

Ex/SC/PHY/PG/CBS/TH/407/2023

**M. Sc. PHYSICS EXAMINATION, 2023**

( 2nd Year, 2nd Semester )

**CONDENSED MATTER PHYSICS (II)**

**PAPER – 407**

Time : 2 hours

Full Marks : 40

**Use separate answer script for each group.**

**Group – A**

Answer *any two* questions.

1. a) Write down any two general structural features of constituent molecules of liquid crystal phase.  
b) For a nematic mesophase containing rigid and rod-like molecules, write down the order parameter tensor. What are the characteristics of this order parameter tensor?  
c) Show that the order parameter vanishes for isotropic liquid phase. 2+(2+2)+4
2. a) Discuss the Maier-Saupe theory of phase transition in a nematic liquid crystal.  
b) What do you mean by plasma frequency of a solid? Is it a characteristic parameter of solid? 6+(2+2)
3. a) For a narrow band gap semiconductor, find out the relation between optical matrix element and the band gap of the semiconductor.  
b) How colour centers can be created in a crystal?

[ Turn over

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- c) Suppose that the energy required to remove a Na atom from the inside of a Na crystal to the boundary is 1 eV. Calculate the concentration of Schottky vacancies at 300K. For Na, no of atoms per unit volume,  $N = 2.5 \times 10^{22} \text{ cm}^3$ . 6+2+2

**Group – B**

Answer *any two* questions.

1. Write down the mean field Hamiltonian used in the BCS theory. How do you use the Cooper pair creation operator,  $\mathbf{P}_k^\dagger$  to write down the BCS ground state,  $|\psi_{\text{BCS}}\rangle$ ? Using BCS approach obtain an expression for the energy gap,  $\Delta$  of a conventional superconductor. 2+2+6
2.
  - i) What is the upper critical field of a superconductor?
  - ii) What do you mean by the long range quantum effects in a superconducting system? Explain the idea of the flux quantization in a superconducting ring.
  - iii) Using Josephson current explain the superconducting quantum interference in a network made of two Superconductor-Insulator-Superconductor (SIS) junctions. 2+5+3
3. What is the exchange integral in one dimensional antiferromagnetic spin chain? How do you explain the

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existence of the spin wave related to the similar spin arrangement? Derive an equation for the angular frequency as a function of wave vector of magnon quasi-particle associated with an one dimensional antiferromagnetic spin chain. 1+2+7