Before answering the question paper the candidate should ensure that they have been supplied the correct question paper. Complaints in this regard, if any, shall not be entertained after the examination.

**Note:** Question No. 1 is Compulsory and attempt two questions from each section. All questions carry equal marks.

1(a) Describe the structures of diamond and obtain its packing fraction. (4)
(b) Show that Phase velocity of associated waves is always greater than the velocity of light in vacuum. (4)
(c) Describe Type-I and Type-II superconductors. (4)
(d) Write features of Drude theory of conduction. (4)
(e) What is Hall Effect? List some applications of Hall Effect. (4)

**SECTION-A**

2(a) Derive relation of Bragg’s law for diffraction of X-rays? Discuss Powder method for crystal structure determination. (10)
(b) What are point defects? Show that the number of Frenkel defects in equilibrium at a given temperature is proportional to \((NN_i)^{1/2}\), where \(N\) and \(N_i\) are number of atoms and interstitial atoms respectively. (10)

3(a) What do you understand by group velocity? Obtain an expression for group velocity. Show that the group velocity of a wave packet associated with a moving particle is equal to the velocity of the particle. (10)

4(a) What do you understand by simple harmonic motion? Obtain the differential equation for simple harmonic motion and obtain expression for time period, velocity and energy. (10)
(b) Derive London equations and discuss how its solution explains Meissner effect and flux penetration. (10)

**SECTION-B**

5(a) How do you define Fermi energy? Derive an expression for Fermi energy. Show that average K.E of an electron is 60% of Fermi energy at absolute zero. (10)
(b) Obtain Richardson-Dushman equation for the thermal current density. (10)

6(a) Derive an expression for the carrier concentration in p-type semiconductors. What would be the position of Fermi level? Explain. (10)
(b) What is Hall Effect? Derive an expression for Hall coefficient. Explain how it helps in the determination of sign of charge carriers in a semiconductor. (10)

7(a) Derive an expression for diamagnetic susceptibility on the basis of Langevin theory and show it is independent of temperature. (10)
(b) Give an account of Langevin’s theory paramagnetism and prove that susceptibility \(\chi\) of paramagnetic substance is proportional to the absolute temperature. (10)