Question Bank
III Semester MSc Physics
Semiconductor Physics

Essay

1. Derive an expression for Fermi energy in a semiconductor
2. Derive an expression for charge concentration in an intrinsic semiconductor
3. Derive an expression for carrier concentration in an extrinsic semiconductor for both N and P type
4. a) Derive an expression for equation of motion of an electron in an energy band
   b) Explain tight binding method for the formation of energy band in a semiconductor

Short, descriptive and problem type

1. a) Define mobility of charge carriers in a semiconductor.
   b) Discuss the band structure of semiconductors.
   c) Find the resistance of an intrinsic germanium rod which is 1 cm long, 1 mm wide and 1 mm thick at 300 K. The intrinsic carrier density at 300 K is 2.5×10^{19} $/m^3$ and the mobilities of electron and hole are 0.39 and 0.19 m^2/VS respectively.
2. a) Distinguish between conductor, insulator and semiconductor.
   b) Explain the meaning of effective mass.
   c) The Fermi level of an 'n' type semiconductor lies at 0.3 eV below the conduction band . If the concentration of donor atom is doubled, where will be the new position of Fermi level? Take $kT = 0.03$ eV
3. a) Define effective mass of an electron.
   b) Derive the expression for intrinsic carrier concentration in a semiconductor.
   c) Calculate the intrinsic concentration of charge carriers at 300 K. Given that $m_e^* = 0.12m_0$,$m_h^* = 0.28m_0$ and the energy gap for germanium is 0.67 eV.

4. a What are intrinsic and extrinsic semiconductors ?
   b Discuss the location of the Fermi levels under suitable limiting conditions.
   c Calculate the resistivity at 300 K for pure germanium from the following data. $E_g = 0.72$ eV $\mu_n = 0.39m^2/\text{VS}$,$\mu_P = 0.19m^2/\text{VS}$.

5. a Derive an expression for electrical conductivity .
   b Explain band gap in semiconductors.
   c Calculate the intrinsic concentration of charge carriers at 300 K. Given that $m_e^* = 0.07m_0$, $m_h^* = 0.4m_0$ and the energy gap for germanium is 0.7 eV.