

6. (a) Give an account of "de Hass-van Alphen effect". How does it provide a powerful method for the study of Fermi Surface ? 7
(b) Distinguish between reduced zone, extended zone and periodic zone schemes of representing energy bands. 8
7. (a) State and prove Bragg's law in reciprocal lattice. 5
(b) What is a polaron ? Describe the phenomena of electron-electron interaction. 5
(c) Explain the difference between a rectifying (Schottky) contact and an Ohmic contact. 5



May 2026

M.Sc. (Second Semester)

Solid State Physics (MPH-203)

Time : 3 Hours]

[Maximum Marks : 75

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any four questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other.

Part A

1. (a) Sketch and the (110), (111) and (102) planes within a simple cubic lattice. 1.5
(b) A unit cell has a dimensions $a = 4\text{\AA}$, $b = 6\text{\AA}$, $c = 8\text{\AA}$, $\alpha = \beta = 90^\circ$ and $\gamma = 120^\circ$. Determine the reciprocal lattice vectors. 1.5
(c) Why does a diatomic linear lattice possess two branches of vibration (acoustic and optical) ? 1.5

- (d) What is the significance of the scattering wave vector Δk being equal to a reciprocal lattice vector G ? 1.5
- (e) Define Fermi energy and Fermi surface. 1.5
- (f) Comment on the statement that effective mass can be positive, negative or indefinite. 1.5
- (g) What is the shortest possible wavelength that can propagate in a linear chain of lattice constant (a) ? 1.5
- (h) Differentiate between N process and U process. 1.5
- (i) Define the Atomic Form Factor. 1.5
- (j) Show that the reciprocal lattice of a Simple Cubic lattice is also Simple Cubic. 1.5

Part B

- 2. (a) Using the structure factor, show that the (100) and (110) planes are forbidden for a Face Centered Cubic (FCC) lattice. 7
- (b) Derive the reciprocal lattice vectors for both the conventional and the primitive unit cells of the fcc lattice. Using these, show that the volume of the reciprocal cell of the primitive lattice is four times that of the conventional lattice. 8

- 3. (a) What are the advantages of neutron scattering in comparison to X-ray scattering by phonons to understand the crystal structure ? 5
- (b) Derive the dispersion relation $\omega(k)$ for a 1D monoatomic linear lattice of atoms with mass M and force constant C . Sketch the dispersion curve and find the group velocity at the boundary of the Brillouin zone. 10
- 4. (a) Discuss the physical significance of the "strength of the potential barrier" (P) in the Kronig-Penney equation. What happens to the energy bands when ($P \rightarrow 0$) and ($P \rightarrow \infty$) ? 5
- (b) Show that the law of Mass Action is independent of the doping concentration for a non-degenerate semiconductor. 10
- 5. (a) Show that magnetic moment is the oscillating function of $1/B$ in the Fermi gas at low temperature. 7
- (b) Derive the energy band expression for a simple cubic lattice using the tight-binding approximation. 8