# CONDENSED MATTER PHYSICS - I

Time : Three Hours]                                                                                 [Maximum Marks : 40

Note : Attempt *two* questions each from Section A and B carrying 8 marks each, and the entire Section C consisting of 8 short answer type question carrying 1 marks each.

## Section - A

1.    What are the assumptions of Einstein's theory of specific heat of solids ? Derive relation for

lattice heat capacity following Einstein's model. Discuss the relation at very high and very low temperatures. Give the predications of the model and compare with experimental observations. 8

2.  Discuss the vibrational modes of one-dimensional monoatomic lattice. Obtain the dispersion relation. What are allowed values of the phonon wave vector ? 8

3.  Discuss Free electron gas model in three dimensions. Derive an expression for density of state for the free electron gas. 8

4.  (a) What do you mean by Fermi gas gand Fermi energy ? What is the physical meaning of Fermi energy ? How does it vary with the temperature and concentration of electrons in a sample? 5

    (b) Find the Fermi energy and Fermi velocity for silver if it has an atomic radius of 1.5 Å, if silver is a monovalent metal with an F.C.C. structure. 3

### Section - B

5.  Discuss Kronig Penny model. Explain the existence of forbidden energy bands in solid. 8

6.  (a) Distinguish between metals, semiconducors and insulators on the basis of theory. 5

    (b) An insulator has an opical absorption which occurs for all wave lengths shorter that 1500 Å. Find the width of forbidden energy band for this insulator. 3

7.  Dicuss the thermodynamics properties of the superconducting state. 8

8.  (a) Discinguish between Type-I and Type-II superconductors.

    (b) What are Brillouim zones ? Discuss the formation of Brillouin zones for a linear lattice. 4

### Section - C

9.  Attempt all parts :

    (a) What is Meissner effcet ?

    (b) Effect mass of an electron.

    (c) What do you understand by Bloch theorem ?

    (d) Calculate the number of electrons per unit length of a crystal if the Fermi energy is 2.37 eV. Given $h = 6.62 \times 10^{-35}$ Js, $m_e = 9 \times 10^{-31}$ kg.

    (e) Dulong and Petti's law.

    (f) "Solid whose energy bands are full cannot be a metal." Comment.

    (g) Shôw that average kinetic energy of a free electron at 0K is $\frac{3}{5}K_f$, where $K_f$ is the Fermi energy.

    (h) Intrinsic and Extrinsic semiconductors. $(8 \times 1 = 8)$