K23P 1423

Reg. No. : .....

Name : .....

III Semester M.Sc. Degree (C.B.S.S. – Reg./Supple./Imp.)
Examination, October 2023
(2020 Admission Onwards)
PHYSICS
PHY 3C11 : Solid State Physics

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **both** questions (either **a** or **b**) : **(2×12=24)**

1. a) Develop the wave equation of an electron in a periodic potential.
   b) Derive an expression for intrinsic carrier concentration in semiconductors.
2. a) Illustrate quantum theory of paramagnetism and arrive at Curie law.
   b) What is Meissner effect ? Derive the London equation and explain its significance.

SECTION – B

Answer **any four** (**1** mark for part **a**, **3** marks for part **b**, **5** marks for part **c**) : **(4×9=36)**

3. a) What is first Brillouin zone ?
   b) Derive Bragg's law from the condition for diffraction in reciprocal space $2\vec{k}\cdot\vec{G} = G^2$ (where $\vec{k}$-wavevector of incoming beam, $\vec{G}$-is the reciprocal lattice vector.)
   c) The Bragg angle corresponding to the first order reflection from (1 1 1) planes in a crystal is 30°, when X-rays of wavelength 1.75 $\mathring{A}$ are used. Calculate the interatomic spacing.

P.T.O.

4. a) What is lattice heat capacity ?

   b) Write a note on Einstein's model of lattice heat capacity.

   c) The Debye temperature of carbon (diamond) is 1850 K. Calculate the specific heat per k mol for diamond at 20 K. Also compute the highest lattice frequency involved in the Debye theory.

5. a) State Ohm's law and write the expression for electrical conductivity.

   b) What is a Bloch function ? Discuss its significance.

   c) A uniform silver wire has a resistivity of 1.54×10^{-8} Ωm at room temperature. For an electric field along the wire of 1 volt/cm, compute the mobility and average drift velocity of the electron assuming that there are 5.8×10^{28} conduction electrons/m^3. Also calculate the relaxation time of the electron.

6. a) What is Hall effect ?

   b) Explain Fermi-Dirac distribution function. Plot this function for various temperature including 0 K.

   c) Calculate the Hall coefficient of sodium based on free electron model. Sodium has bcc structure and the side of the cube is 4.28 $\mathring{A}$.

7. a) What is a Type-I superconductor ?

   b) What is superconductivity ? Write a short note on Dc and Ac Josephson effect.

   c) Calculate the frequency of the AC current produced when a DC voltage of 5 μV is applied across the Josephson Junction.

8. a) What is band gap ?

   b) Write a note on the thermal ionization of donors and acceptors.

   c) In an intrinsic semiconductor, the effective mass of the electron is 0.07 m_e and that of hole 0.4 m_e. If the energy gap is 0.7 eV, determine the intrinsic concentration of charge carriers at 300 K.

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