DPP-1411
M. Sc. (Physics) (Sem. II) Examination
April / May - 2016
PH-422 : Solid State Physics

Time : 2 Hours] [Total Marks : 70

Instructions :

(1) Fill up strictly the details of signs on your answer book.

(2) Figures to the extreme right side indicate full marks of question.

(3) Symbols have their usual meaning.

(4) Assume data if required.

1 Attempt any two questions :

(a) Define a single crystal. How does a crystal differ from a grain and lattice? Describe the scheme to determine the miller indices of a plane. Show that the parallel planes have the same miller indices.

(b) State the properties of a reciprocal lattice. A substance with f.c.c. lattice has density 6250 kg/m³ and molecular weight 60.2. Calculate the lattice constant a. Give Avogadro Number $6.02 \times 10^{26}$ kg/mole.

(c) What is unit cell and Brillouin zone? Discuss the construction of the first three brillouin zones for a square lattice.
2 Attempt any two questions:
   (a) What is the optimum order of x-ray wave length used to observe the diffraction effects? Obtain the Bragg's law from the laue's equations.
   (b) Explain Edge dislocation and Screw dislocation. Derive the equation of structure factor for f.c.c. crystal.
   (c) What types of diffraction patterns are obtained for crystalline and non crystalline solids? Calculate the glancing angle on the cube (100) of a rock salt crystal ($a = 2.814 \text{ Å}$) corresponding to second order diffraction maximum for X-rays of wavelength $0.710 \text{ Å}$.

3 Attempt any two questions:
   (a) Obtain dispersion relation for the lattice wave in a monatomic linear lattice of in terms of wave velocity, mass $m$, spacing $a$ and the nearest neighbor interaction $f$.
   (b) Explain the terms of Quantum Dots and spintronics. Write the applications of semiconductor devices.
   (c) Give the examples of Intrinsic and Extrinsic semiconductors. Calculate the maximum phonon frequency generated by scattering of visible light of wavelength $\lambda = 4000 \text{ Å}$. Given that velocity of sound in medium is $5 \times 10^5 \text{ cm/sec}$, and refractive index is 1.5.

4 Attempt any two questions:
   (a) What is Bloch function? Give the order of band gap for a metal, a semiconductor and an insulator. Explain the conductivity of metals decreases while that of semiconductors increase with rise in temperature.
   (b) Explain AC and DC electrical conductivity. Derive the condition for a set of propagation of electromagnetic radiation.
(c) Write the basic assumption in Kroning-penny model. An insulator has an optical absorption which occurs for all wavelength shorter than 1800 Å. Find the width of forbidden energy band for this insulator. Where

\[ C = 3 \times 10^8 \text{ cm/sec} \text{ and } h = 6.626 \times 10^{-34} \text{ Js}. \]

5 Attempt any two questions:

(a) What is superconductivity? Write the thermal properties of superconductor. Explain Meissner effect?

(b) Define penetration depth for a superconductor. What is the value at the critical temperature? What is the soft and hard superconductor?

(c) Describe the Josephson effect underlying a SQUID. Calculate the penetration depth for a superconducting materials having electron density \( n = 4 \times 10^{26}/m \). What happens to the penetration depth as the critical temperature is approached?

\( m = 9.1 \times 10^{-31} \text{ kg, } e = 1.6 \times 10^{-19} \text{ C, } \mu_0 = 4\pi \times 10^{-7} \text{ S.I. Unit} \)