PHYS 3142 Sping 2019
Computational Methods in Physics
Assignment 6
Due: 29th April 2019

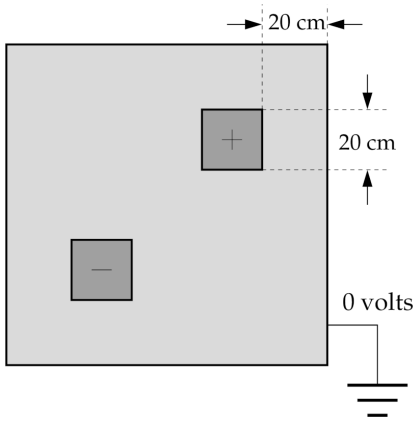
Before you submit your assignment, do remember:

1. the due day
2. submit a report which contains your figures and results
3. make sure your code can run
4. do not upload a compressed file(e.g. rar, zip, ...)

1. Write a program using the Jacobi method to solve Poisson's equation

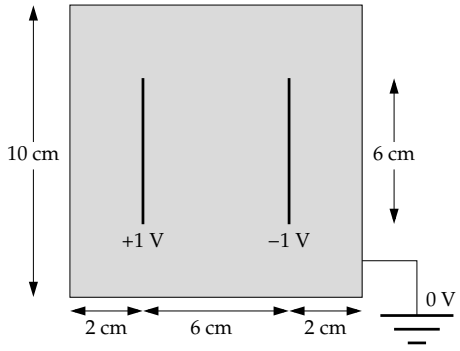
$$\nabla^2\phi = -\frac{\rho}{\epsilon_0}$$

which governs the electric potential in the presence of a charge density ρ. Here ϵ_0 is the permittivity of empty space. We consider a 2-dimensional problem in a square box 1 meter along each side. All the boundaries are kept at 0V, but there will be two square charges in the box, one positive, one negative, as depicted in the figure. The charges are each 20cm on a side and 20cm from the walls of the box and have charge density $\pm 1 C m^{-2}$.



Work in units where $\epsilon_0 = 1$ and continue the iteration until your solution for the electric potential changes by less than 10^{-6} V per step at every grid point. (Hint: Part of the program is shown in the lecture note lect 16-17.pdf)

2. 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 the Gauss-Seidel 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. (The code to make a density plot is shown in the lecture note lect 16-17.pdf)

Hint:

1. Notice that the capacitor plates are at fixed *voltage*, not fixed charge, so 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.

2. The program will take few minutes to get the result converges with high precision. You should start with a low precision (e.g. 10^{-1}) to make sure your program can be converged before increasing the precision.