Homework #5

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1. Calculate the electrostatic potential, φ, by using Newton method and compare the electrostatic potential with the solution obtained by analytical method.

$$N^+ + n_{int}e^{-\varphi/V_T} - n_{int}e^{\frac{\varphi}{V_T}} = 0$$

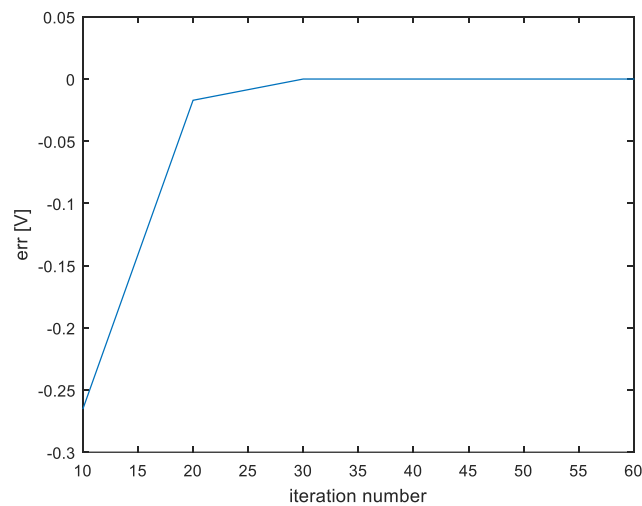| Parameters	Values	
	Acceptor	Donor
N^+ [cm^{-3}]	-10^{18}~-10^{10}	10^{10}~10^{18}
n$_{int}$ [cm^{-3}]	10^{10}	
Initial value of potential [V]	-1	1
Iteration number	60	

Figure 1. Difference between numerical and analytic solution as a function of iteration number.

Iteration number should be larger than 40 times because of correction error. In this calculation, iteration number is 60 times. (Figure 1)
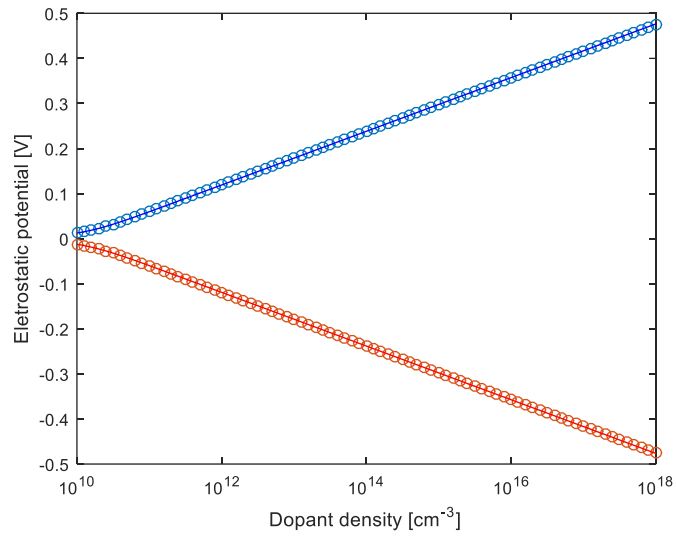
Figure 2. Blue symbol (line) indicate the solution by using numerical (analytic) method when donor uses as a dopant, while red symbol indicate the solution when Acceptor uses as a dopant.

In both case, electrical potential increases as dopant density increases.
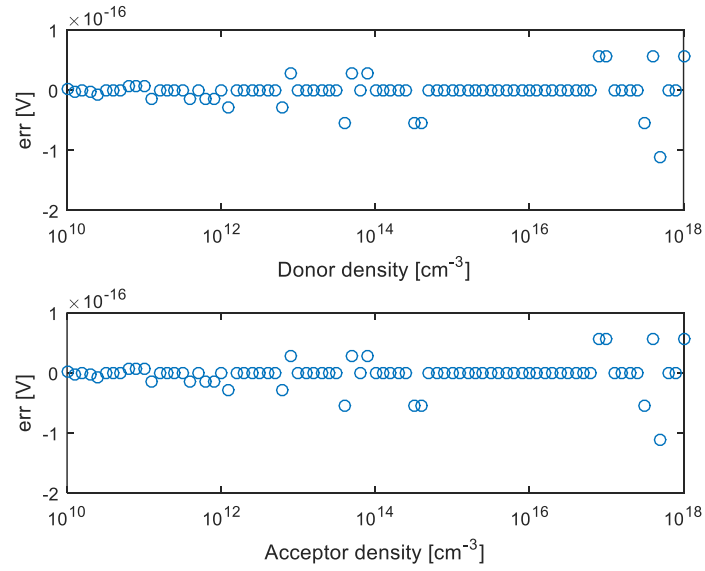

Figure 3. Difference between numerical solution and analytic solution as a function of dopant density.
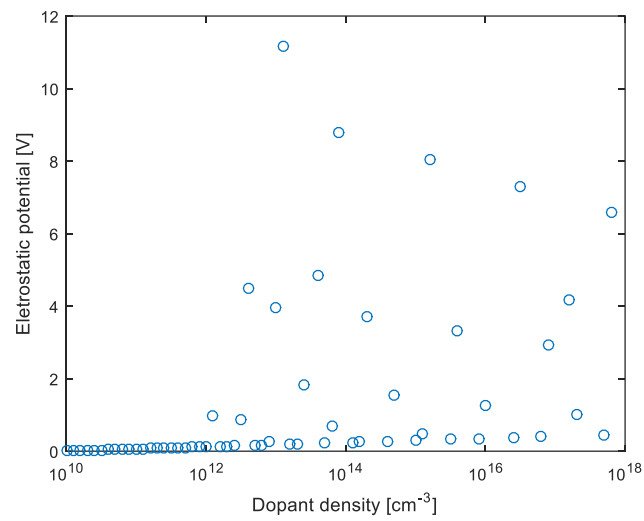
Supplementary

Figure S 1. Numerical solution of electrostatic potential when initial value is -1 (Donor)

If the initial value is not set to an appropriate value, the potential value could be divergent.