TDC (CBCS) Odd Semester Exam., 2023

PHYSICS

(Honours)

(5th Semester)

Course No. : PHSHCC-502T

(Solid-State Physics)

Full Marks : 50
Pass Marks : 20

Time : 3 hours

The figures in the margin indicate full marks for the questions

SECTION—A

Answer *ten* questions, selecting any *two* from each Unit : 2×10=20

UNIT—I

1. Define a crystal. How does a crystal differ from a lattice?

2. What are lattice translation vectors? Name the different types of lattice translation vectors.

3. Explain the basic principle of X-ray diffraction.

UNIT—II

4. What is phonon? Give an evidence for the existence of phonons.

5. Draw the phonon dispersion curve for a diatomic lattice ($m_1 > m_2$).

6. Define Einstein temperature and Debye temperature.

UNIT—III

7. Define the term 'magnetization'. What is the basic cause of paramagnetism?

8. "Relative permeability is unitless." State whether the statement is true or false. Justify your answer.

9. A material has a permeability of 0·1 H/m when the magnetic intensity is 70 A/m. Find the magnetic induction inside the material.

UNIT—IV

10. Define electric susceptibility and dielectric constant.

11. Mention some of the differences between dielectric materials and insulators.

12. What is piezoelectric effect?

UNIT—V

13. Define mobility of a charge carrier. Which has greater mobility, electron or hole?

14. Both *p*-type and *n*-type semiconductors are electrically neutral. Justify the statement.

15. Define penetration depth. What is its value at the critical temperature?

SECTION—B

Answer *five* questions, selecting *one* from each Unit : 6×5=30

UNIT—I

16. *(a)* What is X-ray diffraction? Why is it so called? 1+1=2

(b) What is the importance of Miller indices? Show that parallel planes have same Miller indices. 1+3=4

17. Explain the concept of reciprocal lattice. Describe the importance of geometrical structure factor taking the example of cubic crystals. 2+4=6

UNIT—II

18. Obtain the expression for vibration frequency ω as a function of wave number k for a diatomic periodic linear chain. Show that $\frac{d\omega}{dk}$ must vanish at zone boundary. 5+1=6

19. How does Debye model differ from Einstein model of lattice heat capacity? Discuss the consequences of this difference explaining the low temperature behaviour of specific heat in each case with necessary diagram. 2+4=6

UNIT—III

20. Obtain the expression for diamagnetic susceptibility using Langevin's theory. What is the significance of negative susceptibility? 5+1=6

21. Draw a typical B-H loop and describe different magnetization processes. What are the advantages and disadvantages of such loop? 3+3=6

UNIT—IV

22. Deduce Clausius-Mosotti equation. 6

23. *(a)* Draw a single-diagram showing the representation of three vectors $\vec{p}$, $\vec{E}$ and $\vec{D}$, where symbols have their own meaning. 2

(b) What is the origin of piezoelectricity? Justify the statement that, "All ferroelectric crystals are piezoelectric but all piezoelectric crystals are not ferroelectric". 1+3=4

UNIT—V

24. *(a)* Briefly explain Hall effect. 2

(b) Obtain an expression for conductivity of an intrinsic semiconductor. 4

25. *(a)* What is the difference between a conductor cooled to 0 kelvin and a superconductor? 2

(b) Prove that the Meissner effect and the disappearance of resistivity are mutually consistent. 4

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