K21P 1009

Reg. No. : .....

Name : .....

III Semester M.Sc. Degree (CBSS – Reg./Suppl./Imp.) Examination, October 2021
(2018 Admission Onwards)
Physics
PHY3C11 : SOLID STATE PHYSICS

Time : 3 Hours Max. Marks : 60

SECTION – A

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

I. a) Discuss the Einstein's and Debye's models of lattice specific heat capacity of solids.

OR

b) Define Fermi energy. Derive the expressions for the Fermi energy and density of states of a free electron gas in three dimensions.

II. a) What is Meissner effect ? Discuss the theory of ac and dc Josephson effects exhibited by superconductors.

OR

b) What are paramagnetic materials ? Discuss the quantum theory of paramagnetism and hence derive Curie's law.

SECTION – B

Answer **any four** questions. **1** mark for Part (a), **3** marks for Part (b) and **5** marks for Part (c). **(4×9=36)**

III. a) What are Brillouin zones ?

b) Construct the first Brillouin zone of an oblique lattice in two dimensions.

c) Show that the reciprocal lattice to a body centred cubic lattice is face centred cubic.

P.T.O.

IV. a) What is a phonon ?

b) Write down the dispersion relation and plot the phonon dispersion curve for a one dimensional monoatomic lattice.

c) Prove that for one dimensional monoatomic lattice vibrations, group velocity is equal to phase velocity of waves at low frequencies.

V. a) State Bloch theorem.

b) Write down any four importances of Hall effect.

c) Aluminium has electrical conductivity of 3.8×10^7 mho/m at 27°C. If the Wiedemann-Franz law is valid, calculate thermal conductivity of aluminium due to electronic contribution.

VI. a) Define 'effective mass' of an electron.

b) Show that the Fermi energy level of an intrinsic semiconductor lies at the mid-way between top of the valence band and bottom of the conduction band at absolute zero.

c) The intrinsic carrier concentration in Germanium is $2.35 \times 10^{19}/m^3$ at room temperature. Determine its resistivity if the electron and hole mobilities are 0.39 and 0.19 m^2/V-s.

VII. a) Define vortex state of a superconductor.

b) Briefly explain the BCS theory of superconductivity.

c) Show that an ideal Type-I superconductor has magnetic susceptibility of –1 and has zero relative permeability.

VIII. a) What are ferroelectric domains ?

b) Plot the temperature dependence of the magnetic susceptibility of paramagnetic, ferromagnetic and anti-ferromagnetic materials.

c) A paramagnetic material with 10^{28} atoms/m^3 has a magnetic susceptibility of 3×10^{-4} at 340 K. Calculate its susceptibility at 300 K.
