



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

TDC (CBCS) Odd Semester Exam., 2022

PHYSICS

(Honours)

(5th Semester)

Course No. : PHSOCC-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

- Find the inter planar distance d_{111} for a (111) plane of a simple cubic lattice.
- For a BCC structure, find the relation between lattice constant a and radius of the atom.
- 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 :

(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.

(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?

6

3

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 : 2×2=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 : 2×3=6
 - (i) Ferroelectricity
 - (ii) Piezoelectricity
 - (iii) Pyroelectricity

UNIT—V

9. Answer any two questions : 2×2=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.

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