indices of a plane whose intercepts are a, 4a and a, where a is the lattice constant. Draw (102), [201] and  $(0\bar{4}0)$  in a cubic unit cell. 5
- (b) In a semiconductor with Hall coefficient 145 cc/C having width of 2 cm and thickness 0.2 cm with a magnetic field induction of 2T along the smaller dimension, a current of 150 mA is passing. Calculate the current density and Hall voltage. 5
- (c) Write Sabine's formula explaining each term. Explain how this formula can be used for the determination of absorption coefficient of a given material. 1+4
6. (a) Write five distinct differences between Frenkel and Schottky defect. 5
- (b) Explain how a voltage difference is generated in a p-n junction when it is used in a photovoltaic solar cell. 5
- (c) Explain the principle, construction and working of a magnetostriction oscillator to produce ultrasonic waves. 1+1+3

