Numerical calculation of Capacitance

Assignment #4

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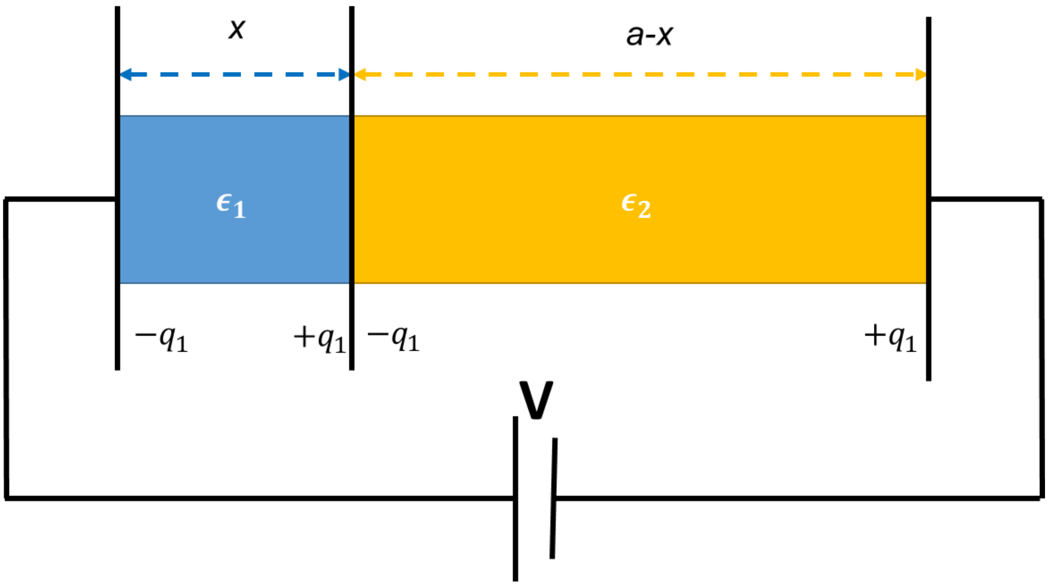

Figure 1 Schematic image for capacitor with 2 different dielectric materials

Analytic solution for capacitance:

$$C_1 = \frac{\epsilon_1 \epsilon_0}{x}; capacitance\ \ per\ \ area\ \ of\ \ material\ \ 1$$

$$\frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2}\ \ ;\text{total capacitance for series capacitor}$$

$$C_{tot} = \frac{\epsilon_1 \epsilon_2 \epsilon_0}{\epsilon_1 (a - x) + \epsilon_2 x}$$

Where ϵ_0 is permittivity of vacuum, $\epsilon_1 \& \epsilon_2$ is relative permittivity of each material, *x* is the thickness of material 1 and a is the total material. The analytic solution is $4.126 \times 10^{-6} F/cm^2$

Numerical solution:

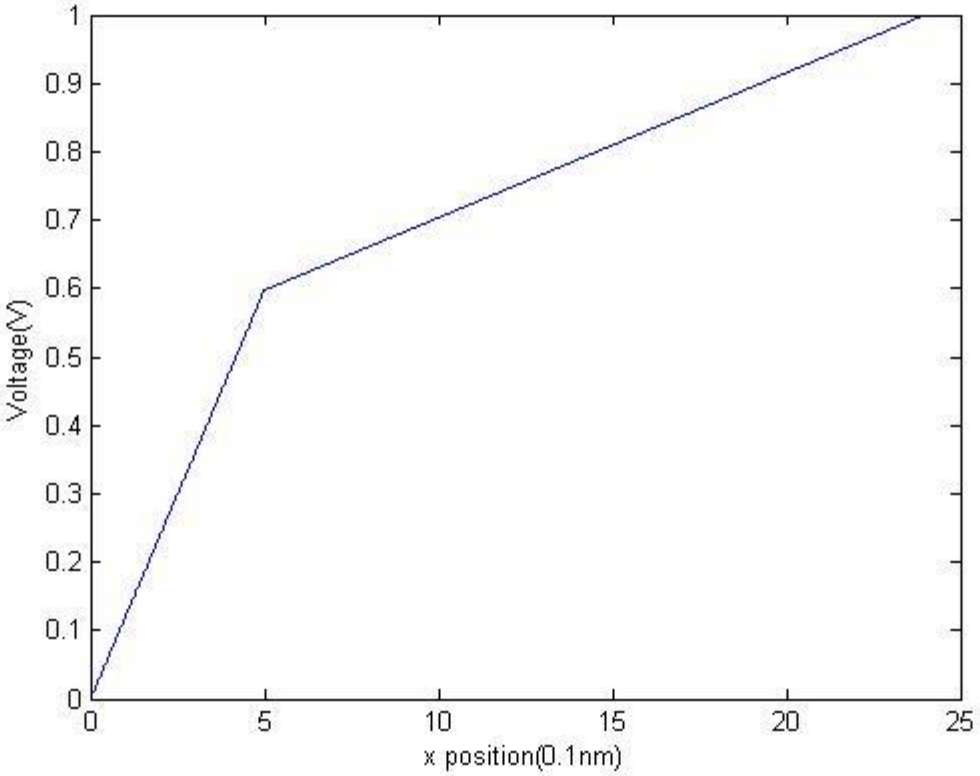

Figure 2 Voltage-Position graph for N = 2400 case.

In the numerical calculation, the voltage difference is used for calculation of capacitance. Because of the charge conservation law, the total capacitance can be calculated as follows:

$$q = C_{tot}V_{tot} = C_1V_1$$

We know the C_1 by easy calculation, and V_1 from the voltage of contact between two materials. From that calculation we can get the results.

N	24	240	2400
Capacitance per unit area($\mu F/cm^2$)	4.082	4.123	4.126
Error (%)	1.07	0.073	0