EE 735: ASSIGNMENT 2 REPORT

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$$n_i^2 = N_c N_v \exp\left[\frac{-(E_c - E_{Fi})}{kT}\right] . \exp\left[\frac{-(E_{Fi} - E_v)}{kT}\right]$$

$$= N_c N_v \exp\left[\frac{-(E_c - E_v)}{kT}\right]$$

$$= \boxed{N_c N_v \exp \frac{-E_g}{kT}} \quad \text{..... (7)}$$

N_c and N_v vary at $T^{3/2}$

Using these formulae, we calculate $n_i = 1.3766*10^{10}\ cm^{-3}$
Grid spacing is 1nm

Q1. ABRUPT

• This potential is called "built-in potential"

$$\boxed{V_0 = V_T \ln\left(\frac{N_A N_D}{n_i^2}\right)}$$

V_T : thermal voltage (= 26 mV at room temp)

N_A : acceptor concentration on p-side

N_D : donor concentration on n-side

n_i : intrinsic carrier concentration

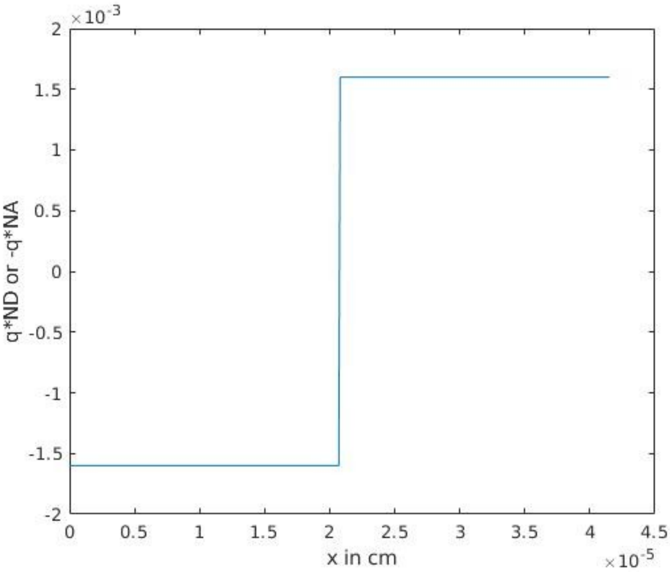
V_0 (the built in voltage) = 0.6984 V
using $V_T = k_B T/q$ with
$k_B = 1.38*10^{-23}$
T = 300K
$q = 1.6*10^{-19}$
$N_D = 10^{16}\ cm^{-3}$, $N_A = 10^{16}\ cm^{-3}$

$$x_p = \frac{N_D}{N_A + N_D} W, \qquad x_n = \frac{N_A}{N_A + N_D} W$$

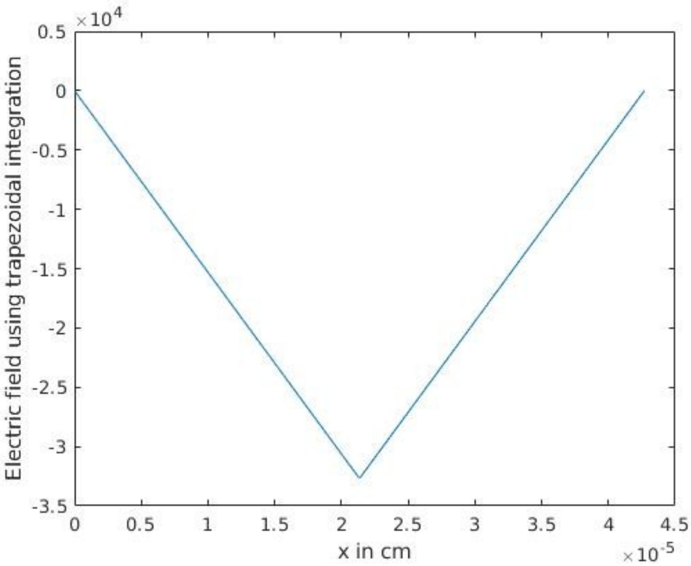
$$\boxed{W = \sqrt{\frac{2e_S}{q}\left(\frac{1}{N_A} + \frac{1}{N_D}\right) V_0} \quad : \quad \text{Depletion Width}}$$

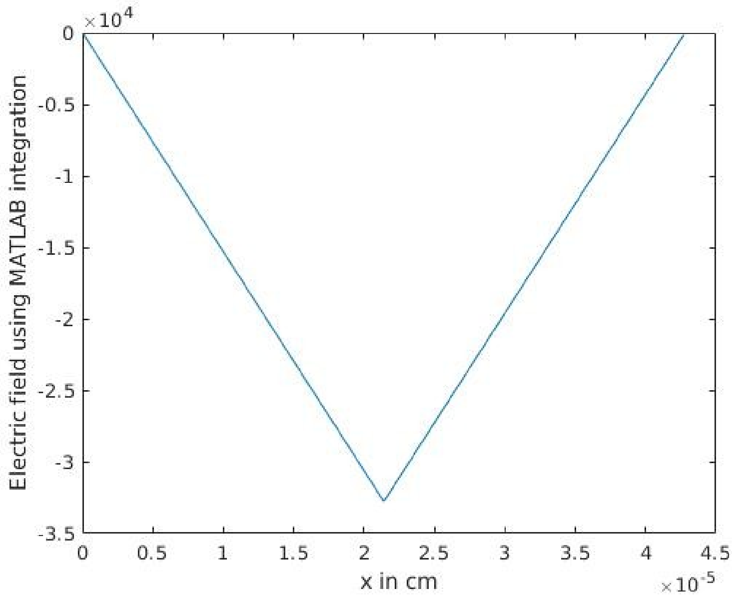
$K_{Si} = 11.8$
$e_s = K_{si}*8.854*10^{-14}$
$x_P = x_N = 214$ nm

roh is as follows:



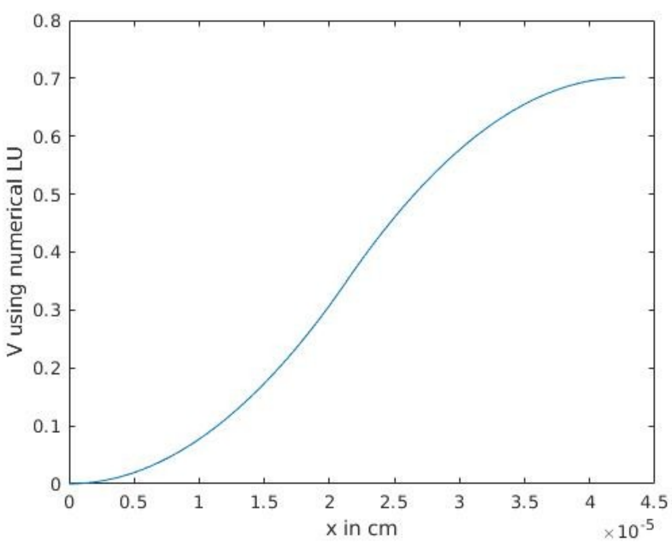
Q1a)

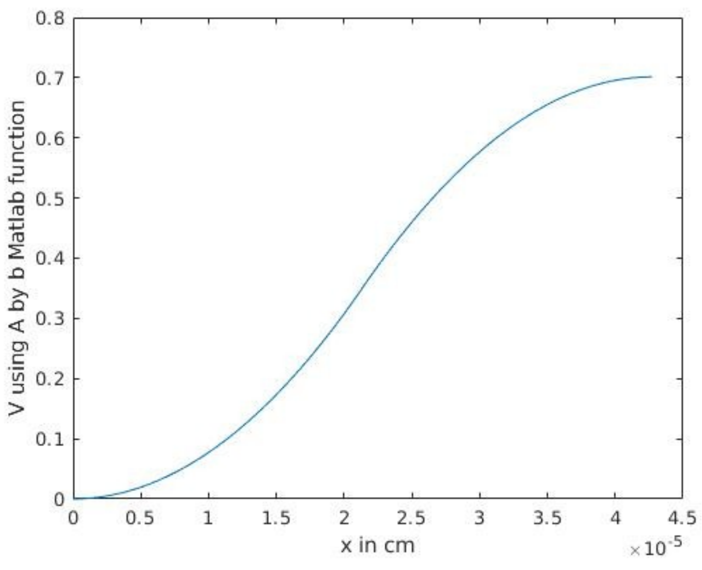




Numerical and MATLAB integration work similarly. At the rightmost edge, numerical integration shows a slight error by being non-zero. On changing grid spacing, this error reduces.

Q1b)



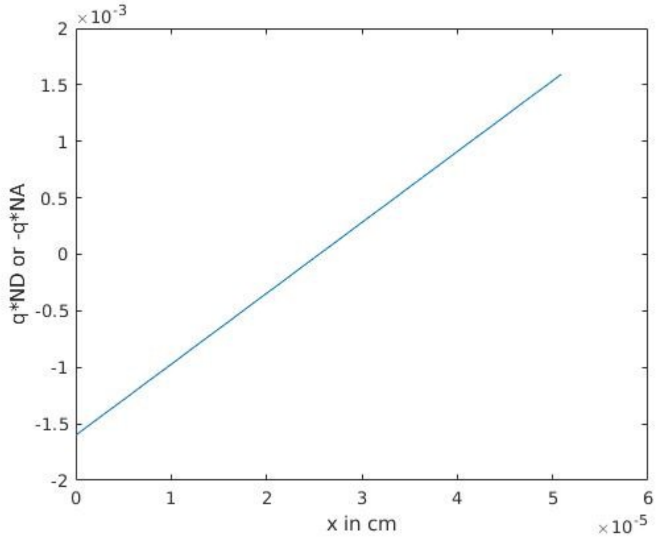


Using central difference discretization scheme, solved the Poisson equation with depletion approximation. We see that we get the correct built in potential. LU decomposition matrices obtained were nearly equal from numerical and MATLAB methods

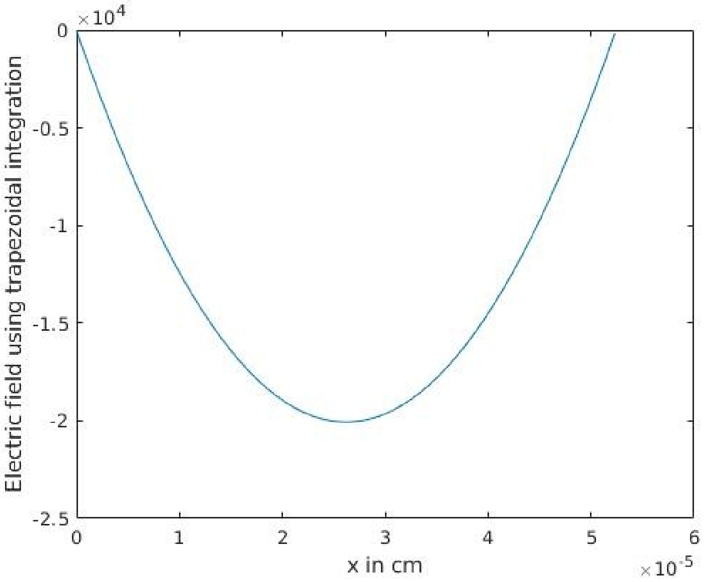
Q1. LINEAR

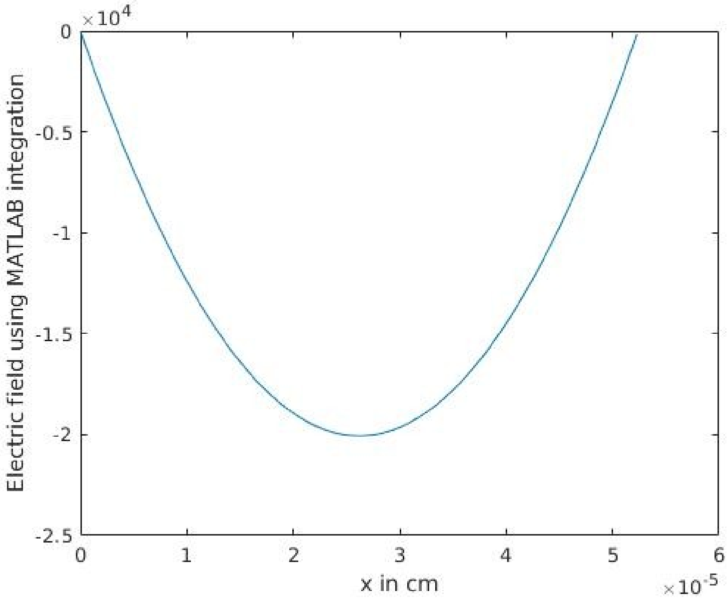
$x_n = ((3*e_S/(q*(N_A+N_D)))*(2*k*T/q)*\ln(0.5*(N_A+N_D)/n_i))^{0.5}$ for a linear graded system.
Using the parameters as used in abrupt, we obtain
$x_P = x_N = 262$ nm

roh is as follows:



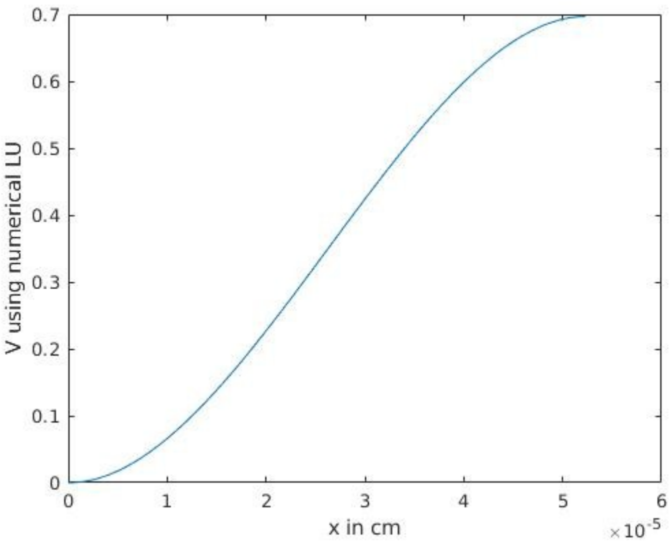
Q1a)

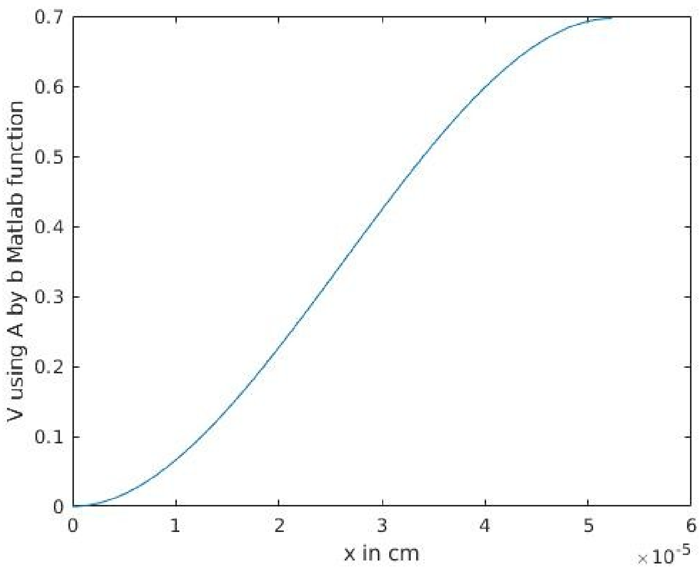




Numerical and MATLAB integration work similarly.

Q1b)





Using central difference discretization scheme, solved the Poisson equation with depletion approximation. LU decomposition matrices obtained were nearly equal from numerical and MATLAB methods.
The built in potential is given as

$$= 2\, V_t \ln\left[\frac{a x_n}{n_i}\right]$$

where $V_T = k_B T/q$ and $a = (N_D + N_A)/(x_n+x_p) = N_D/x_n$ due to symmetry resulting in the same built in potential as the abrupt case.

Q2. Doping concentrations $N_D = 10^{16}$ cm $^{-3}$, $N_A = 2*10^{15}$ cm $^{-3}$. Used Newton Raphson method to solve the charge neutrality equation for finding the fermi energy E_F.

Taking $E_V = 0$; $E_D = E_C - 0.045$ eV; $E_A = E_V + 0.045$eV at 300K
and solving the equation, we obtain $E_F = 0.8895$ eV