

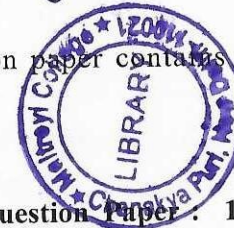
1051

5. (a) Derive the expression for Curie-Weiss law using Weiss theory of Ferromagnetism. (6)
- (b) Discuss the concept of hysteresis and show that the B-H hysteresis loop gives the value of energy dissipated per cubic meter of the material per cycle of magnetization. (6)
- (c) A magnetic substance has 10^{28} atoms/m³. The magnetic moment of each atom is 1.8×10^{-23} Am². Calculate the paramagnetic susceptibility at 300K. What would be the dipole moment of a bar of this material 0.1 m long and having cross-sectional area of 1 cm² in a field of 8×10^4 Am, $\mu_0 = 4\pi \times 10^{-7}$ henry/m, $k_B = 1.38 \times 10^{-23}$ J/K. (3)
6. (a) Explain the concept of Local Electric Field in a dielectric and derive its expression for structures possessing cubic symmetry. (8)
- (b) Obtain Clausius-Mossotti's relation between polarizability and dielectric constant of a solid. (7)
7. (a) Explain the phenomenon of superconductivity. Derive London's first and second equations and discuss penetration depth in a superconductor with the help of a diagram. (12)
- (b) Show that the susceptibility of superconductors is -1 and relative permeability is zero. (3)

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Your Roll No.....

Sr. No. of Question Paper : 1051

02 DEC 2022

Unique Paper Code : 32221502

Name of the Paper : Solid State Physics

Name of the Course : B.Sc. (Hons.) Physics CBCS (Core)

Semester : V

Duration : 3 Hours

Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **five** questions in all.
3. Question number **1** is compulsory.
4. **All** questions carry equal marks.

1. Attempt any **five** of the following : (5×3=15)

- (a) Prove that for a SC lattice, $d_{100} : d_{110} : d_{111} = \sqrt{6} : \sqrt{3} : \sqrt{2}$; where 'd' represents interplanar distance in a crystal.

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- (b) An element has a cubic structure having lattice constant as 4.28 \AA , and with two of its atoms in the unit cube at $(0,0,0)$ and $(1/2, 1/2, 1/2)$. Find out the distance between nearest neighbours in this element.
- (c) The Debye Temperature for Diamond is 2230 K . Calculate the highest possible vibrational frequency.
- (d) The energy near the top of the valence band of a crystal is given by $E = -Ak^2$, where $A = 10^{-39} \text{ Jm}^2$ and k is the wave vector. An electron with wave vector $k = 10^{10} \widehat{k_x} \text{ m}^{-1}$ is removed from an orbital in a completely filled valence band. Find the effective mass, momentum and energy of the hole. Given Planck's constant $h = 6.62 \times 10^{-34} \text{ Js}$.
- (e) What are the basic assumptions of Drude's model for describing electron motion in metals.
- (f) Distinguish between dia-, para- and ferromagnetism.
- (g) Calculate the electronic polarizability of Neon. The radius of Neon atom is 0.158 nm . ($\epsilon_0 = 8.854 \times 10^{-12} \text{ F/m}$).
- (h) Calculate the critical current which can flow through a long thin superconducting wire of aluminium of diameter 10^{-3} m . The critical field for aluminium is $7.9 \times 10^3 \text{ A/m}$.

2. (a) What is Geometrical structure factor? Derive its expression for FCC structure having identical atoms. Will reflection from (211) plane be possible for this structure? (10)
- (b) Show that reciprocal lattice of a BCC lattice is a FCC structure. (5)
3. (a) Derive the expression for specific heat of a solid based on Einstein's model. Explain why this model was not successful. (8)
- (b) Deduce the dispersion relation for a linear monatomic chain of atoms and show that the group and phase velocities of a wave are same in the long wavelength limit. (7)
4. (a) Find the expression for the Hall coefficient of a semiconductor in which both electrons and holes are present in equal concentrations. How will this expression change if the hole concentration is twice the electron concentration and vice-versa? Also, explain how will this expression be modified if the semiconductor is heavily doped with p-type impurity or n-type impurity? (12)
- (b) Distinguish between direct and indirect band gap with the help of diagram. (3)