HW 5 Errata

Last Modified by: Bill Hung

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10.13

10.13

When the switch is open:

$$I_s = \frac{i_{D1}}{e^{v/V_T}-1} = \frac{10^{-3}}{e^{0.6/0.026}-1} = 9.502\times10^{-14}\,A$$

When the switch is closed

$i_{D1} = i_{D2} = 0.5\,mA$

$$v = nV_T \ln\left[\frac{i_D}{I_s}+1\right] = 0.026 \ln\left(\frac{0.5\times10^{-3}}{9.502\times10^{-14}}+1\right) = \boxed{582.0\,mV}$$

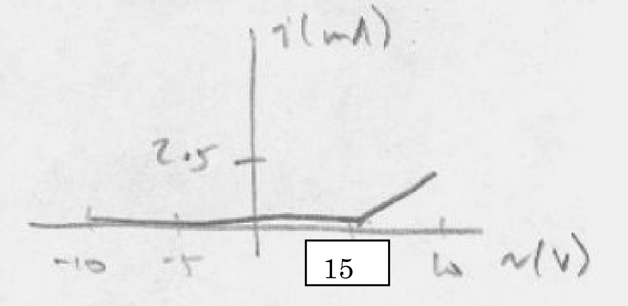
For $n=2$

$$I_s = \frac{10^{-3}}{e^{0.6/(2\times0.026)}-1} = 9.748\times10^{-9}\,A$$

$$v = 2\times0.026 \ln\left(\frac{0.5\times10^{-3}}{9.748e\text{-}9}+1\right) = \boxed{564mV}$$

10.35b

(b) $v > 5 \rightarrow$ on $v < 5 \rightarrow$ off



E2.10d

(d) $\#\text{collisions} = \frac{\Delta t}{\tau_c} = \frac{333.3\,ps}{0.05ps} = \boxed{6.66k}$

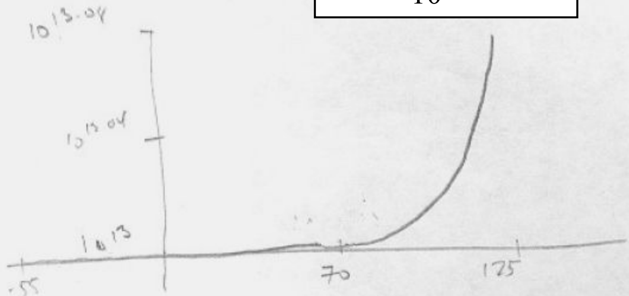
P.2.5

P2.5

(a) $n_0 = \frac{N_d}{2}\left(1+\sqrt{1+4\left(\frac{n_i}{N_d}\right)^2}\right)$

$n_i = A\,T^{3/2}e^{-6608.7/T}$ $\qquad A = \frac{1.42\times10^{9}}{273^{3/2}e^{-6608.7/273}} = 1.026\times10^{16}$

$n_0 = \frac{10^{13}}{2}\left(1+\sqrt{1+\frac{4A^2T^3e^{-(6608.7/T)2}}{10^{-26}}}\right)$



(b) $\frac{p_0}{n_0} = \frac{n_i^2}{n_0^2} = 10^{-3} \rightarrow \frac{n_i}{n_0} = 10^{-3/2}$ $\qquad \frac{AT^{3/2}e^{-6608.7/T}}{\frac{10^{13}}{2}\left(1+\sqrt{1+\frac{4A^2T^3e^{-(6608.7/T)2}}{10^{-26}}}\right)} = 10^{-3/2}$

$\rightarrow$ T=345k

P2.7b

(b) $v_{dn} = -\mu_n E_x = -(1450\,cm^2/Vs)(8.333\times10^2\,V/cm) = \boxed{-1.208\times10^6\,cm/s}$

$v_{dp} = \mu_p E_x = (500\,cm^2/Vs)(8.333\times10^2\,V/cm) =$ 4.167 x 10^5 cm/s

$\Delta t = \frac{\Delta x}{v_{dn}} = \frac{24\,\mu m}{1.208\times10^6\,cm/s} = \boxed{1.987\times10^{-9}\,s}$

P2.7c

(c) $J_n^{dr} = -qnv_{dn} = (-1.6\times10^{-19})(10^{13}\,cm^{-3})(-1.208\times10^6\,cm/s) = \boxed{1.933\,A/cm^2}$

$J_p^{dr} = qpv_{dp} = (1.6\times10^{-19}C)(10^7\,cm^{-3})$ x (4.167 x 10^5 cm/s)=6.67 x 10^{-7} A/cm^2

$\%\,error = \left|\frac{J_p^{dr}}{J_n^{dr}+J_p^{dr}}\right| \times 100\% =$ T=3.45 x 10^{-5} %

1e. The way solved by the original solution is also okay.

$$V_T = \frac{kT}{q} \text{(other forms of Vt are also okay)}$$

$$V_0 = V_T \ln(\frac{N_A N_D}{n_i^2}) = \frac{kT}{q} \ln(\frac{N_A N_D}{n_i^2})$$

$$Wj = x_n + x_p = \sqrt{\frac{2\varepsilon_s}{q}(\frac{1}{N_A} + \frac{1}{N_D})(V_0 - V_D)} = \sqrt{\frac{2\varepsilon_s}{q}(\frac{1}{N_A} + \frac{1}{N_D})\frac{kT}{q}\ln(\frac{N_A N_D}{n_i^2})}$$

$$C_J = \frac{A_D \varepsilon_s}{Wj} = \frac{A_D \varepsilon_s}{\sqrt{\frac{2\varepsilon_s}{q}(\frac{1}{N_A} + \frac{1}{N_D})\frac{kT}{q}\ln(\frac{N_A N_D}{n_i^2})}}$$

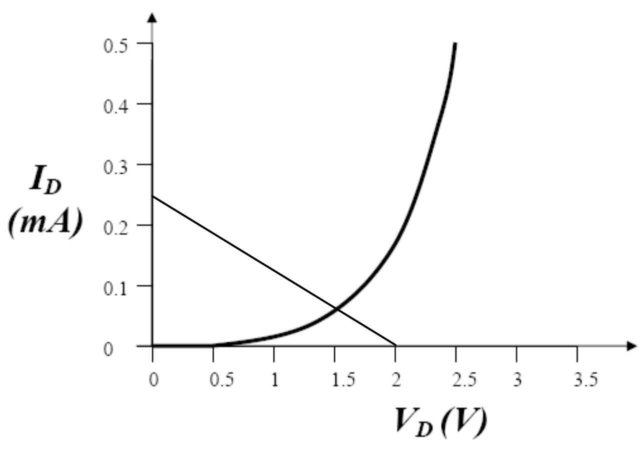
$$C_J = \frac{(5x10^{-4} \cdot 1x10^{-4})(10^{-12})}{\sqrt{\frac{2 \cdot 10^{-12}}{1.6x10^{-19}}(\frac{1}{10^{18} - 10^{17}} + \frac{1}{10^{17} - 9x10^{16}}) \cdot 0.026 \cdot \ln(\frac{(10^{18} - 10^{17})(10^{17} - 9x10^{16})}{10^{20}})}}$$

$$C_J = 1.54x10^{-15} F$$

2b

$$R_D = \boxed{\frac{1}{q_p \mu_p p_0 t} = \frac{1}{(1.6x10^{-19})(275)(1.1x10^{17} - 1x10^{17})(100x10^{-4})} =} \; 27.3\Omega/\square$$

4c



Id = 1.5V

Vd = 0.8mA