

Laplace and Poisson's equations

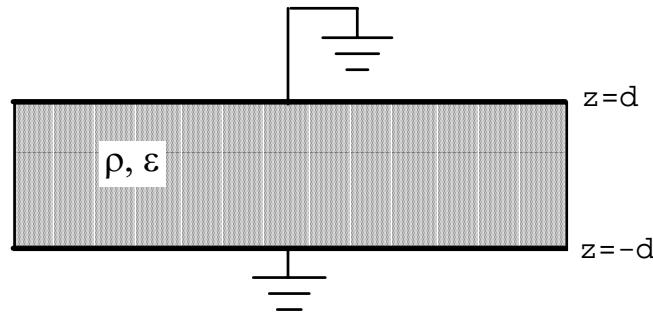
Reading assignment

Ulaby, 4-5.5

Connor and Salon, II-35 → II-39, V-1 → V-7 and V-27 → V-33

Problem 1 (option 1) - analytical solution to Poisson's equation

A charged region of a semiconductor is sandwiched between two grounded conductors as shown below.



- Solve for $V(z)$ by directly integrating Poisson's equation, $\nabla^2 V = -\rho/\epsilon$, and applying the appropriate boundary conditions.
- Find $\mathbf{E}(z)$ and $\mathbf{D}(z)$.
- What is ρ_s on the two conductors?

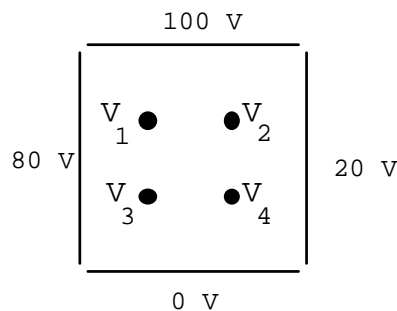
Problem 1 (option 2) - analytical solution to Laplace's equation

A coaxial cable has an inner conductor (at $r = a$) held at voltage V_0 and an outer conductor (at $r = b$) that is grounded. There is no charge other than the surface charge on the conductors.

- Solve for $V(r)$ by directly integrating Laplace's equation, $\nabla^2 V = 0$, and applying the appropriate boundary conditions.
- Find $\mathbf{E}(r)$ and $\mathbf{D}(r)$.
- What is ρ_s on the two conductors?
- What is the capacitance per unit length of the cable?

Problem 2 - finite difference solution to Laplace's equation

Find the voltage at the 4 points below.



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Problem 3 - Use of spreadsheet to solve Laplace's equation

- Use a finite difference calculation on a spreadsheet to solve for the voltage everywhere in the configuration on the left below. The drawing illustrates the cross-section. Assume this figure extends out of the page for a long distance.
- Sketch or plot the equipotentials and electric field lines.
- Find the charge density on the conductor at point P (0,1.5).
- Find the total charge per unit length on the outer and inner conductors.
- Determine the capacitance per unit length between the 2 conductors.

