R 272

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2005.

Second Semester

Electronics and Communication Engineering

PH 1154 — PHYSICS – II

(Regulations 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Find the expression for the electric field in a region whose potential is given by $V = -kxy$; where k is a constant.

2. Define the terms "mobility" and "relaxation time" of free electrons in a metal.

3. What is meant by Hall effect? Write an expression for Hall coefficient.

4. Distinguish between fluorescence and phosphorescence.

5. What do you understand by the terms "critical temperature" and "Critical field" of a superconductor?

6. What is the difference between direct gap and indirect gap semiconductors?

7. Distinguish between soft and hard magnets.

8. Mention four types of polarization mechanisms that can take place in the presence of an electric field in dielectric materials.

9. Mention some important applications of ferrites.

10. What are the main drawbacks of classical free electron theory of metals?

PART B — (5 × 16 = 80 marks)

11. (i) Obtain an expression for the electrical conductivity of a metal on the basis of classical free electron theory. (8)

(ii) Explain the meaning of 'Density of states'. Derive an expression for the number of allowed states per unit volume of a solid. (8)

12. (a) (i) Describe the effect of perpendicular electric field on the motion of charged particles. Derive the appropriate formula for linear deflection. (8)

(ii) An electron accelerated by p.d. of 1000 volts enters at right angles into a uniform magnetic field induction 1.19×10^{-3} Wb/m^2. Find (1) the radius of the electron trajectory in the magnetic field and (2) the angular momentum of the electron (mass of electron = 9.1×10^{-31} kg; charge = -1.6×10^{-19} C). (4)

(iii) An electron is accelerated through a p.d. of 150 volts. This electron is injected into a transverse electric field produced by the application of 20 volt to a pair of parallel plates of length 10 cm and 1 cm apart. A screen is placed at 50 cm away from the center of the applied electric field. Calculate (1) velocity of electron in the field and (ii) deflection on the screen. (4)

Or

(b) (i) Describe the energy band theory of solids with the help of neat band diagrams. Distinguish between metals, insulators and semiconductors on the basis of band theory. (8)

(ii) Calculate the mobility of electrons in copper assuming that each atom contributes one free electron for conduction. Given, resistivity of copper is 1.7×10^{-8} ohm - m, at wt. 63.54, density $= 8.9 \times 10^3$ kg/m^3 and Avogadro number $= 6.025 \times 10^{23}$/gmol. (4)

(iii) Calculate the concentration of free electrons per unit volume of silver. The Fumi energy of its free electrons is 5.5 eV. (Given value of Planck's const, $h = 6.63 \times 10^{-34}$ Js, mass of electron $= 9.11 \times 10^{-31}$ kg). (4)

13. (a) (i) Derive an expression for the electrical conductivity of an intrinsic semiconductor. (8)

(ii) The electron mobility and hole mobility in silicon are 0.17 m^2/V.s and 0.035 m^2/V.s respectively at room temperature. If the carrier concentration is 1.1×10^{16} m^{-3}, calculate the resistivity of silicon at room temperature. (4)

(iii) In an intrinsic semiconductor, the energy gap is 1.2 eV. What is the ratio between its conductivity at 600 K and that of 300 K? (Given : 1 eV = 1.602×10^{-19} J). (4)

Or

(b) (i) What is Hall effect? Derive an expression for the charge density in terms of Hall voltage and further explain how the mobility of the charge carriers can be evaluated by knowing the conductivity. (8)

(ii) A sample of silicon doped with 10^{16} phoshorons atoms/cm^3. Find the Hall voltage in a sample with thickness = 500 μm, Area at cross section = 2.5×10^{-3} cm^{-2}, current = 1 A and magnetic field (B_z) = 10 Wb/cm^2. (4)

(iii) Distinguish between Type I and Type II superconductors in the form of a neat table. (4)

14. (a) (i) Derive an expression for the internal field in a dielectric solids material. (8)

(ii) The dielectric constant of a helium gas at NTP is 1.0000684. Calculate the electronic polarizability of He atoms if the gas contains 2.7×10^{25} atoms/m^3. (4)

(iii) Calculate the polarization produced in a dielectric medium of dielectric constant 6 when it is subjected to an electric field of 100 V/m. (4)

Or

(b) (i) What is ferroelectricity? Explain the hysteresis curve exhibited by a ferroelectric material with a suitable sketch. Give examples for ferroelectric materials. (8)

(ii) Calculate the relative dielectric constant of a barium titanate crystal, which, when inserted in a parallel plate capacitor of area 10 mm × 10 mm and distance of separation of 2 mm, gives a capacitance of 10^{-9} F. $(\varepsilon_0 = 8.854 \times 10^{-12}$ F/m$)$. (4)

(iii) Write a short notes on liquid crystal displays. (4)

15. (a) (i) Give the classification of magnetic materials on the basis of magnetic susceptibility. Briefly discuss the domain theory of ferromagnetism. (8)

(ii) The magnetic material is subjected to a magnetic field of strength 500 A/m. If the magnetic susceptibility of the material is 1.2, calculate the magnetic flux density inside the material $(\mu_0 = 4\pi \times 10^{-7}$ H/m$)$. (4)

(iii) Calculate the energy loss per hour in the iron core of a transformer, if the area of B–H loop is 250 J/m^3 and the frequency of alternating current is 50 Hz. The density of iron is 7.5×10^3 kg/m^3 and mass of the core is 10 kg. (4)

Or