(i) Printed Pages : 4 Roll No. .....

(ii) Questions : 9 Sub. Code : 3 7 1 9

Exam. Code : 0 4 7 4

M.Sc. Physics 3rd Semester

1128

CONDENSED MATTER PHYSICS–I

Paper–PHY-7004

Time Allowed : 3 Hours] **[Maximum Marks : 60**

Note :– Attempt **one** question each from Unit (I—IV) . Unit-V is compulsory. In all attempt **5** questions.

UNIT–I

1. (i) What are ionic crystals ? Explain the formation of an ionic crystal and obtain an expression for its cohesive energy.

   (ii) Calculate the compressibility of sodium chloride assuming a repulsive potential of the from B/r^9 to act between neighbors. Nearest neighbors distance 'r' = 0.281 nm and Madelung constant is 1.7476. 6,6

2. (i) Show that an isotropic crystal has only two independent elastic constants. What is the scheme of elastic constants for an isotropic crystal in the matrix representation ?

   (ii) Prove that in a one dimensional diatomic lattice, both acoustic and optic branches in dispersion curve meet the zone boundary normally. 6,6

UNIT–II

3. Show that in the tight-bonding approximation, the energy E(k) for b.c.c. lattice is given by

$$E(\vec{k}) = E_a - \beta - 8\gamma \cos (a/2)\, k_x \cos (a/2)\, k_y \cos (a/2) k_z$$

Discuss the shape of constant energy surface in $(\vec{k})$-space. 12

4. Derive the wave equation for an electron moving in the following potential field

$U(x) = 0$ for $0 < x < a$; and $u(x) = V_o$ for $a < x < b$

and periodically repeated outside that interval. Show that for $E < V_o$ it leads to the following equation

$$[(\beta^2 - \alpha^2)/2\alpha\beta] \sinh \beta b \sin \alpha a + \cosh \beta b \cos \alpha a = \cos K(a + b)$$

where $\alpha^2 = 2\, mE/\hbar^2$; $\beta^2 = 2m(V_o - E)/\hbar^2$. 12

UNIT–III

5. (i) Define thermopower in metals. Why is it difficult to measure thermopower experimentally ? Discuss a method in brief of the experimental measurement of thermopower.

(ii) The electrical and thermal conductivity of silver at 20°C are $6.22 \times 10^7\ \Omega^{-1}\ m^{-1}$ and $423\ Wm^{-1}K^{-1}$ respectively. Calculate Lorentz number on the basis of quantum free electron theory. 7,5

6. (i) Employing the Boltzmann transport equation, find an expression for the electronic thermal conductivity of metals.

(ii) The relaxation time of a conduction electron in copper is 3.5×10^{-14}s. An electric field of 2.5 V/cm is applied along negative x-axis. Calculate the increase in the x-component of velocity between two collisions. What is the average increase in energy of the electron between two collisions ? 7,5

UNIT–IV

7. (i) What is meant by polarization mechanism in dielectrics ? Discuss the different polarization mechanisms in dielectrics and explain their temperature dependence.

(ii) The Bakelite is found to have the real part of its complex relative dielectric constant as 4.36 with a loss tangent of 2.8×10^{-2} at a frequency of 1 Hz. Calculate the complex polarizability of the materials assuming Lorentz field. (Given $N = 4 \times 10^{28}/m^3$). 8,4

8. (i) Derive the Clausius-Mosotti equation and explain how it can be used to determine the dipole moment of a polar molecule from the dielectric constant measurements.

(ii) Discuss the Weiss theory of ferroelectricity. Give some applications of ferroelectric materials. 8,4

UNIT–V

(Compulsory)

9. Attempt **all** questions :

(a) What are reciprocal lattices ?

(b) Explain metallic bonding in solids.

(c) Explain Bloch theorem.

(d) Define magnetoresistance by taking one example.

(e) What is dielectric loss ? Explain it.

(f) Differentiate between antiferroelectricity and ferrielectricity.

$6 \times 2 = 12$