For Si: $n_i = 1.5 * 10^{10} \frac{1}{cm^3}$, $\epsilon_r = 11.9$.

Elementary charge

$q_e := 1.602 \cdot 10^{-19}\ \mathrm{C}$

Vacuum permittivity

$\varepsilon_0 := 8.854 \cdot 10^{-12}\ \frac{\mathrm{F}}{\mathrm{m}}$

$ni := 1.5 \cdot 10^{10}$ $\varepsilon_r := 11.9$

Doping concentration on P-side

$Na := 8 \cdot 10^{15}$

Temperature :

$T := 300\ \mathrm{K}$

Doping concentration on N-side

$Nd := 2 \cdot 10^{16}$

Boltzmann constant :

$kb := 1.38 \cdot 10^{-23}\ \frac{\mathrm{J}}{\mathrm{K}}$

SMath built in constants:

$\varepsilon_0 = 8.85418781762039 \cdot 10^{-12}\ \frac{\mathrm{F}}{\mathrm{m}}$

$k = 1.3807 \cdot 10^{-23}\ \frac{\mathrm{J}}{\mathrm{K}}$

Permittivity :

$\varepsilon := \varepsilon_0 \cdot \varepsilon_r = 1.0536 \cdot 10^{-10}\ \frac{\mathrm{F}}{\mathrm{m}}$

Built-in voltage, contact potential:

$$Vbi := \frac{kb \cdot T}{q_e} \cdot \ln\left(\frac{Nd \cdot Na}{ni^2}\right) \mathrm{m}^3 = 0.7052\ \mathrm{m}^3\ \mathrm{V}$$

Depletion width (no external bias)

$$W := \sqrt{\frac{2 \cdot \varepsilon \cdot (Nd + Na) \cdot Vbi}{q_e \cdot Nd \cdot Na}} = 0.0004029\ \mathrm{m}$$

Depletion width in the p-region:

$$Wp := \frac{Nd \cdot W}{Nd + Na} = 0.0002878\ \mathrm{m}$$

Depletion width in the n-region:

$$Wn := \frac{Na \cdot W}{Na + Nd} = 0.0001151\ \mathrm{m}$$

From this point on, I don't know how to proceed.

$l := 0$ On figure 4, this is point x=0

Equation given:

$$\frac{d^2}{d x^2} y + \frac{Pnet}{qe \cdot e0} = 0$$

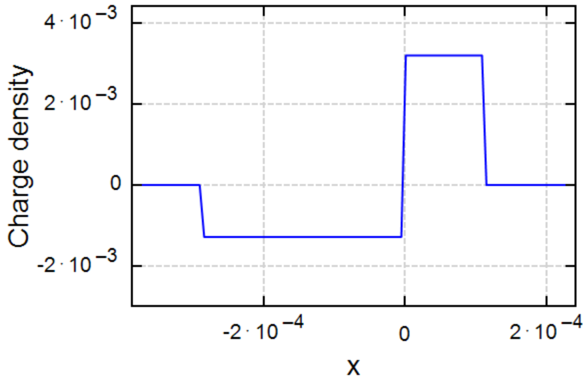
Boundary condition:

$$E = \frac{1}{\varepsilon} \cdot \int_{-Wp}^{Wn} \rho \, d x$$

$$Vo := \frac{q_e}{2 \cdot \varepsilon} \cdot (Wp + Wn)^2 \cdot \frac{Na \cdot Nd}{Na + Nd} \cdot \frac{1}{\mathrm{m}^3} = 0.7052\ \mathrm{V}$$ this is Vbi

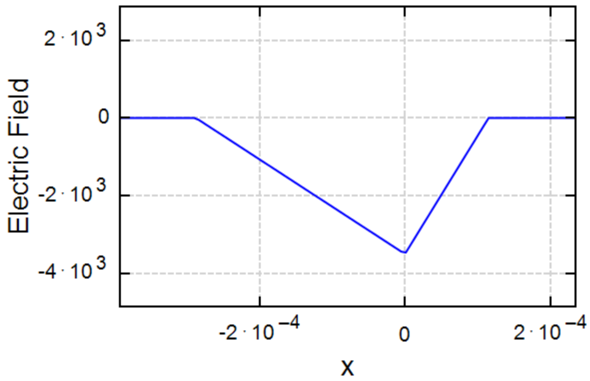
Charge density, electric field an potential

$$\rho(x) := \begin{cases} -q_e \cdot Na & \text{if } -Wp < x < 0 \\ q_e \cdot Nd & \text{if } 0 < x < Wn \\ 0 & \text{otherwise} \end{cases}$$



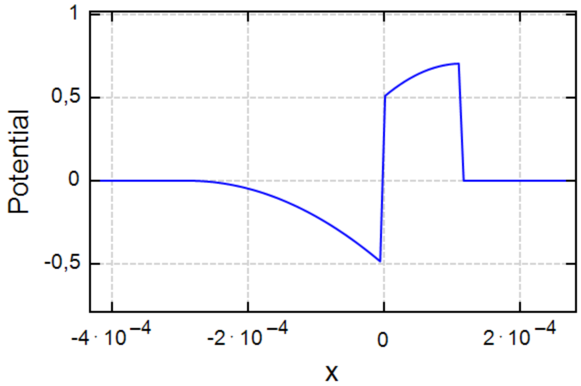
$\rho(x\ \mathrm{m})$

$$E(x) := \begin{cases} -\frac{q_e \cdot Na}{\varepsilon} \cdot (x + Wp) & \text{if } -Wp < x < 0 \\ \frac{q_e \cdot Nd}{\varepsilon} \cdot (x - Wn) & \text{if } 0 < x < Wn \\ 0 & \text{otherwise} \end{cases}$$



$E(x\ \mathrm{m})$

$$V(x) := \begin{cases} -\frac{q_e \cdot Na}{2 \cdot \varepsilon} \cdot (x + Wp)^2 & \text{if } -Wp < x < 0 \\ Vbi - \frac{q_e \cdot Nd}{2 \cdot \varepsilon} \cdot (x - Wn)^2 & \text{if } 0 < x < Wn \\ 0 & \text{otherwise} \end{cases}$$



$V(x\ \mathrm{m})$