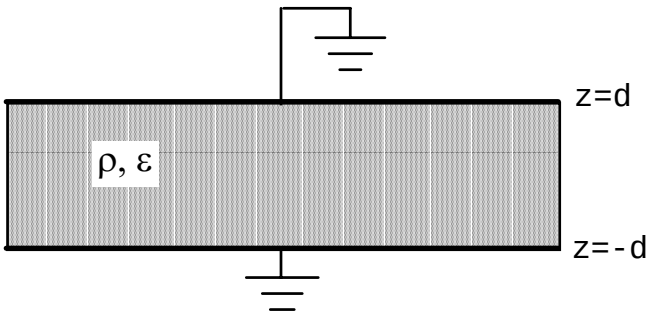
Laplace and Poisson's equations

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.

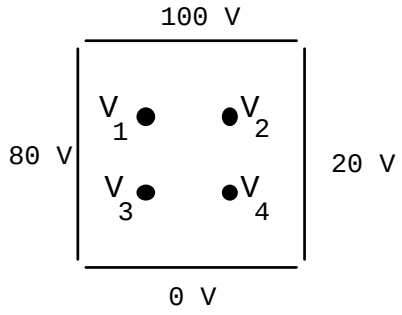


a. Solve for V(z) by directly integrating Poisson's equation, $\nabla^2 V = -\rho/\varepsilon$, and applying the appropriate boundary conditions.
b. Find **E**(z) and **D**(z).
c. What is ρ_s on the two conductors?

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.

a. Solve for V(r) by directly integrating Laplace's equation, $\nabla^2 V = 0$, and applying the appropriate boundary conditions.
b. Find **E**(r) and **D**(r).
c. What is ρ_s on the two conductors?
d. 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.



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

a. 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.

b. Sketch or plot the equipotentials and electric field lines.

c. Find the charge density on the conductor at point P (0,1.5).

d. Find the total charge per unit length on the outer and inner conductors.

e. Determine the capacitance per unit length between the 2 conductors.