Course 22

Wednesday, 27 November 2024 10:14

Exercise_ser
ies 4_EE557

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

SCHOOL OF ENGINEERING (STI)
Institute of Electrical Engineering (IEL)

EPFL

EE 557 - Semiconductor devices I

Responsable : Prof. Elison Matioli
Responsable TA: Lucas Mazzone (lucas.mazzone@epfl.ch)

Exercises - list 4

1. Consider a **PN-junction** with two doped contacts on each side as shown in the figure below. The **doping** of the n-side is $N_D = 10^{17}\ cm^{-3}$ and the doping of the p-side is $N_A = 10^{16}\ cm^{-3}$. At equilibrium, the Schottky barrier height of the metal semiconductor junction is $\phi_{Bn} = 0.7\ eV$.

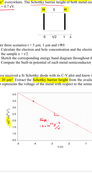
Consider three scenarios (= 3 pts): 1 pts and 0 Pts

a) Calculate the electron and hole concentration and the electric field at the centre of the PN-junction.

b) Sketch the corresponding energy band diagram throughout the structure.

c) Compute the built-in potential of each metal semiconductor junction.

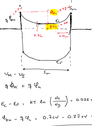
2. You have manufactured a Schottky diode with the n+ side and know that the junction's area is $20 \times 20\ \mu m^2$. Extract the **Schottky barrier height** from the available information (V in the plot represents the voltage of the metal with respect to the semiconductor).



a) $n_0 = 10^{17}\ cm^{-3}$

$\phi_{Bn} = 0.7\ eV$

b)



$\phi_{Bn} = E_c - E_F$

$\phi_{Bn} = \phi_{Bn} - \phi_{Bn}$

$\phi_{Bn} = E_c - E_F = kT\ln\left(\frac{N_c}{n_0}\right) = 0.026 \times \ln\left(\frac{3.1\times10^{19}}{10^{17}}\right) = 0.23\ eV$

$\phi_{Bn} = \phi_{Bn} - \phi_{Bn} = 0.7\ eV - 0.23\ eV = 0.47\ eV$

$x_d = \sqrt{\frac{2\varepsilon_s \phi_{Bn}}{qN_D}} = \sqrt{\frac{2 \times 11.8\ F/cm \times 0.47\ eV}{1.6\times10^{-19}\ C \times 10^{17}\ cm^{-3}}} = 0.35\ \mu m$

c)