Homework #5
Computational Physics
Fall 2019
Due Tuesday, November 26, at 5pm

1. Exercise 9.7 from Newman

2. You will use the relaxation method to solve for the potential of a series of charged particles. In the github under HOMEWORK5 there is a datafile names “particles.dat.” Inside this datafile is a set of (x,y) coordinates for a series of charged particles, all with charge equal to the electron charge. The range of coordinates is [0,100]. As with example 9.2 in Newman, these particles are placed in a box that is grounded on all 4 sides.

(a) Using the cloud-in-cell technique, assign the charges to a two-dimensional grid of size [0,M] per side, with M=100. The centers of each grid cell (i,j) is (i+0.5,j+0.5). Produce an image of the charge density field.

(b) Use standard relaxation method to solve for Poisson’s equation. Produce an image showing the resulting potential field. Note the number of iterations it takes to converge. Use the same convergence criterion as the example in Newman, such that the maximum difference for any cell in the grid between the current and prior step is 1.0E-10.

(c) Now use the Guass-Seidel overrelaxation method to solve for Poisson’s equation. Determine the optimal value of the overrelaxation parameter ω, using one of the techniques discussed in class and in the chapter on nonlinear equations. Golden ratio search is a good example. Find the optimal value of ω to a precision of 0.001. Produce a plot showing how your answer for ω evolves with each step in your minimization process.

Just a reminder that the equation you are solving for is:

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