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/m^3. The magnetic moment of each atom is 1.8×10^{-23} Am^2. 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 cm^2 in a field of 8×10^4Am, $\mu_0 = 4\pi \times 10^{-7}$ 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)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 1051 **C**

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.

(b) An element has a cubic structure having lattice constant as 4.28 Å, 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 $A = 10^{-39}$ Jm^2 and k is the wave vector. An electron with wave vector $k = 10^{10}\ \hat{k_x}\ m^{-1}$ 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 $h = 6.62 \times 10^{-34}$ 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. ($\varepsilon_0 = 8.854 \times 10^{-12}$ 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 7.9×10^3 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)