2019

PG

2nd Semester Examination

PHYSICS

Paper - PHS 202

Full Marks : 40 Time : 2 Hours

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Group - 202.1

1. Answer any *two* of the following : 2×2=4

   (a) Discuss clearly the first-order and the second order transitions of superconducting to normal state.

   (b) What do you mean by polarizability and what is its S.I. unit ?

   (c) It is required to breakup a cooper pair in the lead which has the energy gap of 2.73 eV. What is the maximum wavelength of the photon which will accomplish the job ?

[Turn Over]

(d) For lead, superconductivity ensures at 7.19 K when there is a zero applied magnetic field. When the Magnetic field of 0.074T is applied at temperature 2.0K superconductivity will stop. Find the magnetic field that should be applied so that superconductivity will not occur at any temperature.

2. Answer any *two* of the following : 2×4=8

(a) What do you mean by penetration depth in a type-I superconductor? Determine the penetration depth of a superconductor having a super-electron density of $4\times10^{-28}m^{-3}$ 2+2

(b) Derive the expression for frequency dependent complex dielectric constant for a gas of free, non interacting electrons. Show the variation of it with frequency.

(c) Explain the Meissner Effect.

(d) Set up Clausius-Mossotti relation between polarizability and dielectric constant in a solid.

3. Answer any *one* of the following : 8×1=8

(a) Derive the expression of tunnelling current across the junction in case of a.c. Josephson Effect. Show how the frequency of an unknown

electromagnetic wave can be measured from the effect. 6+2

(b) Obtain the expression for the difference of entropy between the normal and the superconducting states of a specimen. Hence discuss the discontinuity in the heat capacity at T_c.

Group - 202.2

Answer Q. No. 1 & 2 and any *one* from the rest.

1. Answer any *two* of the following : 2×2=4

(i) Find an expression of distribution function of holes over the donor level.

(i) Find the neutrality condition when a semiconductor is doped with acceptor impurity.

(iii) The minority carrier lifetime in ptype material is 10^{-7} second. The mobility of electron in *Si* is 0.15 $m^2v^{-1}s^{-1}$ at 300 k. If 10^{20} electron/m^3 are injected at $x = 0$, what is the diffusion current density just at the junction ?

(iv) Explain ohmic contact for metal / semiconductor (*n* type) junction by drawing the band diagram ?

2. Answer any *two* of the following : 2×4=8

(i) In an n type semiconductor, the Fermi level lies 0.4 eV below the conduction band. If the concentration of donor atom is doubled, find the new position of fermi level assuming K_BT = 0.03 eV. 4

(ii) Show that electric field is maximum just at the p-n junction ? 4

(iii) What is quadratic recombination ? Show that under quadratic recombination the carrier decay hyperbolically. 1+3

(iv) Derive Einstein relation for hole assuming a p-n junction under equilibrium condition ? 4

3. Explain what is meant by abrupt junction. Find an expression of junction capacitance assuming abrupt junction ? 2+6

4. (a) Find an expression of growth of carriers in a semiconductor when illuminated with weak intensity light ?

(b) Find an expression of intrinsic carrier concentration of a semiconductor. 6+2