Exercice1 : $Nc = 3.10^{19}\left(\frac{T}{300}\right)^{\frac{3}{2}} = 2.5.10^{19}\left(\frac{m_c^*}{m_e}\right)^{3/2}\left(\frac{T}{300}\right)^{3/2} \Rightarrow \left(\frac{m_c^*}{m_e}\right) = \left(\frac{3.10^{19}}{2.5.10^{19}}\right)^{2/3} = 1.129 \Rightarrow m_c^* = 1.129\ m_e$

$Nv = 1.10^{19}\left(\frac{T}{300}\right)^{3/2} = 2.5.10^{19}\left(\frac{m_v^*}{m_e}\right)^{3/2}\left(\frac{T}{300}\right)^{3/2} \Rightarrow \left(\frac{m_v^*}{m_e}\right) = \left(\frac{1.10^{19}}{2.5.10^{19}}\right)^{2/3} = 0.543 \Rightarrow m_v^* = 0.543\ m_e$

0.5+0.5

$n_i = \sqrt{N_c N_v} exp\left(-\frac{E_g}{2k_B T}\right) = 4.39.\,10^{13}\ cm^{-3}$ 0.5+0.5

La concentration d'impuretés$=\frac{\mathbf{4.4\ 10^{22}}}{2.10^7} = \mathbf{2.2.10^{15}}\ cm^{-3}$ 1

Le dopage de type p Na=2.2. $\mathbf{10^{15}}\ cm^{-3}$ 0.5+0.5

A T ambiantes : $\begin{cases} p = \mathrm{Na} + \mathrm{n} \\ n.p = n_i^2 \end{cases}$ 0.5 $\Rightarrow p^2 - \mathrm{Na.p} - n_i^2 = 0$ 0.5 $\Rightarrow \begin{cases} p = \frac{\mathrm{Na} + \sqrt{\mathrm{Na}^2 + 4n_i^2}}{2} \\ n = \frac{2\ n_i^2}{\mathrm{Na} + \sqrt{\mathrm{Na}^2 + 4n_i^2}} \end{cases}$ 0.5+0.5

P= $2.20088.10^{15}\ cm^{-3}$ 0.5 n=$8.75656\ 10^{11}\ cm^{-3}$ 0.5

$n = N_c \exp -\frac{(Ec - EF)}{k_B T} \Rightarrow EF - Ec = k_B T \ln\left(\frac{n}{N_c}\right) = k_B T \ln\left(\frac{n_i^2}{\mathrm{Na}N_c}\right)$ *0.5*

$EF - Ec = -0.451\ eV$ 0.5

Exercice2 :

l'équation de continuité pour les porteurs de charge minoritaires

$\frac{dp(x,t)}{dt} = -\frac{1}{e}\frac{dJ_p}{dx} - r_p + g_p$ 0.5 $J_p(diff) = -eD_p\frac{dp}{dx}$ $\frac{dp}{dt} = D_p\frac{d^2 p}{dx^2} - \frac{p - p_0}{\tau_p}$ 0.5+0.5

Régime stationnaire $\frac{\boldsymbol{dp}}{\boldsymbol{dt}} = \mathbf{0}$ 0.5

$\frac{d^2p}{dx^2} - \frac{1}{L_p^2}\Delta p = 0$, tel que **$L_p = (D_p\tau)^{1/2}$ ($\tau=\tau_p$) , on a :** $\frac{d^2p}{dx^2} = \frac{d^2\Delta p}{dx^2}$ **0.5**

La solution est $\Delta p\ (x) = A\ e^{x/Lp} + Be^{-x/Lp}$ **0.5**

Conditions aux limites : $\Delta p\ (x) = (\Delta p)_0\ \ et\ \Delta p\ (w) = 0$ **0.5+0.5**

$\begin{cases} A + B = (\Delta p)_0 \\ A\ e^{w/Lp} + Be^{-w/Lp} = 0 \end{cases}$ **0.5** $\Rightarrow \begin{cases} A = \frac{-(\Delta p)_0}{sh\left(\frac{w}{Lp}\right)} e^{-w/Lp} \\ B = \frac{(\Delta p)_0}{sh\left(\frac{w}{Lp}\right)} e^{w/Lp} \end{cases}$ **0.5+0.5** $\Rightarrow \Delta p\ (x) = \frac{(\Delta p)_0}{sh\left(\frac{w}{Lp}\right)} sh\left(\frac{w-x}{Lp}\right)$ **0.5**

Courant de diffusion $j_{diff} = -qD_p\frac{dp}{dx} = -qD_p\frac{d\Delta p}{dx} = \frac{qD_p}{Lp}\frac{(\Delta p)_0}{sh\left(\frac{w}{Lp}\right)}\ ch\left(\frac{w-x}{Lp}\right)$ **0.5+0.5**

Exercice 3

1-La concentration intrinsèque ni :

$$n_i = \sqrt{N_c N_v} exp\left(-\frac{E_g}{2k_BT}\right) = 2.5.10^{19}\left(\frac{m_c^*}{m_e}\right)^{0.75}\left(\frac{m_v^*}{m_e}\right)^{0.75} exp\left(-\frac{E_g}{2k_BT}\right) = 7.78.10^9 cm^{-3}$$ 1 point

2. La concentration en majoritaires et minoritaires de chaque côté

Coté N, $n = N_d = 10^{15} cm^{-3}, p = \frac{{n_i}^2}{n} = 6.05.10^4 cm^{-3}$ 0.5+0.5

Coté P : $p = N_a = 5.10^{16} cm^{-3}, n = \frac{{n_i}^2}{p} = 1.21.10^3 cm^{-3}$ 0.5+0.5

3- . Le potentiel de diffusion $V_d = \frac{k_BT}{q} ln\frac{N_d N_a}{{n_i}^2} = 0.713\ eV$ 0.5+0.5

4- La largeur de la ZCE : $w = \sqrt{\frac{2\varepsilon}{q} V_d \frac{N_d + N_a}{N_d . N_a}} = \sqrt{\frac{2.10^{-10}}{1.6.10^{-19}} 0.713 \frac{10^{21}+5.10^{22}}{10^{21}.5.10^{22}}} = 9.73.10^{-7} m$ 0.5+0.5

E_f-E_{fi} dans les zones neutres :

zone neutre Coté N : $n = n_i \exp\frac{(E_F - E_{Fi})}{k_BT} = N_d \Rightarrow (E_F - E_{Fi}) = k_BT.ln\frac{N_d}{n_i}$=0.306 eV 0.25+0.25

zone neutre Coté P : $p = n_i \exp - \frac{(E_F - E_{Fi})}{k_BT} = N_a \Rightarrow (E_F - E_{Fi}) = -k_BT.ln\frac{N_a}{n_i}$=-0.408 eV 0.25+0.25