DEPARTMENT OF PHYSICS AND NANOTECHNOLOGY
SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

18PYB103J –Semiconductor Physics

Lecture-10

SOLVING PROBLEMS

SRM Institute of Science and Technology

1.

9 The effective mass of the conduction electron in Si is 0.31 times the free electron mass. Find the conduction electron density at 300 K, assuming that the Fermi level lies exactly at the centre of the energy band gap (= 1.11 eV).

Electron concentration in CB is = $$n = 2\left[\frac{2\pi m_e kT}{h^2}\right]^{3/2} \exp\frac{-(E_c - E_F)}{kT}$$

$$n = 2\left[\frac{2\pi(0.31\times 9.1\times 10^{-31}\times 1.38\times 10^{-23}}{(6.63\times 10^{-34})^2}\right]^{3/2} T^{3/2} \exp\frac{-(E_c - E_F)}{kT}$$

$$= \left[4.81\times 10^{21}(0.31)^{3/2}(300)^{3/2}\right]\left[e^{-\frac{1.11/2}{0.0259}}\right]$$

$$= \left[4.31\times 10^{21}\right]\left[4.94\times 10^{-10}\right] = 2.13\times 10^{15}\, m^{-3}$$

2.

10 In intrinsic GaAs, the electron and hole mobilities are 0.85 and 0.04 $m^2 V^{-1}s^{-1}$ respectively and the effective masses of electron and hole respectively are 0.068 and 0.50 times the electron mass. The energy band gap is 1.43 eV. Determine the carrier density and conductivity at 300K.

Conductivity of a semiconductor is given by

$$\sigma = (n e \mu_e + p e \mu_p)$$

$$= n_i e (\mu_e + \mu_p)$$

$$= (2 \times 10^{12}) \times (1.6 \times 10^{-19}) [(0.85 + 0.04)]$$

$$= 2.85 \times 10^{-7} \text{ mho / m}$$