UNIVERSITY OF THE PUNJAB

B.S. 4 Years Program : Fifth Semester – Fall 2021

Roll No. .....

Paper: Solid State Physics-1 **Course Code: PHY-303** **Time: 3 Hrs.** **Marks: 60**

Q.1. Give short answers of the following: **(15x2=30)**

a) Differentiate between primitive and non-primitive lattice with the help of diagram.

b) Define Bravais and non-Bravais lattice. Explain with the help of diagram.

c) Write down the importance of Miller indices for indexing the atomic planes.

d) Define Brillouin zone. Explain importance of Brillouin zones in solid state physics.

e) Draw hexagonal close-packed (hcp) structure and show all atoms in the hcp unit cell.

f) Write down Bragg equation and write what each term appearing in it represents. What is the limitation on Bragg's law to observe diffraction in crystals?

g) Define the terms cohesive energy and Madelung energy. Explain the difference in these two energies.

h) Define photon and phonon. What is a common characteristic of photon and phonon?

i) Explain the terms group velocity and phase velocity. Which one is responsible for energy transmission in medium?

j) Define Dulong-Petit law of lattice heat capacity? Draw a heat capacity versus temperature plot to support statement.

k) What are anharmonic crystal interactions? Explain briefly.

l) What is meant by quantization of elastic waves? Discuss briefly.

m) What is the origin of *Van der Waals* interaction in crystals? What is its nature and how it varies between two identical inert gas atoms?

n) Calculate the value of Madelung constant for a linear chain of alternate positive and negative ions separated by a repeat distance R.

o) Calculate the linear density of an FCC crystal along [110].

Answers the following questions.

Q. 2

Express electron distribution $n(\rho)$ for a crystal in Fourier series. Use Fourier analysis of periodic distribution to show $n(\rho)$ obeys translation periodicity of the lattice if values of wave-vector K that appear in the corresponding Fourier series are reciprocal lattice vectors $G = hA + kB + lC$; (where h, k, l = integers and A, B, C are fundamental vectors of the reciprocal lattice). Establish integral equation for $n(\rho)$ which measures the amplitude of the diffracted beam. **(10)**

Q. 3

Assuming nearest neighbor interactions only, derive the dispersion relation for monoatomic lattice and calculate the maximum frequency propagating through the lattice. Also, plot the dispersion curve within the first Brillouin zone boundaries. **(8+2)**

Q. 4

Discuss in detail: (i) thermal conductivity of solids and ii) contribution of electrons to heat capacity of solids. **(5+5)**