



2022/TDC/ODD/SEM/PHSHCC-502T/156

TDC (CBCS) Odd Semester Exam., 2022

PHYSICS

(Honours)

(5th Semester)

Course No. : PSHCC-502T

(Solid State Physics)

Full Marks : 50

Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

UNIT—I

1. Answer any *two* questions : 2×2=4

(a) Find the inter planar distance d_{111} for a (111) plane of a simple cubic lattice.

(b) For a BCC structure, find the relation between lattice constant a and radius of the atom.

(c) If a unit cell has the characteristics $a = b = 10.5 \text{ \AA}$, $c = 6 \text{ \AA}$, $\alpha = \beta = \gamma = 90^\circ$, identify to which crystal system does the unit cell belong.



(2)

2. Answer any *one* question : 6
- (a) Calculate atomic radii for SC, FCC and BCC structures.
- (b) (i) Prove that the reciprocal lattice of a BCC lattice is an FCC lattice. 3
- (ii) The primitive basis vectors of a lattice are $\vec{a} = \hat{i} + 2\hat{j}$, $\vec{b} = 4\hat{j}$ and $\vec{c} = \hat{k}$. What are the primitive translation vectors of its reciprocal lattice? 3

UNIT—II

3. Answer any *two* questions : 2×2=4
- (a) Find the angle between the plane (111) and plane direction (111).
- (b) Why are X-rays used for the analysis of crystal structure?
- (c) What is reciprocal lattice? How does it differ from direct lattice?
4. Answer any *one* question : 6
- (a) In what respect Einstein's theory of lattice specific heat is superior to classical theory? Obtain the values of molar specific heat at (i) $T \gg \theta_E$ and (ii) $T \ll \theta_E$, θ_E being the Einstein's temperature. What are the shortcomings of Einstein's theory?

(3)

- (b) Derive vibrational modes of a diatomic linear lattice. Name the different branches of the dispersion relation curve. What is the difference between the two branches?

UNIT—III

5. Answer any *two* questions : 2×2=4
- (a) How does the Laue approach differ from the Bragg approach?
- (b) In which respect, Debye theory is superior to Einstein's theory of lattice specific heat? Explain.
- (c) What is the significance of Curie temperature?
6. Answer any *one* question : 6
- (a) What do you mean by ferromagnetism and the ferromagnetic domains? Discuss the Weiss theory of ferromagnetism, and explain how magnetic susceptibility varies with temperature.
- (b) Discuss Langevin's classical theory on paramagnetism and its physical significance. Derive Curie's law of paramagnetism from Langevin's theory.



(4)

UNIT—IV

7. Answer any *two* questions : $2 \times 2 = 4$
- (a) Define magnetization and magnetic permeability.
 - (b) Define dipole moment and polarizability.
 - (c) What do you mean by effective mass of an electron?
8. Answer any *one* question : 6
- (a) Define polarization and polarizability of a dielectric material. Derive Clausius-Mosotti relation between polarizability and dielectric constant of a solid.
 - (b) Write short notes on the following : $2 \times 3 = 6$
 - (i) Ferroelectricity
 - (ii) Piezoelectricity
 - (iii) Pyroelectricity

UNIT—V

9. Answer any *two* questions : $2 \times 2 = 4$
- (a) Why does a semiconductor behave as an insulator at 0 K?
 - (b) What is the concept of hole? How does it differ from a free electron?
 - (c) Define mean lifetime and diffusion length and write the relation between the two.

(5)

10. Answer any *one* question : 6
- (a) Deduce the expression for the concentration of electrons in conduction band and holes in valence band of an intrinsic semiconductor at temperature T .
 - (b) Explain the formation of a Cooper pair in a superconductor. Give an account of BCS theory of superconductivity, and discuss how it explains the phenomenon of superconductivity.
