10/08/2022 FN

(Pages : 3) 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 varies 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 statics.

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 [1111] and [001] directions in a cubic crystal.

(b) The unit cell parameter of NaCl crystal is 5.6 A° and the modulus of elasticity along [100] direction is 5×10^{10} 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 $2.18 \times 10^{-40}\ Fm^2$, calculate its dielectric constant at 0°C and 1 atmosphere

(3 × 5 = 15 Marks)

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