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Engineering Physics

Tutorial 3

2) $E = \frac{hc}{\lambda}$

$\lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{0.7 \times 1.6 \times 10^{-19}}$

$= 17.75 \times 10^{-7}$

$= 17750 \times 10^{-10}$

$= 17750 \text{ Å}$

3) $\rho = 1.72 \times 10^{-8} \Omega m$

$\therefore \sigma = \frac{1}{\rho} = \frac{1}{1.72 \times 10^{-8}} = 58.1 \times 10^{6} \text{ mho/m}$

$n = 10.41 \times 10^{28} \text{ m}^{-3}$

$\therefore \mu = \frac{\sigma}{ne} = \frac{58.1 \times 10^{6}}{10.42 \times 10^{28} \times 1.6 \times 10^{-19}}$

$\mu = 3.488 \times 10^{-3} \frac{m^2}{VS}$

4) $E_F - E = 0.012 \text{ eV}$

$\therefore KT = \frac{1.38 \times 10^{-23} \times 300}{1.6 \times 10^{-19}} = 0.02587 \text{ eV}$

$\therefore 1 - f(E) = 1 - \frac{1}{1 + e^{(E - E_F)/KT}}$

$= 1 - \frac{1}{1 + e^{\left(\frac{0.012}{0.02587}\right)}}$

$= 0.386$

$\therefore$

5) $E_F = 5.5 eV$, $T = 300K$, $F(E) = 0.9$

$K = 1.38 \times 10^{-23} J/K = 86.25 \times 10^{-6} eV$

$\therefore KT = 86.25 \times 10^{-6} \times 300 = 0.026$

$$\therefore F(E) = \frac{1}{1 + e^{(E - E_F)/KT}}$$

$$\therefore 0.9 = \frac{1}{1 + e^{(E - 5.5)/0.026}}$$

$$\therefore e^{(E-5.5)/0.026} = \frac{1}{0.9} - 1$$

$\therefore$ ~~$E = -2.9A$~~

$E = -2.197 \times 0.026 + 5.5$

$E = 5.443 eV$

6) $R_H = 145 cc/C$,

$w = 2cm$, $t = 0.2cm$

$B = 2T$, $I = 150mA$

$$\therefore J = \frac{I}{A} = \frac{I}{wd} = \frac{150 \times 10^{-3}}{2 \times 10^{-2} \times 0.2 \times 10^{-2}} = 3750 A/m^2$$

$$\therefore R_H = \frac{V_H}{JBd}$$

$\therefore V_H = R_H JBd$

$\therefore V_H = 145 \times 10^{-6} \times 3750 \times 2 \times 0.2 \times 10^{-2}$

$\therefore V_H = 21.75 \times 10^{-4} V$

~~$V_H = 21.75 mV$~~ $V_H = 2.175 mV$

7) $$f(E) = \frac{1}{1 + e^{(E - E_F)/KT}}$$

$K = 1.38 \times 10^{-23}$ J/K , $T = 300^\circ$ K

$$KT = \frac{1.38 \times 10^{-23} \times 300}{1.6 \times 10^{-19}} = 0.026 \text{ eV}$$

$\therefore f(E) = 0.99$

$$0.99 = \frac{1}{1 + e^{(E - 2.1)/0.026}}$$

$$\therefore 1 + e^{(E - 2.1/0.026)} = \frac{1}{0.99} = 1.01$$

$$\therefore e^{(E - 2.1)/0.026} = 0.01$$

$\therefore E - 2.1 = -0.1197$

$\therefore E = 1.981$ eV

8) For intrinsic semiconductor, $n_e = n_h = n_i$

$\therefore \sigma_{in} = n_i e (\mu_e + \mu_n)$

$$n_i = \frac{\sigma_{in}}{e(\mu_e + \mu_n)} = \frac{4 \times 10^{-4}}{1.6 \times 10^{-19} (0.4 + 0.14)}$$

$n_i = 1.388 \times 10^{16}$ m^3

9) $-(E-E_F) = 0.02$

$= 0.02 \times 1.6 \times 10^{-19}$ J

$= 3.2 \times 10^{-21}$ J

As $F(E) = \frac{1}{1+e^{(E-E_F)/KT}}$

$T = 300K$,

$F(E) = \frac{1}{1+e^{(-3.2\times10^{-21})/(1.38\times10^{-23}\times300)}}$

$= \frac{1}{1+e^{-0.7729}}$

$= 0.6841$

$T = 1000k$,

$F(E) = \frac{1}{1+e^{(-3.2\times10^{-21})/(1.38\times10^{-23}\times1000)}}$

$= \frac{1}{1+e^{-0.2318}}$

$= 0.5576 \simeq 0.56$.

10) thickness = 0.3mm

PD = 2V

$A = 1cm^2$

Ge is an intrinsic semiconductor.

$\therefore \sigma = ne(\mu_n + \mu_e)$

$= 2\times10^{19} \times 1.6\times10^{-19} (0.36 + 0.17)$

$= 1.696$ mho/m.

$\rho = \frac{1}{\sigma} = \frac{1}{1.696} = 0.5896$ ohm m.

$\therefore R = \frac{\rho L}{A} = \frac{0.5896 \times 0.0003}{10^{-4}} = 1.769\ \Omega$

$I = \frac{V}{R} = \frac{2}{1.769} = 1.13\ A$