2019

PG

2nd Semester Examination

PHYSICS

Paper - PHS 202

[Old Syllabus]

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 - A

1. Answer any *two* of the followings :-   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

[Turn Over]

is the maximum wavelength of the photon which will accomplish the job ?

2. Answer any *two* of the followings : $2 \times 4 = 8$

(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 $4 \times 10^{-28} m^{-3}$ $2+2$

(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.

3. Answer any *one* of the followings :- $8 \times 1 = 8$

(a) Derive the expression of tunneling 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.

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.   6+2+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.

Write down Clausius-Mossotti relation between polarizability and dielectric constant in a solid and give its physical significance.   5+3+2

Group - B

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

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

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

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

[Turn Over]

2. Answer any *two* of the followings :　　　　$2 \times 3 = 6$

   (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 assuring $k_B T = 0.03$ eV.

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

   (iii) Derive Einstein relation for hole assuming a p-n junction under equiliberium condition ?

3. Explain what is meant by abrupt junction. Find an expression of junction capacitance assuming abrupt junction ? How you determine experimentally the barrier potential?　　　　$2+6+2$

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

   (b) How will you determine lifetime experimentally ?

   (c) Find an epression of intrinsic carrier concentration of a semiconductor.　　　$6+2+2$