Reg. No..... Name..... **P238**

M SC DEGREE END SEMESTER EXAMINATION MAY - 2015

M SC PHYSICS SEMESTER – 2

COURSE: P2PHYT08 - CONDENSED MATTER PHYSICS

Time: 3 Hours Max. Marks: 75

PART A (Objective)

(Answer **all** questions. Each question carries **1** marks)

1. The atomic radius for a fcc lattice with lattice constant a is
   (a) a/2 (b) (√3 a)/4 (c) (√2 a)/4 (d) (√2 a)/3
2. A phonon is emitted or absorbed in
   (a) elastic scattering of a photon by a crystal
   (b) inelastic scattering of a photon by a crystal
   (c) both the elastic and inelastic scattering of a photon by a crystal
   (d) None of them
3. Average kinetic energy of a free electron in a three dimensional lattice with Fermi energy
   E_f at 0K is
   (a) 1/3 E_f (b) 5/3 E_f (c) 2/5 E_f (d) 3/5 E_f
4. Liquid crystals commonly used in display devices are
   (a) Smectic (b) Nematic (c) Cholesteric (d) Dielectric
5. The relation connecting the electric field E, dielectric displacement vector D and polarization P is given by
   (a) $D=\varepsilon_o EP$ (b) $D=\varepsilon_o EP^2$ (c) $D=\varepsilon_o E^2P^2$ (d) $D=\varepsilon_o E+ P$

(1 x 5 = 5)

PART B (Short questions)

(Answer **any 5** questions. Each question carries **2** marks)

6. Prove that a reciprocal lattice vector $G=ha^*+kb^*+lc^*$ is normal to the plane (hkl) of the direct lattice.
7. Explain Wiedmann-Franz-Lorentz law.
8. State Bloch theorem.
9. When donor type impurities are added to a semiconductor the concentration of holes decreases. Explain.
10. Explain positive TCR for conductors and negative TCR for intrinsic semiconductors.
11. What is piezo electricity?
12. Explain superconducting fullerene.
13. Give the principle of SQUID.

(2 x 5 = 10)

PART C (Problems /Short essays)
(Answer **any 3** questions. Each question carries **4** marks)

14. Show that reciprocal lattice to a bcc lattice is an fcc lattice.

15. Evaluate the temperature at which there is 1% probability that a state with energy 0.5 eV above the Fermi level will be occupied by an electron.

16. What is a Brillouin zone? Explain the construction of first Brillouin zone of a square lattice in two dimensions.

17. The London penetration for Pb at 3K and 7.1 K are 39.6nm and 173 nm respectively. Calculate its transition temperature as well as penetration depth at 0 K.

18. The intrinsic carrier density at room temperature in Germanium is $2.37X10^{19}$ m^{-3}. If the electron and the hole mobilities are 0.38 and 0.18 $m^2V^{-1}s^{-1}$ respectively, calculate the resistivity of the intrinsic Germanium.

(4 x 3 = 12)

PART D (Essays)
(Answer **all** questions. Each question carries **12** marks)

19. (a) Derive an expression for structure factor of a crystal. Calculate the structure factor for a bcc unit cell and find out the planes from which X-ray reflection vanish.

OR

(b) What are density of states in metals? Derive an expression for density of states and hence obtain an expression for Fermi energy of metals.

20. (a) Discuss the Kronig-Penng model for a linear lattice. How does it lead to the formation of energy bands in solids?

OR

(a) Derive an expression relating the shift in Fermi level and carrier density in an intrinsic semiconductor.

21. (a) Derive an expression for the specific heat of solids on the basis of Debye model. How does this model differs from Einstein's model. Discuss the variation of Debye's specific heat with temperature.

OR

(b) Discuss Weiss dipole theory of ferroelctricity and show that spontaneous polarization is possible below Curie temperature.

22. (a) Discuss the quantum theory of paramagnetism.

OR

(b) Derive London equations and explain coherence length.

(12 x 4 = 48)