LOYOLA COLLEGE (AUTONOMOUS), CHENNAI – 600 034

M.Sc. DEGREE EXAMINATION – **PHYSICS**

FOURTH SEMESTER – **APRIL 2023**

PPH 4503 – SOLID STATE PHYSICS

Date: 05-05-2023   Dept. No.   Max. : 100 Marks
Time: 09:00 AM - 12:00 NOON

PART – A	(10 x 2 = 20 Marks)

Q. No	**Answer ALL questions**
1.	Given that the intercepts made by a crystal plane on the cartesian coordinate axes 2,3,4, find the Miller indices of the plane.
2.	Find the maximum radius of interstitial sphere that can just fit the void at $\frac{1}{2},\frac{1}{2},\frac{1}{2}$ between the body-centered atoms of BCC structure.
3.	An insulator has an optical absorption which occurs for all wavelengths shorter than 1800 Å. Find the width of the forbidden energy band for this insulator.
4.	What is an intrinsic semiconductor?
5.	Write the relation connecting dielectric constant and electric susceptibility.
6.	Define the term atomic polarizability.
7.	Mention the essential parameters for a ferroelectric substance.
8.	State Hund's rule.
9.	Write a note on hard superconductors.
10.	Name the materials used for SQUID fabrication.

PART – B	(4 x 7.5 = 30 Marks)

	Answer any FOUR questions
11.	Obtain Laue's equations for x-ray diffraction by crystals. Show that these are consistent with the Bragg's law.
12.	**a)** Given that the effective mass of the electron is double its rest mass, calculate the crystal momentum for a free electron of energy 0.02 eV, taking the origin at the bottom of the conduction band. **(2.5)**

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	b) The number of electrons per unit length of a crystal is 0.5 electron per angstrom unit. Determine the Fermi energy. Given, $h = 6.62 \times 10^{-34} Js,\ m = 9 \times 10^{-31} kg$. **(5)**
13.	Describe the periodic zone scheme, extended zone scheme and reduced zone scheme for representing E-k relationships.
14.	With a neat sketch, discuss Hall effect in semiconductors and hence derive the expressions for Hall coefficient and Hall resistance.
15.	a) Estimate the order of diamagnetic susceptibility of Cu from the following data: radius of Cu-atom = 1Å, lattice parameter = 3.608 Å. Assume that only one electron per atom makes the contribution. **(4)** b) Find the magnetizing force and the relative permeability of a magnetic material having a magnetization 3380 A/m and flux density 0.0048 Wb/m^2. **(3.5)**
16.	Discuss the important aspects of BCS theory of superconductors.

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PART – C   **(4 x 12.5 = 50 Marks)**

Answer any FOUR questions

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17.	Based on the Ewald's construction, derive the Bragg's law in vector form.
18.	Discuss the Kronig- Penney model by considering characteristic features of electron propagation in crystals.
19.	Derive the Clausius- Mossotti equation connecting the dielectric constant and polarizability. **(8)** Determine the percentage of ionic polarisability in NaCl crystal having an index of refraction and a static dielectric constant 5.6. **(4.5)**
20.	Discuss the lattice vibrations of a linear mono atomic lattice and obtain the equations for a standing wave, group velocity and force constant.
21.	Discuss in detail the Langevin's quantum theory of paramagnetism.

22.	With necessary diagrams, explain the AC and DC Josephson effects.

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