HW3 –solutions

8.6 For a p$^+$n junction $I_s \sim I_{s,p} = Aep_{no}\sqrt{\frac{D_p}{\tau_{p0}}} = Ae\frac{n_i^2}{N_d}\sqrt{\frac{D_p}{\tau_{p0}}} = 3.94\times10^{-15}\,A$

Then $I_D = I_S \exp\frac{V_D}{V_t} = 9.54\times10^{-7}\,A$

$$\frac{J_n}{J_n + J_p} = \frac{\frac{eD_n n_{po}}{L_n}}{\frac{eD_n n_{po}}{L_n} + \frac{eD_p p_{no}}{L_p}} = \frac{1}{1 + \frac{D_p L_n N_a}{D_n L_p N_d}} = 0.95$$

8.7 $\frac{N_a}{N_d} = \frac{1-0.95}{0.95}\frac{D_n L_p}{D_p L_n} = \frac{0.05}{0.95}\sqrt{\frac{D_n}{D_p}} = 0.08$

Since $\tau_{n0} = \tau_{po}$

8.11 First take the mobilities from the text $\mu_p = 480$ $\mu_n = 1350$ - then find disffusion coefficients $D_p = \mu_p V_t = 12.5 cm^2/s, D_n = \mu_n V_t = 35 cm^2/s$. Next find the diffusion lengths $L_p = \sqrt{D_p \tau_{p0}} = 11.1\times10^{-4} cm = 11.1\mu m, L_p = \sqrt{D_n \tau_{n0}} = 37.4\times10^{-4} cm = 37.4\mu m$ and intrinsic concentrations $p_{n0} = n_i^2/N_d = 2.25\times10^5 cm^{-3}$ $n_{p0} = n_i^2/N_a = 4.5\times10^4 cm^{-3}$.

a. $I_{ps} = Ae\frac{D_p p_{n0}}{L_p} = 4\times10^{-14}\,A,$

b. $I_{ns} = Ae\frac{D_n n_{p0}}{L_n} = 6.7\times10^{-15}\,A$

c. $V_{bi} = V_t \ln\frac{N_a N_d}{n_i^2} = 0.617V,\ \frac{1}{2}V_{bi} = 0.309V \quad p_n(\frac{1}{2}V_{bi}) = p_{n0}\exp\frac{V_{bi}}{2V_t} = 3.42\times10^{10} cm^{-3}$

d. The total current is $I = \left(I_{ns} + I_{ps}\right)\exp\left(\frac{V_{bi}}{2V_t}\right) = 7.13\times10^{-9}\,A$

The hole diffusion current $I_p(x = x_n + L_p/2) = I_{ps}\exp\left(\frac{V_{bi}}{2V_t}\right)\exp\left(-\frac{1}{2}\right) = 3.68\times10^{-9}\,A$

The electron current is $I_n(x = x_n + L_p/2) = I - I_p(x = x_n + L_p/2) = 3.45\times10^{-9}\,A$

8.22 $g_d = \frac{I_{DQ}}{V_t} = 0.0077\Omega^{-1}$

$$C_d = \frac{1}{2V_t}(I_{p0}\tau_{p0} + I_{n0}\tau_{n0}) = \frac{1}{2V_t}I_{DQ}\tau_{n0} = \frac{I_{DQ}}{2V_t}\tau_{n0} = \frac{1}{2}g_d\tau_{n0} = 3.86\times10^{-8}\,F$$

8.48 **a.** $I_R / I_F = 0.2$ then $erf\sqrt{\dfrac{t_s}{\tau_{p0}}} = \dfrac{I_F}{I_F + I_R} = \dfrac{1}{1+.2} = 0.833 \quad t_s = 0.956\tau_{p0}$

b. $I_R / I_F = 1.0$ then $erf\sqrt{\dfrac{t_s}{\tau_{p0}}} = \dfrac{I_F}{I_F + I_R} = \dfrac{1}{1+1} = 0.5 \quad t_s = 0.228\tau_{p0}$

$$I_0 = \left(\frac{n_i^2}{N_d} \sqrt{\frac{D_p}{\tau_{p0}}} + \frac{n_i^2}{N_a} \sqrt{\frac{D_n}{\tau_{n0}}} \right) eA = \frac{eAn_i^2 \left(\sqrt{D_p} + \sqrt{D_n} \right)}{N_d \sqrt{\tau_0}} = 0.41 \times 10^{-14} A$$

$$W = sqrt$$