PHYSICS

PHY : 204

CONDENSED MATTER PHYSICS-I

Full Mark: 80

Time: 3 Hours

The figures in the margin indicates full marks for the questions :

1. . Answer the following   1×5=5

    (a) The position of the Fermi level in n-type semiconductor at absolute zero is

    (i)   At the middle of the conduction band and valance band

    (ii) At the middle of the conduction band and donor level

    (iii) At the middle of the valance band and acceptor level

    (iv) None of the above   1

    (b) The polarization of dielectric material results in

    (i) absorption of electron

    (ii) release of high velocity protons

    (iii) creation of electric dipoles

    (iv) production of eddy currents   1

    (c) At the point of inflection

    (i) Electrons are completely bounded

(ii) The velocity of the electron is maximum

(iii) Effective mass of electron become zero

(iv) None of the above   1

(d) In a solid or liquid dielectrics, with external applied electric field, as the electronic polarizability α_e increases, the internal field E_i

(i) increases   (ii) decreases

(iii) remains unaltered   1

(e) The free electron theory completely fails to explain

(i) diamagnetic susceptibility

(ii) heat capacity and the paramagnetic susceptibility

(iii) ferromagnetic susceptibility

(iv) heat capacity and the diamagnetic susceptibility   1

2. Answer the following   2×5=10

(a) Explain the phenomenon of piezoelectricity. Name few piezoelectric materials and its usage.   2

(b) Discuss the variation of conductivity with temperature for an n-type semiconductor.   2

(c) What is Meissner effect?   2

(d) What are hard and soft magnetic materials? Give example for each and their usage.   2

(e) Find the probability distribution for electrons at absolute zero temperature for both $E < E_F$ and $E > E_F$.   2

2   PTO

3. Answer the following(any five)   5x5=25

(a) Discuss the quantum theory of paramagnetism and obtain an expression for susceptibility.   5

(b) Explain the physical phenomenon of diamagnetism and paramagnetism. Discuss Weiss theory of paramagnetism and obtain the equation for Curie-Weiss law.   2+3

(c) Show that the atomic scattering factor is equal to the atomic number at zero incident angle.   5

(d) Explain the variation of velocity (v) and effective mass (m^*) of an electron as a function of k.   5

(e) Show that the X-ray diffraction in the reciprocal lattice vectors is

$$\left(\frac{\vec{S}}{\lambda} - \frac{\vec{S}_0}{\lambda} \right) = h\vec{b}_1 + k\vec{b}_2 + l\vec{b}_3$$

(the symbols have their usual meaning)   5

(f) Discuss the various recombination processes of exited electrons in the conduction band.   5

4. Answer the following(any four)   10x4=40

(a) (i) What are Brillouin zones? Draw the Brillouin zones for two dimensional square lattice of side 'a' and explain the significance of the zones.   2+3

(ii) Discuss how the band theory of solid classifies the solids into conductors, semiconductors and insulators.   5

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(b) (i) Explain the phenomenon of spontaneous polarization in ferroelectric material. 4

(ii) Derive Clausius-Mossotti equation and hence obtain the Debye's relation. 6

(c) Distinguish between intrinsic and extrinsic semiconductors. Obtain the Expression carrier concentration for an intrinsic semiconductors 2+8

(d) Define reciprocal lattice? Show that reciprocal lattice (σ_{hkl}) is perpendicular to the (*hkl*) plane and the value is reciprocal to the interplanar spacing (d_{hkl}). What is the need of using reciprocal lattice? 2+6+2

(e) What are symmetry elements in crystal? Discuss the various symmetry operations in a cubic crystal. Define point group symmetry operation. 2+6+2

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