K25P 2907

Reg. No. : .....

Name : .....

III Semester M.Sc. Degree (CBCSS – OBE – Reg./Supple./Imp.) Examination, October 2025
(2023 Admission Onwards)
PHYSICS/PHYSICS WITH COMPUTATIONAL AND NANO SCIENCE SPECIALIZATION
MSPHY03C14/MSPHN03C14 : Condensed Matter Physics – I

Time : 3 Hours Max. Marks : 60

SECTION – A

Answer **any 5**, **each** one carries **3** marks.

1. State the Bragg law and mention its significance in X-ray diffraction.
2. What is phonon momentum ? Write its expression.
3. Define Bloch functions and their physical significance.
4. Write a note on the Hall effect in metals.
5. What are ferromagnetic domains ?
6. State the Meissner effect and its importance. **(5×3=15)**

SECTION – B

Answer **any 3**, **each** one carries **6** marks.

7. Derive the expression for the group velocity v_g of phonons in a 1D lattice and show how it relates to the slope of the dispersion curve.
8. Derive the Fermi-Dirac distribution function and prove that at absolute zero, all states up to the Fermi energy are filled and all higher states are empty.

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9. Show that the Weiss molecular field hypothesis leads to the Curie-Weiss law : $\chi = \frac{C}{T - \theta}$, where θ is the Weiss constant.

10. Calculate the Hall coefficient for an n-type semiconductor having electron concentration 8×10^{21} m^{-3}. Deduce the type of dominant carrier.

11. Estimate the London penetration depth, given the superconducting electron density $n_s = 5 \times 10^{28}$ m^{-3}, mass $m = 9.11 \times 10^{-31}$ kg, and fundamental constants. **(3×6=18)**

SECTION – C

Answer **any 3**, **each** one carries **9** marks.

12. Derive the dispersion relation for the vibration of a diatomic one-dimensional lattice and describe the shape of the dispersion plot in the first Brillouin zone.

13. Explain quantization of energy bands using the Kronig-Penney model.

14. Discuss the classical and quantum theories of diamagnetism.

15. Starting from first principles, derive the formula for intrinsic carrier concentration in semiconductors and analyze its dependence on temperature and energy gap.

16. Explain the microscopic mechanism of superconductivity as described by the BCS theory. Include discussion on Cooper pair formation, energy gap, and coherence length. **(3×9=27)**

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