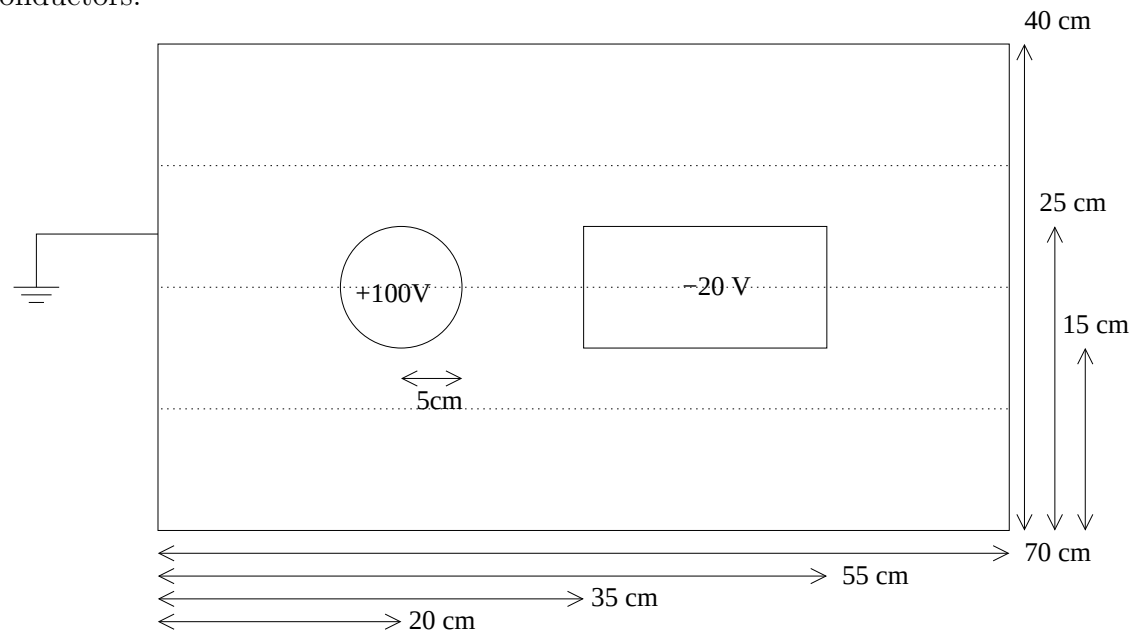
EE 333 Electricity and Magnetism, Fall 2009
Homework #10 Assignment

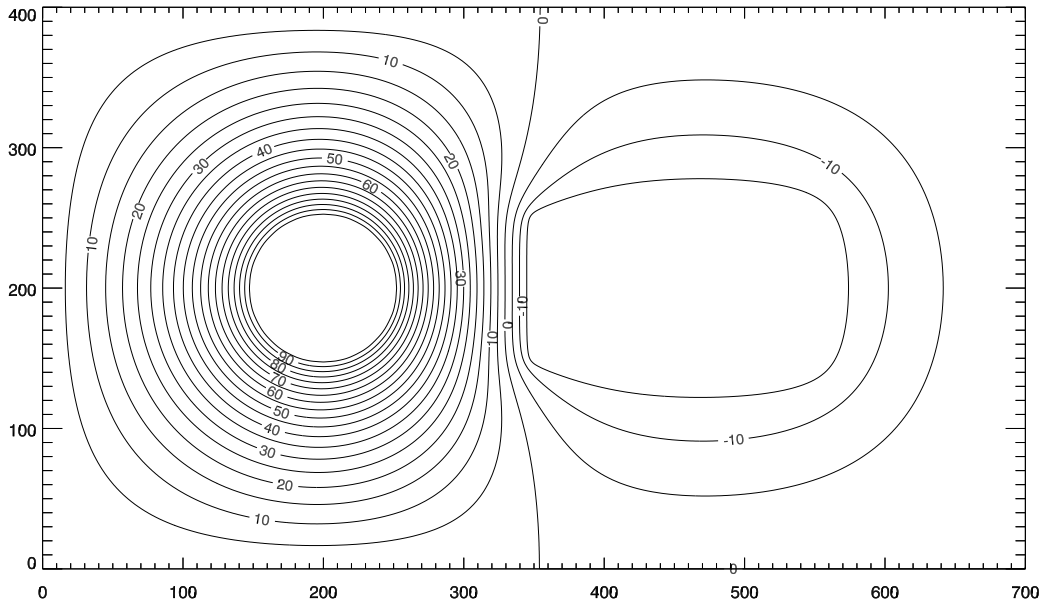
In this problem you will solve the Laplace equation numerically for the following configuration of conductors:



The configuration consists of a grounded shield surrounding a hollow space which contains a rectangular solid conductor at potential $-20\,\mathrm{V}$, and a circular solid conductor at potential $100\,\mathrm{V}$. You are to find the potential everywhere else.

I recommend using a grid of 701 points in the horizontal axis (thus one point every millimeter), and 401 points in the vertical axis (again one point every millimeter). Further I suggest you make two arrays. The first array will contain the potential, and the second array will be a marker array of the same size which contains a value (for example 1) for boundary conditions (i.e. values that should no be changed), and another value (for example 0) for free space. Initialize the non-boundary array elements to zero potential and apply the relaxation algorithm.

Continue iterating until the solution is "good enough", or until you have complete a very large number of iterations. Good enough might be that the largest changes in the array during an iteration is $0.01\,\mathrm{V}$, whereas a large number iterations might be 10^4. I wrote a program in C to solve this problem and it completed 10^4 iterations in 113 seconds. Here is a contour plot of the potential pattern which my program computed:



Your assignment is as follows:

1. Write a program to replicate this result by programming the relaxation algorithm in any language you choose.

2. Make a contour plot of the potential similar to the one I show above.

3. Plot the X (horizontal to the right), and Y (vertical up) components of the electric field as a function of position along the three dotted curves. Use separate plots as appropriate to avoid clutter, and be sure to label the axis correctly. The three dotted lines are at vertical locations 10, 20, and 30 cm from the bottom.

4. Turn in the program and the plots.

If you do all this correctly, and repeat the above for a different and interesting pattern of conductors I will double your grade on this homework problem. However, you will not receive extra credit if your results for the given problem are incorrect.