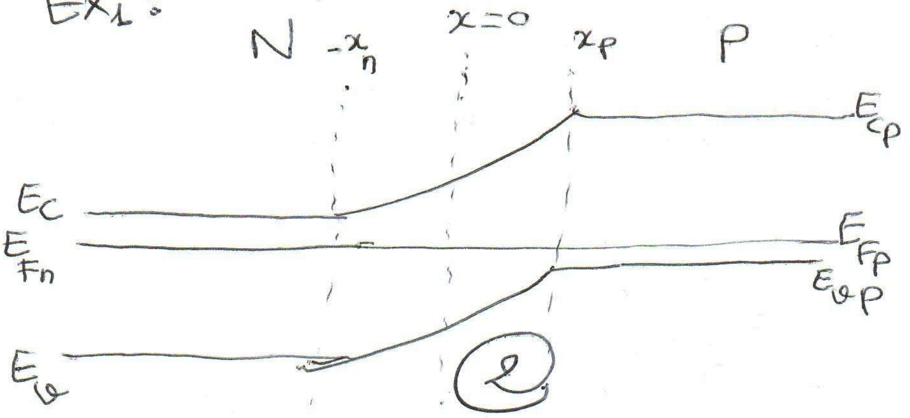
1) on a : $\begin{cases} n + N_a = p + N_d & (1) \\ n \cdot p = n_i^2 & (0,5) \end{cases}$ à T ambiante. $\Rightarrow p = \frac{n_i^2}{n}$.

$$\Rightarrow n^2 + (N_a - N_d)\,n - n_i^2 = 0 \quad (1)$$

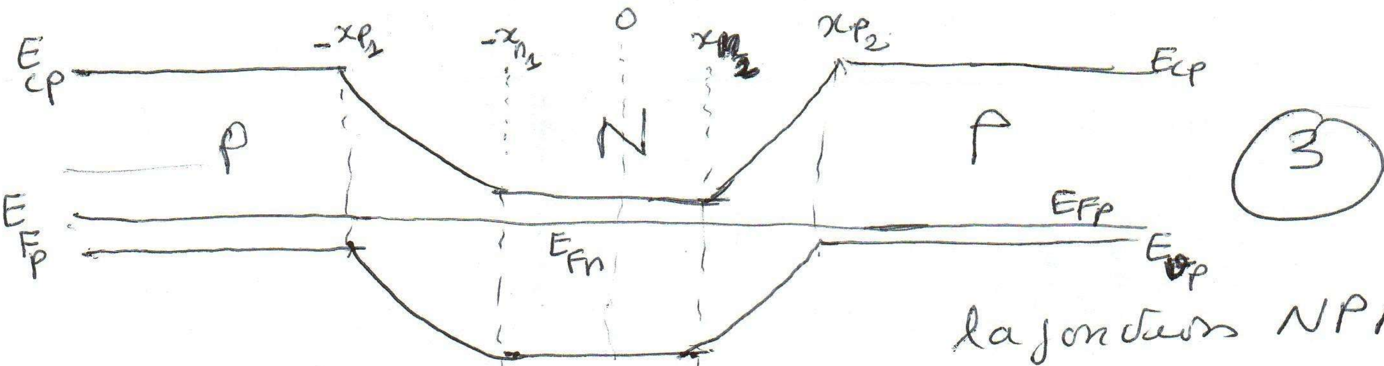
$$\Rightarrow n = \frac{-(N_a - N_d) + \sqrt{(N_a - N_d)^2 + 4 n_i^2}}{2} \quad (1), \quad p = \frac{2 n_i^2}{-(N_a - N_d) + \sqrt{(N_a - N_d)^2 + 4 n_i^2}} \quad (0,5)$$

$n = 9 \times 10^{13}\ cm^{-3}$ (0,5) , $p = 6,25 \times 10^{5}\ cm^{-3}$ (0,5)

Ex1 :




(diagramme énergétique de la jonction NP)




la jonction NPN.

Ex3 : $N_c = 2.5 \times 10^{19} \left(\frac{m_c^*}{m_e}\right)^{3/2} \left(\frac{T}{300}\right)^{3/2}$ , $N_v = 2.5 \times 10^{19} \left(\frac{m_v^*}{m_e}\right)^{3/2} \left(\frac{T}{300}\right)^{3/2}$.

$$n = \sqrt{N_c N_v}\ \exp -\left\{\frac{E_g}{2 k_B T}\right\} \quad (1)$$

$$n = 2.5 \times 10^{19} \left(\frac{m_c^*}{m_e}\right)^{3/4} \left(\frac{m_v^*}{m_e}\right)^{3/4} \exp -\left\{\frac{E_g}{2 k_B T}\right\} = 7.78\ 10^{9}\ cm^{-3} \quad (1)$$

côté N : $\begin{cases} n = N_d = 5 \times 10^{15}\ cm^{-3} & (0,5) \\ p = \frac{n_i^2}{N_d} = 1.21 \times 10^{4}\ cm^{-3} & (0,5) \end{cases}$

côté P : $\begin{cases} p = N_a = 2 \times 10^{14}\ cm^{-3} & (0,5) \\ n = \frac{n_i^2}{N_a} = 3,03 \times 10^{4}\ cm^{-3} & (0,5) \end{cases}$

$$V_d = \frac{k_B T}{q} \ln\left(\frac{N_a N_d}{n_i^2}\right) = \frac{1.38 \times 10^{-23} \times 300}{1,6 \times 10^{-19}} \ln\left(\frac{2 \times 10^{14} \times 5 \times 10^{15}}{(7.78 \times 10^{9})^2}\right) = 0,612\ \text{Volt} \quad (1)$$

la largeur de la ZCE : $w = \sqrt{\frac{2\varepsilon}{q} \frac{(N_a + N_d)}{N_a N_d} V_d}$

$N_a = 2\times10^{14}\ cm^{-3} = 2\times10^{20}\ m^{-3}$

$N_d = 5\times10^{15}\ cm^{-3} = 5\times10^{21}\ m^{-3}$

$\begin{cases} \varepsilon = 10.443\ 10^{-11}\ F.m^{-1} \\ q = 1.6\times10^{-19}\ C,\ V_d = 0.612\ Volt \end{cases}$

$w = 2.0389\ 10^{-6}\ m.$ (1)

dans la région neutre de N.

$n = N_d = n_i \exp\left\{\frac{E_{FN} - E_{Fi}}{k_B T}\right\} \Rightarrow E_{FN} - E_{Fi} = k_B T \ln\left(\frac{N_d}{n_i}\right)$

$= 0.348\ eV.$ (1)

dans la région neutre P.

$p = N_a = n_i \exp\left\{\frac{E_{Fi} - E_{FP}}{k_B T}\right\} \Rightarrow E_{FP} - E_{Fi} = -k_B T \ln\left(\frac{N_a}{n_i}\right)$

$= -0,264\ eV.$ (1)

dans la région N

on a : $R_N = \frac{\rho_N . L_N}{S} = \frac{1}{|q|\mu_n N_d} . \frac{L_N}{S} = 8.93\times10^{5}\ \Omega$ (1)

$R_p = \frac{\rho_p . L_p}{S} = \frac{1}{|q|\mu_p N_a} . \frac{L_p}{S} = 6.25\times10^{5}\ \Omega$ (1)

$L_N = 100m,\ S = 10^{-6} m,\ \mu_n = 0,14\ m^2/Vs,\ \mu_p = 0,05\ m^2/Vs$

$q = 1.6\times10^{-19},\ N_a = 2\times10^{20}\ m^{-3},\ N_d = 5\times10^{21}\ m^{3}.$

pour $L_N = L_p = 100\ mm,\ R_N = 893\ \Omega,\ R_p = 625\ \Omega.$