Computational Microelectronics HW.5

EECS, 20204003

Phil-Hun, Ahn

1. Double Gate FET

1) Numerical Expression

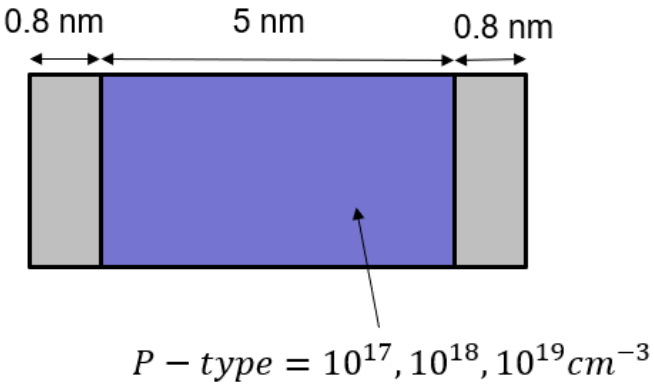

Fig. 1 Double Gate FET

$$\mathbf{A}=\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \epsilon_1 & -2\epsilon_1 & \epsilon_1 & 0 & 0 \\ 0 & \epsilon_1 & -\epsilon_2-\epsilon_1 & \epsilon_2 & 0 \\ 0 & 0 & \epsilon_2 & -2\epsilon_2 & \epsilon_2 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix},$$

$$\mathrm{b(ii,1)}=(\Delta x)^2\ \frac{\mathrm{qN_{accpetor}}}{\epsilon_0} \quad \text{(on Silicon region)}$$

$$\mathrm{b(ii,1)}=(\Delta x)^2\ \frac{\mathrm{qN_{accpetor}}}{2\epsilon_0} \quad \text{(on Interface region)}$$

$$\mathrm{b(ii,1)}=0 \quad \text{(on Oxide)}$$

HW5 is similar to HW4 which the differences are that there are two interfaces and existence of charges which should be considered.

For Silicon oxide, 3.9 is used for relative permittivity. For Silicon, 11.7 is used for relative permittivity.

By solving Ax=b equation, electrostatic potential is given.

2) Analytic expression

Analytic solution of potential should be obtained to compare with numerical solution.

$$\phi(t_{ox}) = -\frac{3t_{ox}qN_{acceptor}t_{si}}{2\varepsilon_{si}} \quad (at\ interface)$$

$$\phi(x) = \frac{\phi(t_{ox})}{t_{ox}}x \quad (at \quad Oxide1)$$

$$\phi(x) = \frac{qN_{acceptor}}{2\varepsilon_{si}}(x - t_{ox})(x - t_{ox} - t_{si}) + \phi(t_{ox}) \quad (at\ interface2)$$

$$\phi(x) = -\frac{\varphi(t_{ox})}{t_{ox}}(x - 2t_{ox} - t_{si}) \quad (at \quad Oxide2)$$

3) Results

a) Electrostatic Potential ($N_a = 10^{17}\ cm^{-3}$)

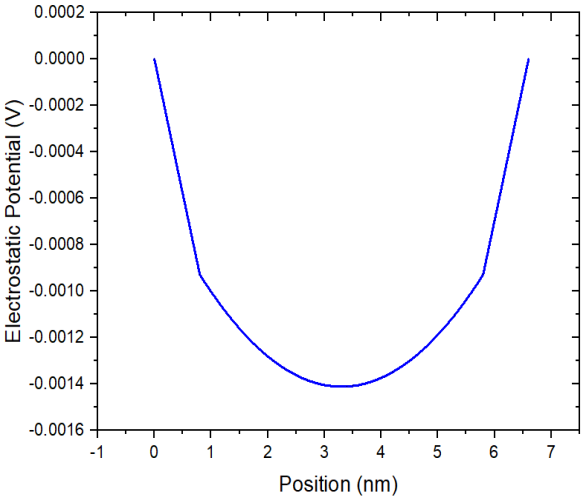

Fig 2. Position vs. Potential graph which is solved numerically.

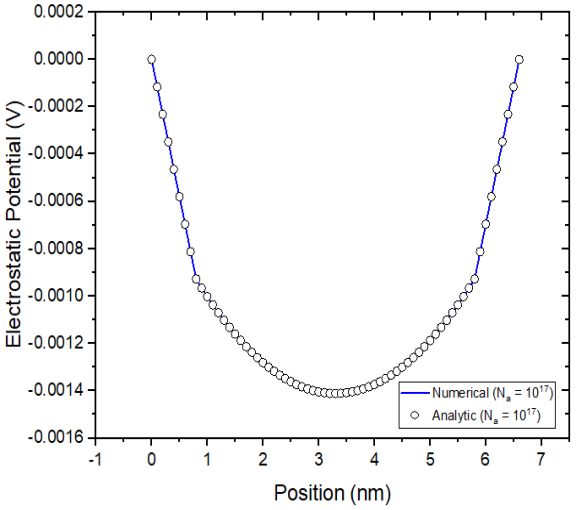

Fig 3. Analytic solution and numerical solution are compared in this figure.

b) Electrostatic Potential ($N_a = 10^{18}\ cm^{-3}$)

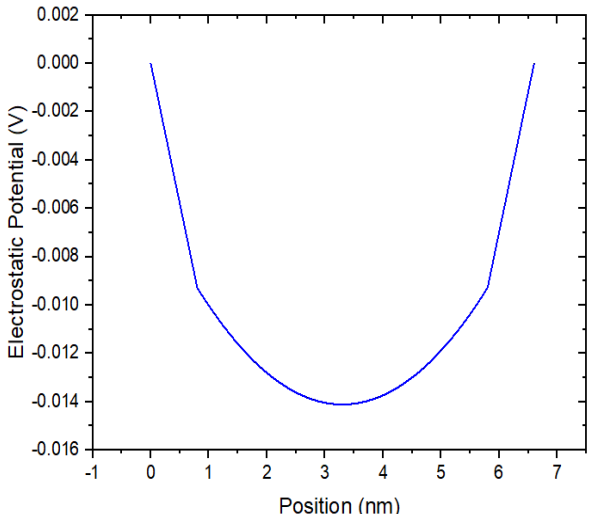

Fig 4. Position vs. Potential graph which is solved numerically.

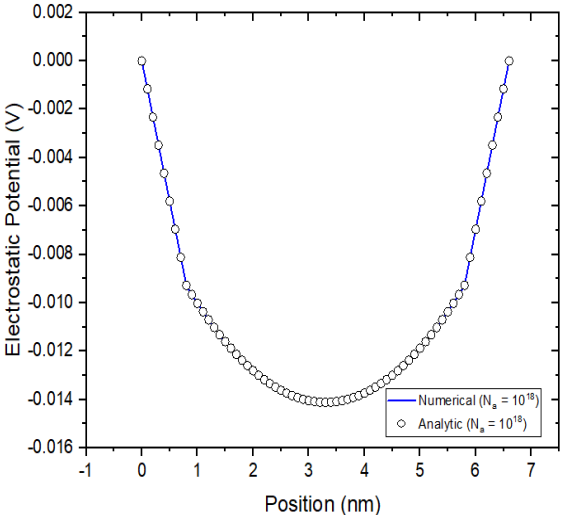

Fig 5. Analytic solution and numerical solution are compared in this figure.

c) Electrostatic Potential ($N_a = 10^{19}\,cm^{-3}$)

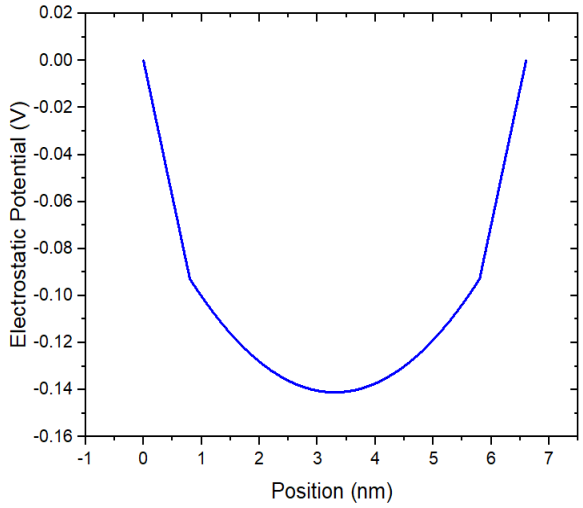

Fig 6. Analytic solution and numerical solution are compared in this figure.

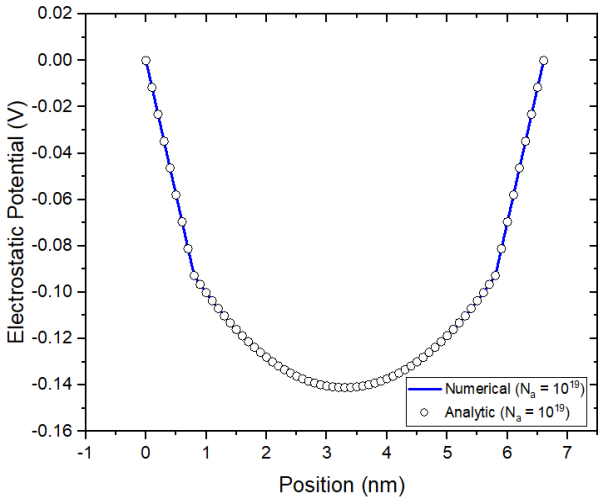

Fig 7. Analytic solution and numerical solution are compared in this figure.

The numerically solved results are consistent with analytically solved results as represented in figures .