

Indian Institute of Technology, Delhi

Fundamentals of Semiconductors and Dielectrics (PYL201/EPL213)

Minor 1

Max = 20 marks

Answer all questions

1. In terms of lattice constant 'a', what is the distance between nearest neighbour atoms in (i) BCC and (ii) FCC lattice?2 marks
2. Draw the reciprocal lattice of the rectangular unit cell of $|b| = 4|a|$ (a, b are unit cell lattice parameters), draw first Brillouin zone and identify of principal symmetry points and line joining points.2 marks
3. A silicon sample is uniformly doped with 10^{16} phosphorus atoms/cm³ and 2×10^{16} boron atoms/cm³ (at 300K). If all the dopants are fully ionized,
 - (a) What will be the carrier concentration and its nature?
 - (b) Estimate the extrinsic and intrinsic Fermi energy levels

... 4 marks
4. If we have the data for conductivity vs temperature for the extrinsic silicon (dopant $N_d = 10^{16}$ cm⁻³), explain the temperature dependence (relevant diagrams/equations). Estimate the maximum device operating temperature. ... 6 marks
5. Write the properties of conduction and valence band states in typical semiconductors, with special reference to effective masses. Provide relevant diagrams/equations ... 6 marks

(nd)

For Silicon, $E_g = 1.12$ eV; $m_0 = 9.1 \cdot 10^{-31}$ kg, $\hbar = 1.05 \cdot 10^{-34}$ J-s; $m_c^* = 1.18 m_0$; $m_h^* = 0.81 m_0$; $k_b = 8.617 \cdot 10^{-5}$ eV K⁻¹, $N_c = 2.78 \times 10^{25}$ 1/m³, and $N_v = 9.84 \times 10^{24}$ 1/m³.

$n_p = n_i^2$

$n = N_d \exp\left(-\frac{(E_c - E_F)}{kT}\right) = n_i \exp\left(-\frac{(E_c - E_F)}{kT}\right)$

$p = N_a \exp\left(-\frac{(E_F - E_v)}{kT}\right) = p_i \exp\left(-\frac{(E_F - E_v)}{kT}\right)$



