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 2.4×10^4 Jkmol^{-1}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 $2 \times \dfrac{10^5}{\pi}$ gauss. If the fluxoid or flux quantum is approximately equal to 2×10^{-5} gauss – 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 6.02×10^{28} atoms/m^3 and its Fermi energy is 11.63 eV. Determine the Pauli's paramagnetic susceptibility.

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