

Time: 2 hours

Marks: 60

1. Question number 1 is compulsory
2. Attempt any three from remaining
3. Figure to right indicates marks
4. Assume necessary data

Q1 attempt **any 5** from following

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1. Explain the steps to calculate the Miller indices of a plane.
2. Calculate the distance between two carbon atoms of a basis of the diamond structure, if the lattice constant of structure is  $5 \text{ \AA}$ .
3. Draw the diagrams to show the variation of fermi level with temperature for n-type and p-type semiconductors.
4. Define reverberation of time. State the factors on which it depends upon.
5. Calculate the number of turns required to produce a flux of  $10^{-3} \text{ Wb}$  around an iron ring of  $5 \text{ cm}^2$  cross section and 20 mm mean diameter having an air gap of 2 mm wide across it. The relative permeability of iron is 1000.
6. Two parallel plate capacitors having equal and opposite charges are separated by a dielectric slab of thickness 2 cm. If the electric field inside is  $10^6 \text{ V}$  and dielectric constant is 3, calculate the polarization and displacement density.
7. Explain the statement "crystal acts as three dimensional grating with X-rays".

Q.2) **a.** Explain Hall effect & its significance. A bar of n type Ge of size  $0.010 \text{ m} \times 0.001 \text{ m}$  is mounted in a magnetic field of  $2 \times 10^{-1} \text{ T}$ . The electron density in the bar is  $7 \times 10^{21} / \text{m}^3$ . If one millivolt is applied across the long ends of the bar, determine the current through the bar and the voltage between Hall electrodes placed across the short dimensions of the bar. Assume  $\mu_e = 0.39 \text{ m}^2 / \text{vs}$ .

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**b.** Explain various point defects in crystals. Estimate the number of Frenkel defects per  $\text{mm}^3$  in AgCl if energy of formation of frenkel defects is 1.5 eV at  $700^\circ \text{K}$ . The molecular weight of AgCl is 0.143 kg/mol and specific density is 5.56.

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Q.3) **a.** Draw the unit cell of HCP. Derive the number of atoms/unit cell, the c/a ratio and the void space percentage.

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b. With a neat labelled diagram explain the principle, construction and working of a piezoelectric oscillator. 7

Q.4) a. For an intrinsic semiconductor show that the Fermi level lies in the centre of the forbidden energy gap. 5

b. Calculate the energy loss per minute in the core (of mass 40 Kg) of a transformer, if area of the hysteresis loop is 1900 erg/cc. Frequency is 100 cycles/sec and density of the material of the core is 7.5 gm/cc

c. Derive the relation between polarization, dielectric susceptibility and dielectric constant. 5

Q. 5) a. Explain the determination of the crystal structure using Braggs spectrometer. 5

b. 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 1cm<sup>2</sup> and plate separation 0.12 cm. 5

c. Define Ligancy and critical radius ratio in case of ionic solid. Write the conditions for stability of ionic crystals in 3-D. 5

Q.6) a. Two ships are anchored at certain distance between them. An ultrasonic signal of 50 KHz is sent from one ship to another via 2 routes. First through water and second through atmosphere. The difference between the time intervals for receiving the signals at the other ship is 2 seconds. If the velocity of sound in atmosphere and seawater are 348 m/s and 1392 m/s respectively, find the distance between the ships. Also find the time taken by the signal to travel through water. 5

b. Explain principle, construction & working of a solar cell. 5

c. Distinguish between diamagnetic, paramagnetic & ferromagnetic materials. 5

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