

This question paper contains 4 printed pages.]

Your Roll No. ....

**1230**

**B.Sc. (Hons.) / III**

**A**

**PHYSICS – PAPER – XX**

**(Physics of Materials)**

**Time : 3 Hours.**

**Maximum Marks : 38**

*(Write your Roll No. on the top immediately on receipt of this question paper.)*

Question No. 1 is compulsory.

Attempt one question from each of the units.

1. Attempt any five of the following :  $2 \times 5 = 10$
- (a) Prove that the volumes of unit cells of a direct lattice and a reciprocal lattice are inversely proportional to each other.
  - (b) Show that a five fold rotational symmetry is not possible in a crystal.
  - (c) Prove that the number of normal modes of vibration in a monoatomic lattice of finite length is equal to the number of atoms in the lattice.

- (d) Explain the properties of ferrites.
- (e) Dielectric constant of NaCl for d.c. field is 5.68 whereas its refractive index is 1.54 at visible wavelength. Explain why it is so ?
- (f) Distinguish between conductors, semi-conductors and insulators on the basis of band theory of solids.
- (g) Calculate the position of Fermi level at 300 °K temperature w.r.t. the intrinsic Fermi level for Si doped with  $10^{16}$  In. atoms/cm<sup>3</sup> assuming complete ionization of impurities.

Given, intrinsic carrier concentration =  $1.45 \times 10^{10}$  /cm<sup>3</sup> at 300 °K and Boltzmann constant  $K = 0.862 \times 10^{-4}$  eV/K.

### UNIT - I

2. (a) Define Miller indices. Derive an expression for interplanar spacing between nearest (hkl) planes in a cubic lattice. 3
- (b) Explain the term Packing Fraction. Calculate the packing fraction for (i) Simple Cubic, (ii) b.c.c; and (iii) f.c.c. 4
3. (a) Deduce Bragg's law  $2\vec{K} \cdot \vec{G} + G^2 = 0$  for X-ray diffraction by crystal. The symbols have their usual meaning. 4
- (b) Obtain the parameters for the first two Brillouin zones of a square lattice of side  $a$  and draw the diagram. 3

## UNIT - II

4. (a) State the assumptions made in Einstein theory of lattice specific heat of solids. Derive formula for molar heat capacity of solids. 5
- (b) Describe the shortcomings of Einstein's theory and how was it modified by Debye? 2
5. (a) Give an account of quantum theory of paramagnetism for high and low temperatures. 4
- (b) Discuss the B-H hysteresis loop for a ferromagnetic substance. Distinguish soft and hard ferromagnets. 3

## UNIT - III

6. (a) Explain the term dielectric polarizability. Obtain an expression for local electric field at an atom in a dielectric medium. 5
- (b) Draw a diagram between frequency and total polarizability showing contribution of frequency ranging from microwave to ultraviolet. 2
7. (a) Deduce Clausius-Mossotti relation and obtain expression for Molar polarizability: 4
- (b) Write a note on ferro-electricity and discuss P-E hysteresis loop. 3

#### UNIT - IV

8. (a) State Bloch's theorem. Obtain the energy spectrum of an electron in a one dimensional periodic potential. How does it leads to the formation of energy bands ? 5
- (b) Discuss the concept of effective mass. How does it vary with wave vector  $K$  ? 2
9. (a) What is superconductivity ? Distinguish between Type I and Type II superconductors. 2
- (b) Derive London's equation and obtain an expression for penetration depth. 5
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