

# Lab 3

<https://support.soe.ucsc.edu/matlab-self-serve-installation>

## Introduction

The main goal of lab3 is to reproduce the results of lab2 using the MATLAB simulation tool. We will use the PDE tool box to numerically solve Laplace equation  $\nabla^2 V = 0$ , and the equation for the potential  $V(x, y)$  is in a two-dimensional region.

## Part1: coaxial line

1. Type **pdetool** in command line to enter into pde toolbox

### 2. Geometry Definition

2.1 Set both  $x$ - and  $y$ -axis limits to  $[-1.5 \ 1.5]$ . To do this, select **Options > Axes Limits** and set the corresponding ranges. Then select **Options > Axes Equal**.

2.2 Draw the following two circles. The radius of inner circle is 0.1 and the outer one is 1. Label them as cir1 and cir2 respectively.

2.3 Model the frame by entering cir2-cir1 in the **Set formula** field.

### 3. Supported PDEs - Choose Physics Field and Boundary Conditions

3.1 Set the application mode to **Electrostatics**.

3.2 Specify the boundary conditions. To do this, switch to the boundary mode by selecting **Boundary > Boundary Mode**. Select the specific boundary and Then go to **Boundary > Specify Boundary Conditions** to specify corresponding boundary condition. Or use **Shift + click** to select multiple boundaries at a time and double click these boundaries to specify boundary condition.

3.3 For the inner boundaries, use the Dirichlet boundary condition with  $h = 1$  and  $r = 10$ . For the outer boundaries, use the Dirichlet boundary condition with  $h = 1$  and  $r = 0$ . ( $r$  is the voltage which is applied onto the edge)

3.4 Specify the coefficients by selecting **PDE > PDE Specification** or clicking the **PDE** button on the toolbar. Specify  $\epsilon = 1$  and  $\rho = 0$ . ( $\rho$  is space charge density. Here there is no charge between these two edges.)

### 4. Meshing and Solution

4.1 Initialize the mesh by selecting **Mesh > Initialize Mesh**.

4.2 If you want to solve the PDE with finer mesh, go to select **Mesh > Refine Mesh**.

4.3 Solve the PDE by selecting **Solve > Solve PDE** or clicking the = button on the toolbar.

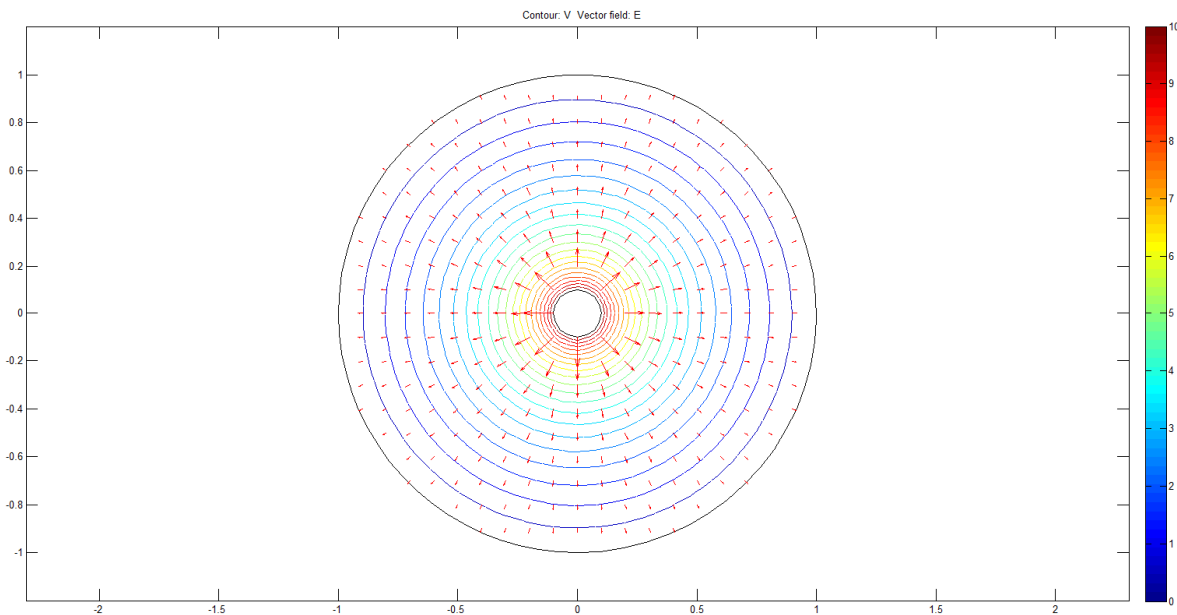
## 5. Postprocess

5.1 Plot the equipotential lines using a contour plot. To do this, select **Plot > Parameters** and uncheck **Color** and choose the **contour** plot in the resulting dialog box.

5.2 To display equipotential lines at every 1 volt, select **Plot > Parameters** and enter 10 in the **Contour plot levels** field.

5.3 To display electric field, check **Arrows** and choose electric field in the resulting dialog box.

5.4 Go to **Colormap** to change colormap and choose **jet**.

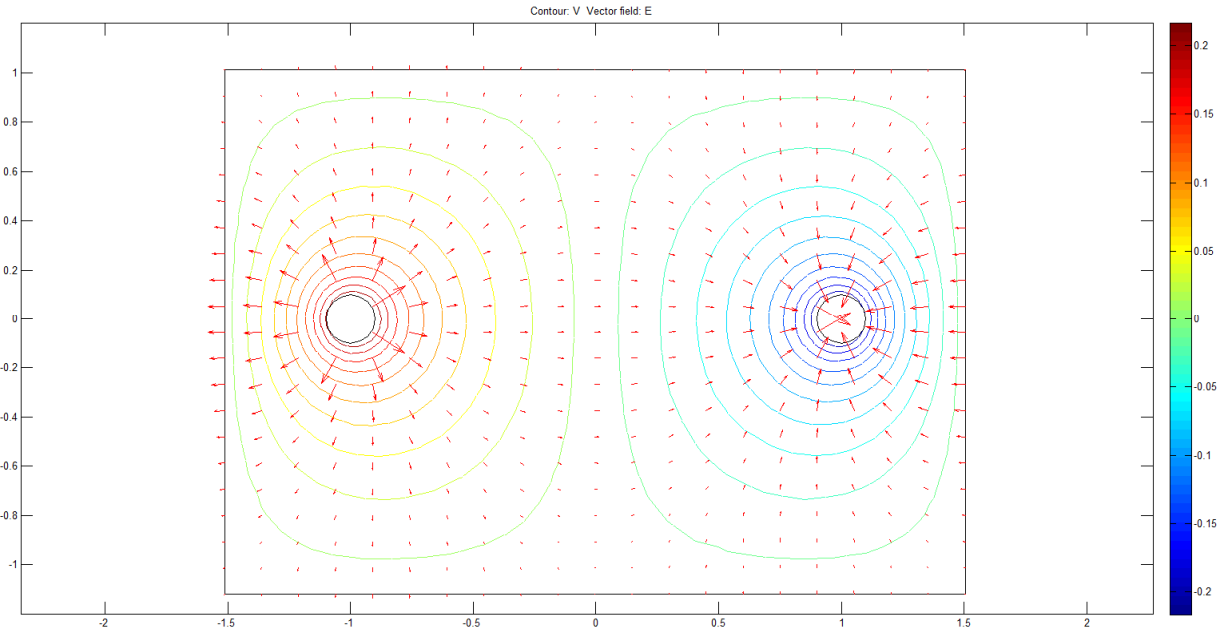


## Part2: dipole

Hints:

Set the outer rectangle to Dirichlet boundary which  $V = 0$ .

Set the left inner circle to Neumann boundary which  $g = 1$  and right circle to  $g = -1$ . Here  $g$  represents how many positive charges are on the selected surface.



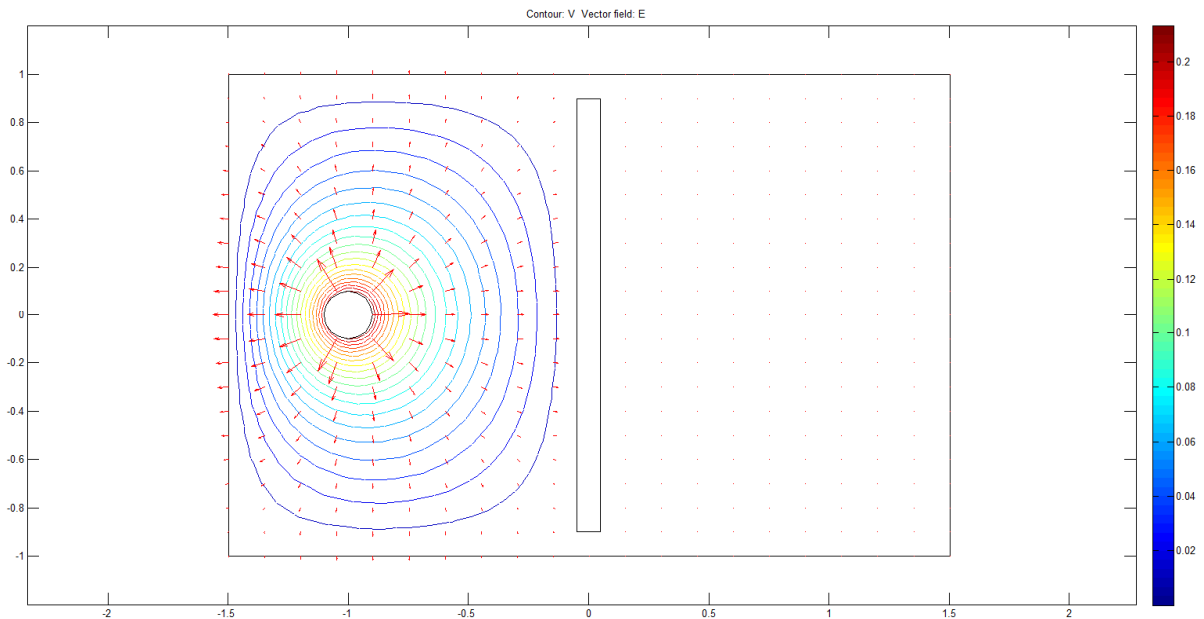
### Part3: image method

Hints:

Set the outer rectangle to Dirichlet boundary which  $V = 0$ .

Set the left inner circle to Neumann boundary which  $g = 1$ ,

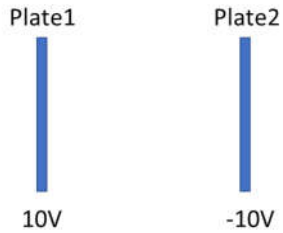
Set the conducting plane to Dirichlet boundary which  $V = 0$ .



Things to turn in:

Please specify which boundary you use for the corresponding surface or edge.

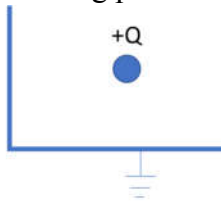
1. Parallel plates. Plate1 is maintained at 10V and Plate2 is fixed at -10V and distance  $d = 3$ .



2. Two positively charged circles and distance  $d = 2$ .



3. One positively charged circles is located at  $d=1.5$  from two grounded perpendicular conducting plane.



4. Use image method (image charges) to simulate electric field in case3 and the conducting planes are removed. (hint: Four charged circles system)