



K22P 1423

Reg. No. :

Name :

III Semester M.Sc. Degree (CBSS – Reg./Sup./Imp.)

Examination, October 2022

(2019 Admission Onwards)

PHYSICS

PHY 3C11 : Solid State Physics

Time : 3 Hours

Max. Marks : 60

SECTION – A

(2×12=24)

Answer **both** questions (either **a** or **b**) :

1. a) What is first Brillouin zone ? Discuss the construction of reciprocal lattices to SC, BCC and FCC lattices with appropriate discussions on the first Brillouin zone.
b) What is a phonon ? Derive an expression for phonon dispersion relation in a diatomic linear lattice and discuss its optical and acoustic modes.
2. a) Discuss the energy levels of a free electron gas in three dimensions and derive an expression for the density of states.
b) What is Meissner effect ? Derive the London equations and explain its significance.

SECTION – B

(4×9=36)

Answer **any four** (1 mark for Part **a**, 3 marks for Part **b**, 5 marks for Part **c**) :

3. a) What is Fermi energy ?
b) Discuss the effect of temperature on the Fermi-Dirac distribution function.
c) The Fermi energy of copper is 7 eV. Calculate the heat capacity of electron gas at room temperature in copper assuming one free electron per atom. Compare this with the lattice specific heat value of $2.4 \times 10^4 \text{ Jkmol}^{-1}\text{K}^{-1}$.

P.T.O.



4. 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 .
5. a) What is a Type-I superconductor ?
b) Explain the BCS theory of superconductivity.
c) Consider a Type II superconductor being placed in a small magnetic field. The field is slowly increased till the field starts penetrating the superconductor. The strength of the field at this point is $2 \times \frac{10^5}{\pi} \text{ gauss}$. If the fluxoid or flux quantum is approximately equal to $2 \times 10^{-5} \text{ gauss} - \text{cm}^2$. Find the penetrating depth of this superconductor.
6. a) What is isotope effect in superconductivity ?
b) What is superconductivity ? Write a short note on Dc and Ac Josephson effect.
c) The critical temperature for mercury with isotope mass 202 is 4.159 K . Determine its critical temperature when its isotope mass is 200.7. Assume $\alpha = 0.5$.
7. a) What is piezoelectricity ?
b) Write a note on ferroelectric crystals and discuss its classification.
c) The magnetic field intensity in a piece of ferric oxide is 10^6 A/m . If the susceptibility of the material at room temperature is 1.5×10^{-3} , calculate the magnetization and flux density in the material.
8. a) What are diamagnetic and paramagnetic materials ?
b) Briefly explain the process of cooling by isentropic demagnetization.
c) A paramagnetic material has $6.02 \times 10^{28} \text{ atoms/m}^3$ and its Fermi energy is 11.63 eV . Determine the Pauli's paramagnetic susceptibility.