

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.

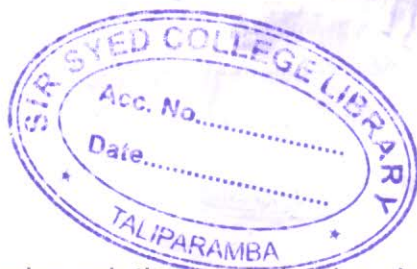
SECTION – B

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.

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- 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 $2.35 \times 10^{19}/\text{m}^3$ at room temperature. Determine its resistivity if the electron and hole mobilities are 0.39 and $0.19 \text{ m}^2/\text{V-s}$.
- 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.
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