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N – 6242

Reg. No. :

Name :

Fourth Semester M.Sc. Degree Examination, June 2022

Physics

PH 241 : CONDENSED MATTER PHYSICS

(2018 – 2019 Admission)

Time : 3 Hours

Max. Marks : 75

SECTION – A

Answer any five questions. Each question carries 3 marks.

1. (a) Distinguish between a linear lattice, plane lattice and space lattice.
- (b) Derive the dispersion relation between angular frequency ω and wave vector k for 1D periodic lattice?
- (c) Explain how the symmetry properties are satisfied by energy bands?
- (d) Explain how mobility of a given semiconductor varies with temperature.
- (e) What is ferroelectricity? Name any two ferroelectric materials and their applications.
- (f) Obtain an expression for paramagnetic susceptibility of free electrons on the basis of classical laws.
- (g) What are the important applications of Hall effect?
- (h) Write a note on relaxation time

(5 × 3 = 15 Marks)

P.T.O.



SECTION – B

Answer all questions. Each question carries 15 marks.

- II. (a) What is meant by crystal imperfections? Classify them in the order of their geometry?

Or

- (b) Explain Debye's model and Einstein's model? Mention essential differences in the model and note the consequences of these differences.

- III. (a) Based on Fermi-Dirac statistics, state the nature of Fermi distribution function. How does it vary with temperature?

Or

- (b) Discuss the Kronig-Penney model for the motion of an electron in a periodic potential. Show from (E-K) graph that material can be classified into conductors, insulators and semi-conductors.

- IV. (a) Describe Langevin's theory for a paramagnetic gas and its limitations. Obtain paramagnetic susceptibility of a free electron gas employing quantum statistics.

Or

- (b) Explain how X-ray diffraction can be used as an effective tool to determine the structure of nano materials.

(3 × 15 = 45 Marks)

SECTION – C

Answer any three of the following questions. Each question carries 5 marks.

- V. (a) Calculate the angle between [111] and [001] directions in a cubic crystal.
- (b) The unit cell parameter of NaCl crystal is $5.6 \text{ \AA}$ and the modulus of elasticity along [100] direction is $5 \times 10^{10} \text{ N/m}^2$. Estimate the wavelength at which an Electromagnetic radiation is strongly reflected by the crystal. At.wt. of Na=23 and Cl=37.
- (c) Explain why silver obeys Dulong-Petit law at room temperature but diamond does, not?



- (d) If a dust particle of one μgm requires 100 s to cross a distance of 1mm which is the separation between two rigid walls of the potential. determine the quantum number described by this motion.
- (e) Find the ratio between the kinetic energies of an electron in a two-dimensional square lattice (a) when $k_x = k_y = \frac{\pi}{a}$ and (b) when $k_x = \frac{\pi}{a}$ and $k_y = 0$.
- (f) Assuming that the polarizability of Kr atom is $2.18 \times 10^{-40} \text{ Fm}^2$, calculate its dielectric constant at 0°C and 1 atmosphere.

(3 × 5 = 15 Marks)



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