

2012
B.A./B.Sc. (General) Fifth Semester
Physics
Paper – A: Condensed Matter Physics – I

Time allowed: 3 Hours

Max. Marks: 44

NOTE: Attempt five questions in all, including Question No.7 (Section -C) which is compulsory and selecting two questions each from Section A-B. Use of log tables and non-programmable calculator is allowed.

x-x-x

Section-A

1. (a) What is K-space? Show that FCC lattice is the reciprocal lattice of BCC with lattice constant $\frac{2\pi}{a}$. 5
(b) Determine the Miller Indices of plane that makes an intercept of 2\AA , 3\AA & 4\AA on the coordinate axes of an orthorhombic crystal with $a:b:c = 4:3:2$. 4
2. (a) Describe hexagonal close packed (hcp) structure. What is the coordination number in hcp? Calculate its atomic packing fraction? 5
(b) Derive geometrical structure factor. How is it related to atomic scattering factor? 4
3. (a) Derive the Laue's equations of diffraction for X-rays and obtain Bragg's diffraction condition for them. 5
(b) Explain Ewald construction for reciprocal lattice. 4

Section B

4. (a) Obtain expressions of Fermi energy, total energy and density of states for a free electron gas in one dimension. Show the variation of density of states with energy. 6
(b) What is electrical conductivity? Using free electron theory, derive ohm's law. 3
5. (a) Given the solution of Schrodinger equation for a one dimensional periodic lattice $\frac{P \sin \alpha a}{\alpha a} + \cos \alpha a = \cos ka$, where $\alpha = \left(\frac{2mE}{\hbar^2}\right)^{1/2}$ discuss the formation of energy band in solids. 6
(b) What is meant by effective mass of an electron? What is its significance? Discuss the condition when the effective mass of an electron become positive negative and infinity. 3
6. (a) Explain Hall Effect. Obtain the expression for Hall coefficient. 5
(b) Compute the carrier concentration and conductivity of intrinsic Ge at 300 K. 5
Given $m_e^* = m_h^* = 9.1 \times 10^{-31} \text{kg}$, $\mu_e = 0.38 \text{m}^2 \text{V}^{-1} \text{s}^{-1}$, $\mu_h = 0.18 \text{m}^2 \text{V}^{-1} \text{s}^{-1}$, $E_g = 0.68 \text{eV}$, $k = 1.38 \times 10^{-23} \text{JK}^{-1}$, $\hbar = 1.053 \times 10^{-34} \text{Js}$. 4

P.T.O.

(2)

Section C

(Attempt any **Eight** parts)

7. (i) What are Miller indices?
(ii) Define reciprocal lattice vector.
(iii) State Bloch theorem.
(iv) State Wiedemann-Franz relation.
(v) What are Brillouin zones?
(vi) Define atomic scattering factor.
(vii) What is the cause of failure of free electron theory?
(viii) What are coordination numbers for SC, BCC and FCC lattices?
(ix) What is the difference between free electron gas in metals, ordinary gas obeying kinetic theory?
(x) Semiconductors have negative temperature coefficient of resistance. Explain its meaning.

8×1=8

x-x-x