**ECE 305 – Spring 2018**

**Homework 4 solution**

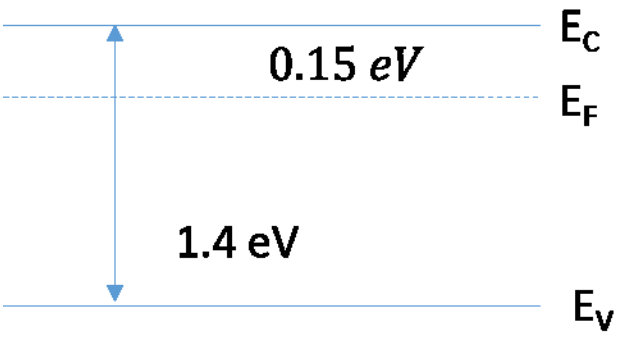
1. a

n-type region:

$$n \approx N_D$$

$$n = N_C e^{(E_F - E_C)/kT}$$

$$(E_F - E_C) = kT ln\left(\frac{n}{Nc}\right) = 0.026\ ln\left(\frac{10^{16}}{4 \times 7 \times 10^{17}}\right) = -0.15\ eV$$

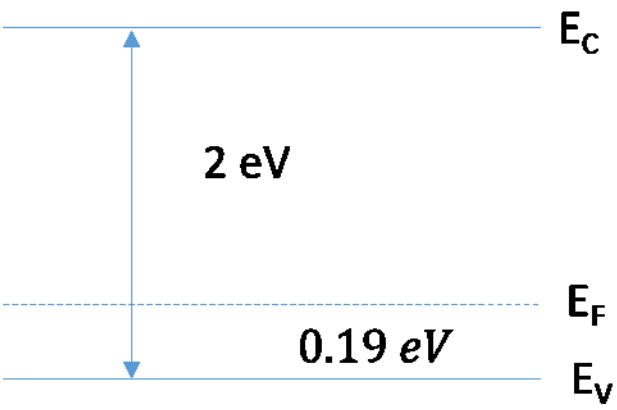



p-type region:

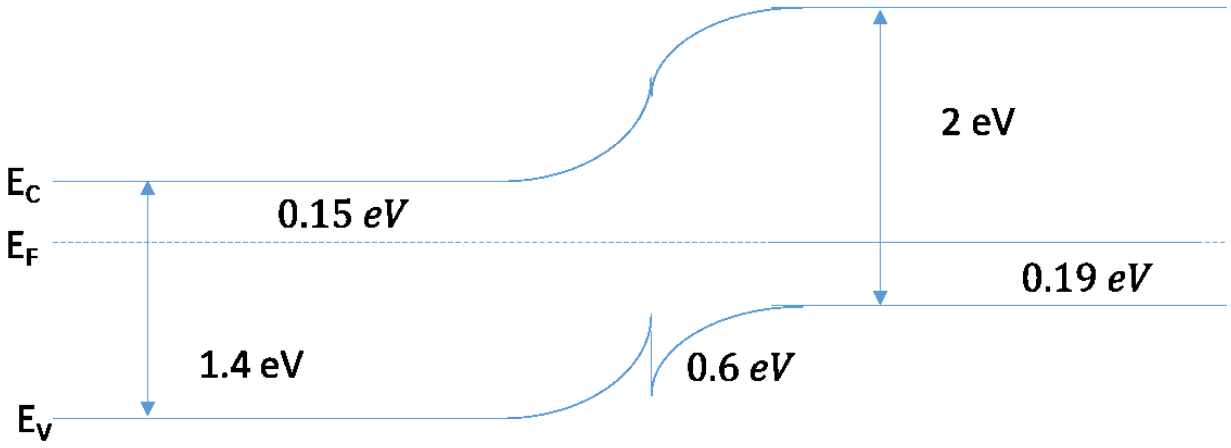
$$p \approx N_A$$

$$p = N_V e^{(E_V - E_F)/kT}$$

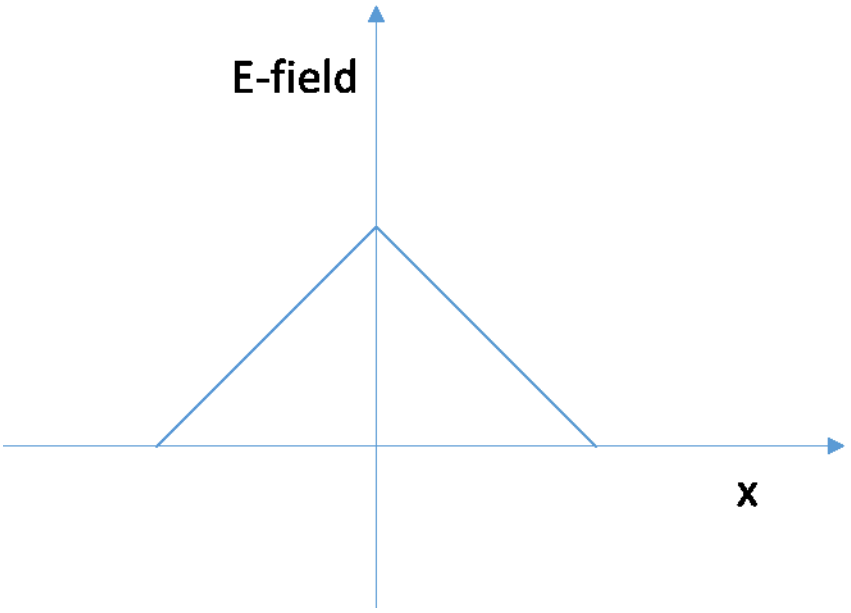
$$(E_V - E_C) = kT ln\left(\frac{p}{Nv}\right) = 0.026\ ln\left(\frac{10^{16}}{1.59 \times 10^{19}}\right) = -0.19\ eV$$



b.




c. Using depletion approximation:

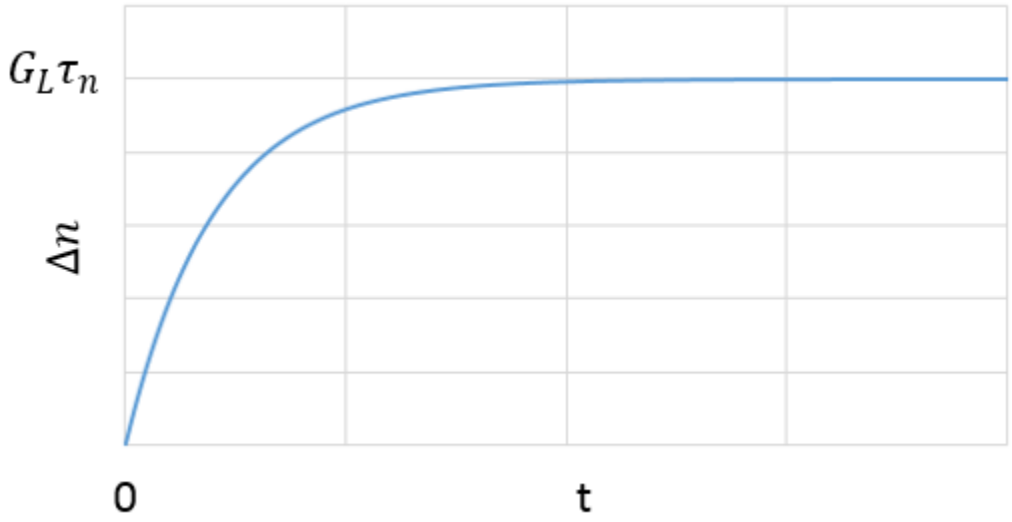


2. a. $\frac{\partial \Delta n}{\partial t} = -\frac{\Delta n}{\tau_n} + G_L \qquad t \geq 0$

b. $\Delta n = G_L \tau_n + Be^{-\frac{t}{\tau_n}}$

$\Delta n = 0 \; at \; t = 0$

Thus, $\Delta n = G_L \tau_n - G_L \tau_n e^{-\frac{t}{\tau_n}}$




The excess majority carrier concentration shows similar behavior as the excess minority carrier concentration, and the steady state excess majority carrier concentration goes to $G_L\tau_p$. However, the magnitude of excess majority carrier concentration is usually relatively insignificant compared to magnitude of majority carrier concentration.

c.

$\Delta n(50\mu s) = G_L \tau_n - G_L \tau_n e^{-\frac{1}{2}}$=3.93× $10^{13}$ $cm^{-3}$

$\Delta n(\infty) = 1 \times 10^{14}$ $cm^{-3}$

Therefore $\Delta n(50\mu s)$ is 0.39 times the $\Delta n(\infty)$.