Module-1 (Electronics Engg.)

B.Tech 1st Year (I Sem)

TUTORIAL SHEET NO. 1

Q 1. A silicon wafer is 0.5 mm thick

(a) A potential of 100mV is applied across the thickness, what is the electron drift velocity if their mobility is $0.2 m^2/V\text{-}s$.

(b) How much time is required for an electron to move across the thickness?

Ans: $v_d = 40$ m/s , T = 12.5 μ-s (hint: E=V/d)

Q 2. The motilities of free electrons and holes in a pure germanium are 0.38 and 0.18 $m^2/V\text{-}s$. Find the value of intrinsic conductivity. Assume $n_i = 2.5 * 10^{19}/m^3$ at room temperature.

Ans: $\sigma_i = 2.24$ S/m

Q 3. Find the intrinsic carrier concentration of germanium, if its intrinsic resistivity at 300K is 0.50 Ω-m. It is given that the electronic charge is $1.6 * 10^{-19}$ coulombs and that electrons and hole mobilities are 0.39 and 0.19 $m^2/V\text{-}sec$ respectively.

Ans: $n_i = 2.155 * 10^{19} /m^3$.

Q 4. Find the concentration of holes and electrons in a p-type germanium at 300K, if the conductivity is 100 $(\Omega\text{-cm})^{-1}$ Also find these values for N-type silicon. if the conductivity is 0.1 $(\Omega\text{-cm})^{-1}$. Given for germanium. $n_i = 2.5 * 10^{13}/cm^3$ $\mu_n = 3800\ cm^2/V\text{-sec}$; $\mu_p = 1800\ cm^2/V\text{-sec}$ and for silicon $n_i = 1.5 * 10^{10}/cm^3$; $\mu_n = 1300\ cm^2/V\text{-sec}$; $\mu_p = 500\ cm^2/V\text{-sec}$

Ans: for p-type $n = 1.8 * 10^9/cm^3$, $p = 3.47 * 10^{17}/cm^3$, for n-type $n = 4.8 * 10^{14}/cm^3$, $p = 4.7 * 10^5/cm^3$.

Q 5. In a semiconductor at room temperature (300 °K). the intrinsic carrier concentration and resistivity are $1.5 * 10^{16}/m^3$ and $2 * 10^3$ Ω-m. It is converted to an extrinsic semiconductor with a doping concentration of $10^{20}/m^3$. For the extrinsic semiconductor, calculate the minority carrier concentration and resistivity.

$\mu_p/\mu_n = 1/2$

Ans: minority carrier concentration = $2.25 * 10^{12}$ atoms/m^3 , resistivity = 0.5998 Ω-m.

Q 6. In N-type Si bar which is 2 cm long and has a cross- section of 2 mm * 2 mm when a 1 V battery is connected across it, a current of 8mA flows. Find doping level and drift velocity. Given $\mu = 1300\ cm^2/V\text{-}s$

Ans: $N_D = 192 * 10^{13}/cm^3$, $V_d = 650$ cm/sec .

Q 7. In a doped semiconductor, there are $4.52 * 10^{24}$ holes and $1.25 * 10^{14}$ electrons per cubic meter. What will be the carrier density in undoped specimen? Electron and hole mobilities are 0.38 $m^2/V\text{-}s$ and 0.18 $m^2/V\text{-}s$ respectively. Calculate the conductivity of intrinsic and the doped semiconductors.

Ans : $n_i = 2.38 * 10^{19}/m^3$, $\sigma_i = 2.14$ S/m , $\sigma_p = 130$ KS/m.

$\sigma_p = p \cdot \mu_p \cdot q$
$= 4.52 \times 10^{24} \times 0.18 \times 1.6 \times 10^{-19}$