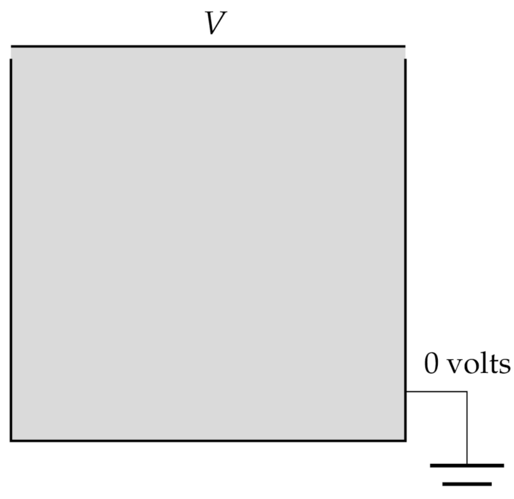
Spring 2021
PHYS 377 Advanced Computational Physics
HW # 6b

<u>Problem 1:</u> Simple electrostatics problem

An empty box has conducting walls, all of which are grounded at 0 volts except for the wall at the top, which is at some other voltage V. The small gaps between the top wall and the others show that they are insulated from one another. Assume that these gaps have negligible width.

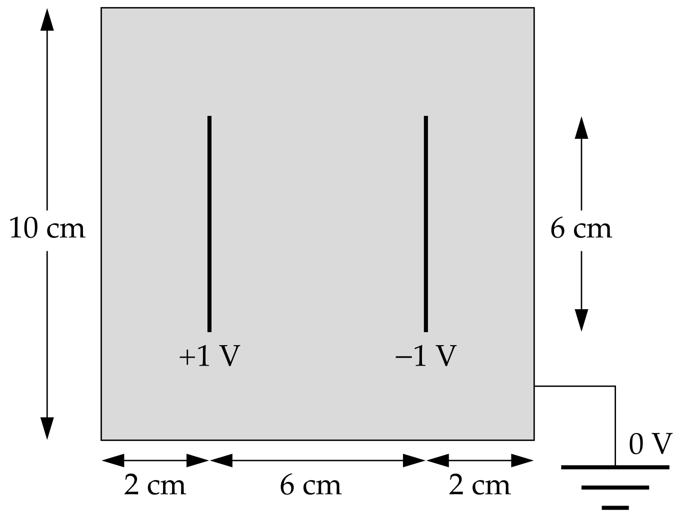


For the two-dimensional case, solve the ***Laplace's equation*** for the electrostatic potential ϕ, subject to boundary conditions that $\phi = V$ on the top wall and $\phi = 0$ on the other walls. **The framework is described in the lecture**.

Write a Program that implements the combined overrelaxation/**Gauss–Seidel method** to solve ***Laplace's equation*** for the two-dimensional problem (**similar to HW Problem 6a-1**)—a square box 1 m on each side, at voltage $V = 1$ volt along the top wall and zero volts along the other three. Use a grid of spacing $a = 1$ cm, so that there are 100 grid points along each wall, or 101 if you count the points at both ends. Continue the iteration of the method until the value of the electric potential changes by no more than $\delta = 10^{-6}$ V at any grid point on any step, then make a density plot of the final solution. Experiment with different values of ω to find which value gives the fastest solution. In general, larger values cause the calculation to run faster, but if you choose too large a value the speed drops off and for values above 1 the calculation becomes unstable.

<u>Problem 2:</u> Electronic capacitor

Consider the following simple model of an electronic capacitor, consisting of two flat metal plates enclosed in a square metal box:



For simplicity let us model the system in two dimensions. Using ***any of the methods*** we have studied, **write a program** to calculate the **electrostatic potential** in the box on a grid of 100×100 points, where the walls of the box are at voltage zero and the two plates (which are of negligible thickness) are at voltages ± 1 V as shown. Have your **program calculate** the value of the potential at each grid point to a precision of 10^{-6} volts and then **make a density plot** of the result.

<u>Hint:</u> Notice that the capacitor plates are at fixed *voltage*, not fixed charge, so this problem differs from the problem with the two charges in the previous HW problem. In effect, the capacitor plates are part of the boundary condition in this case: they behave the same way as the walls of the box, with potentials that are fixed at a certain value and cannot change.