2022

M.Sc.

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.

Illustrate the answers wherever necessary.

PHS–202.1 SOLID STATE - II

[Marks : 20]

1. Answer any *two* questions : 2×2

(a) What is the difference between a superconductor and a perfect conductor ?

(b) Draw the variation of $\vec{M}$ and $\vec{B}$ with applied magnetic field for a superconductor.

(c) Evaluate the penetration depth of a super conductor having super electron density 4×10^{28} m^{-3}.

(d) Draw the variation of resistivity with temperature for a perfect metal, normal metal and a superconductor.

2. Answer any *two* questions : 2×4

(a) What is Meissner effect? Show how London equations lead to this effect.

(b) Show that the current density in a super conductor can be expressed as

$$\vec{J} = -\frac{\vec{A}}{\Lambda_s c} + \frac{\hbar}{q_{\Lambda_s}} \nabla\theta .$$

Where the symbols have their usual meaning.

(c) The optical index of refraction and the dielectric constant for water are 1.33 and 8.1 respectively. Determine the percentage of ionic polarizability.

(d) Derive the expressions for $\varepsilon'(\omega)$ and $\varepsilon''(\omega)$ for electronic polarizibility.

3. Answer any *one* question : 1×8

(a) (i) A superconducting tin has a critical temperature of 3.7 K in zero magnetic fields and a critical field of 0.0306 T at 0K. Find the critical field at 2K.

(ii) Consider the total current in a super conductor as the superposition of the contributions to the current from the super electrons pair and the normal electrons, hence determine the propagation characteristics at finite temperatures of a superconductor. 2+6

(b) What is Josephson Effect ? Explain a.c Josephson Effect and show the value of $h/2e$ can be measured from a.c. Josephson Effect. 2+6

PHS–202.2 SEMICONDUCTOR PHYSICS

[Marks : 20]

4. Answer any *two* questions : 2×2

(a) For an intrinsic semiconductor with gap width E_g = 0.75 eV, find the position of Fermi level at 300K. Given m_e^* = 1.6 m_e, m_p^* = 0.5 m_e.

(b) Find an expression of barrier potential of a p-n junction under equilibrium condition.

(c) A Silicon is doped with 10^{17} As atoms/cm^3. Find the barrier potential for a symmetric junction at room temperature. Given m_e^* = 1.1 m_e, m_p^* = 0.56 m_e.

(d) Explain what is meant by law of mass action for a doped semiconductor.

5. Answer any *two* questions : 2×4

(a) Derive Einstien relation assuming a p-n junction under equilibrium condition.

(b) Explain with band diagram the formation of Ohmic contact.

(c) Derive diode equation for a p-n junction.

(d) Find an expression of open circuit voltage in a solar cell and explain the mechanism.

6. Answer any *one* question : 1×8

(a) Derive an expression of carrier concentration of electrons for a non-degenerate semiconductor. Show also that carrier concentration is independent of temperature for degenerate one.

(b) Explain what is photo conductivity and hence find an expression of growth of carrier under illumination. How will you determine lifetime of a carrier.

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