

PE – 488
(524) M.Sc. PHYSICS (Fourth Semester)
Examination June 2022 Compulsory/Optional
Group - Paper -I
CONDENSED MATTER PHYSICS-II

Time : Three Hours]

[Maximum Marks : 80
[Minimum Pass Marks : 29

नोट : दोनों खण्डों से निर्देशानुसार उत्तर दीजिए। प्रश्नों के अंक उनके दाहिनी ओर अंकित हैं।

Note : Answer from both the Sections as directed. The figures in the right-hand margin indicate marks.

Section-A

Q 1. Answer the following question :-

1x10=10

- (a) Which state has more entropy-superconducting or normal?
- (b) What are the independent properties that characterizes a super conductor?
- (c) What is the value of fluxoid?
- (d) How the transition temperature gets affected by frequency in a super conductor?
- (e) if a semiconductor contains equal no. of donors and acceptors, how the semiconductor will behave?
- (f) Which has greater mobility - electron or hole?
- (g) what is optical mode of wave propagation in a linear diatomic crystal?
- (h) Write down the dispersion relation for a one dimensional monatomic lattice.
- (i) How the coefficient of thermal conductivity is related to mean free path of phonons?
- (j) What is the maximum number of covalent bonds an atom of the n^{th} group (in periodic table) can form?

Q 2. Answer the following question:-

2x5=10

- (a) How does the electron-phonon interaction help to produce the cooper pairs?
- (b) How does the total polarizability of a dielectric material depend on frequency?
- (c) Plot curves for Landau function versus variable parameter x^2 for first order phase transition.
- (d) Graphically represent the variation of resistivity (P) against temperature (T) for intrinsic semiconductor.
- (e) Why do covalent crystals usually have lower packing efficiency than the ionic crystals?

Section - B

Answer all questions of the following :-

Q 3. (a) Explain how the persistent currents Set up inside a superconductor.

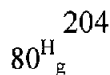
6

(b) Give a comparative study between those properties which donot change and which change in superconducting transition.

6

(c) The transition temperature of H_g with an average atomic mass of 200.59 amu is 4.153K. Determine the transition temperature of one of its isotopes .

3



Or

How do the electrical, magnetic, thermodynamic and optical properties of super conductors differ from those of normal conductors? Give some potential applications of superconductors.

12+3

Q 4. (a) Briefly explain dielectric polarization.

4

(b) What do you mean by dipolar polarizability? Show that dipolar polarizability is inversely proportional to absolute temperature.

11

Or

(a) What do you mean by 1st order and 2nd order phase transition?

4

(b) Discuss Landau's theory of phase transition for 2nd order only

8

(c) Ferroelectricity does not arise from the rotation of dipole meoments - explain this.

3

P.T.O.

- Q 5. (a) Explain the temperature dependence of conductivity of an intrinsic semiconductor. 3
 (b) The electron and hole mobilities in a Si sample are 0.135 and $0.048 \text{ m}^2/\text{V}\cdot\text{s}$ respectively. Determine the conductivity of intrinsic Si at 300 K if the intrinsic carrier concentration is $1.5 \times 10^{16} \text{ atoms}/\text{m}^3$. The sample is then doped with 10^{23} phosphorus atoms/ m^3 . Determine the equilibrium hole concentration, conductivity and Position of Fermi level relative to the intrinsic level. 12

Or

- Explain the elastic, magnetic and thermal properties of nanostructured materials. 15
 Q 6. Derive dispersion relationship for a one dimensional diatomic crystal and discuss the nature of acoustic and optical modes. Show that the group velocity vanishes at the zone boundary. Give physical interpretation of the result. 11+2+2

Or

The radii of Na^+ and Cl^- ions are 0.98 and $1.81 \text{ \AA}$ respectively. The Young's modulus of NaCl in $[100]$ direction is $5 \times 10^{10} \text{ N/m}^2$. Assuming that the extension in $[100]$ direction produces negligible contraction in the perpendicular directions, calculate the wavelength at which the electromagnetic radiation is strongly reflected by NaCl crystal. Atomic masses of Na and Cl are 23 and 35.5 amu respectively. 15

-----000-----