

Exam. Code : 224802  
Subject Code : 104779

M.Sc. Physics 2<sup>nd</sup> Semester (Batch 2023-25) (CBGS)

CONDENSED MATTER PHYSICS—I

Paper : PHY-455

Time Allowed—3 Hours] [Maximum Marks—100

**Note** :—Attempt FIVE questions in all, selecting at least ONE question from each section. The fifth question may be attempted from any section. All questions carry equal marks.

SECTION—A

1. Derive an expression for the specific heat of solids on the basis of Debye model. How does the Debye model differ from the Einstein model? Discuss the variation of Debye specific heat with temperature? 20
2. Derive wave equation for elastic waves in a cubic crystal. Solve it for longitudinal and transverse waves moving in [0 1 0] direction and calculate ratio of velocities for two waves. 20

SECTION—B

3. (i) Discuss various types of dislocations in a crystal. Calculate stress field of dislocations. 10  
(ii) The energy required to remove a pair of ions, Na<sup>+</sup> and Cl<sup>-</sup>, from NaCl is ~2eV. Calculate the approximate number of Schottky imperfections present in the NaCl crystal at room temperature. 10
4. (i) What are point defects? Derive an expression for temperature dependence of Schottky defects. 10  
(ii) What are colour centers? How they are produced? Explain F-center and V-center. What is the opposite to F center? 10

SECTION—C

5. State and derive Boltzmann transport equation. Also explain its physical significance. 20
6. (i) Explain the variation of electrical conductivity with temperature both at low and high temperature regions. Hence explain the Matthiessen's rule. 10  
(ii) A uniform copper wire whose diameter is 0.16 cm carries a steady current of 10 amp. Its density and atomic weight are respectively, 8920 kg/m<sup>3</sup> and 63.5. Calculate the current density and the drift velocity of the electrons in copper. 10

### SECTION—D

7. (i) What are various polarizabilities ? Discuss the classical theory of electronic polarizability and obtain the corresponding dispersion relation. 15
- (ii) Find the total polarizability of  $\text{CO}_2$ , if its susceptibility is  $0.985 \times 10^{-3}$ . Density of carbon dioxide is  $1.977 \text{ kg/m}^3$ . 5
8. What are the limitations of dipole theory of ferroelectricity ? Elucidate the ferroelectric behaviour of Barium titanate. 20

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