Assignment 2

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Question 1

Adam Langevin 100935879.

a) At 80 points for the total length, with the boundary conditions V=V0 at x=0, and V = 0 at x=L, with the sides being isolated.

b) The case for V=V0 at x=0 and x=L wuth a density of 100 points per unit lenght, the V(x) plot of the voltage as a function of position is in figure 3 and 4.

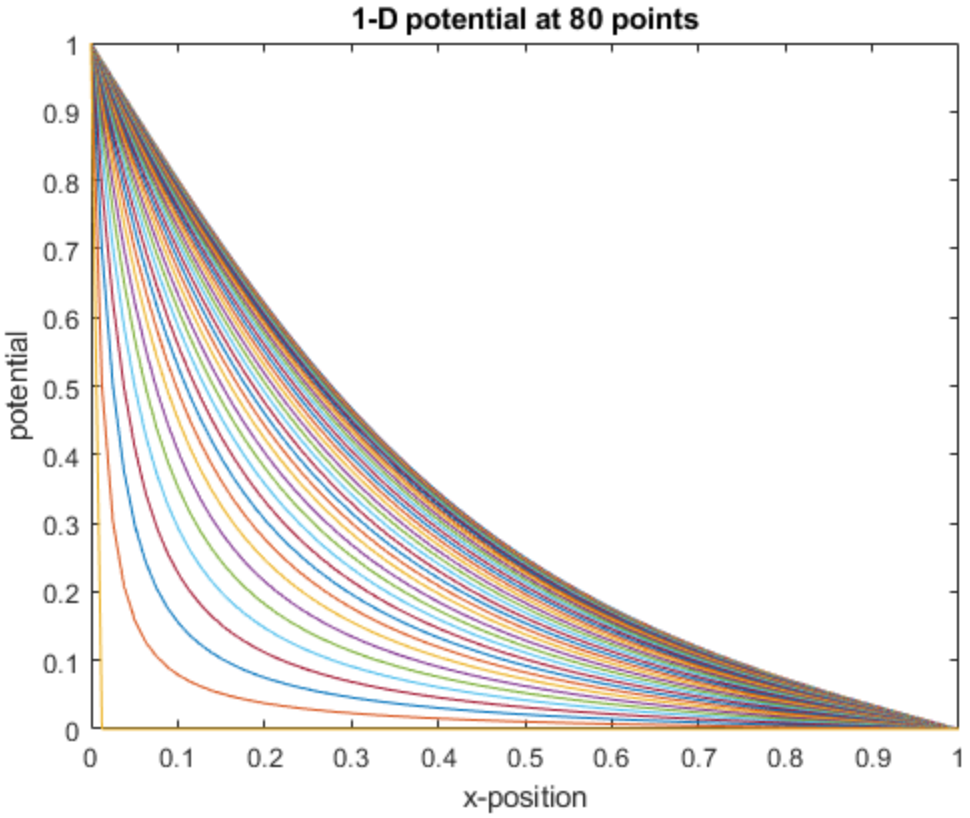
The size of the meshing of the area shows more detail of the area as the number of points calcualted increasses, but the time needed to calculate it increases at a much faster rate when in two dimensions than when in one. Depending on the problem the mesh size only shows so much, and adding more points doesnt add more information.

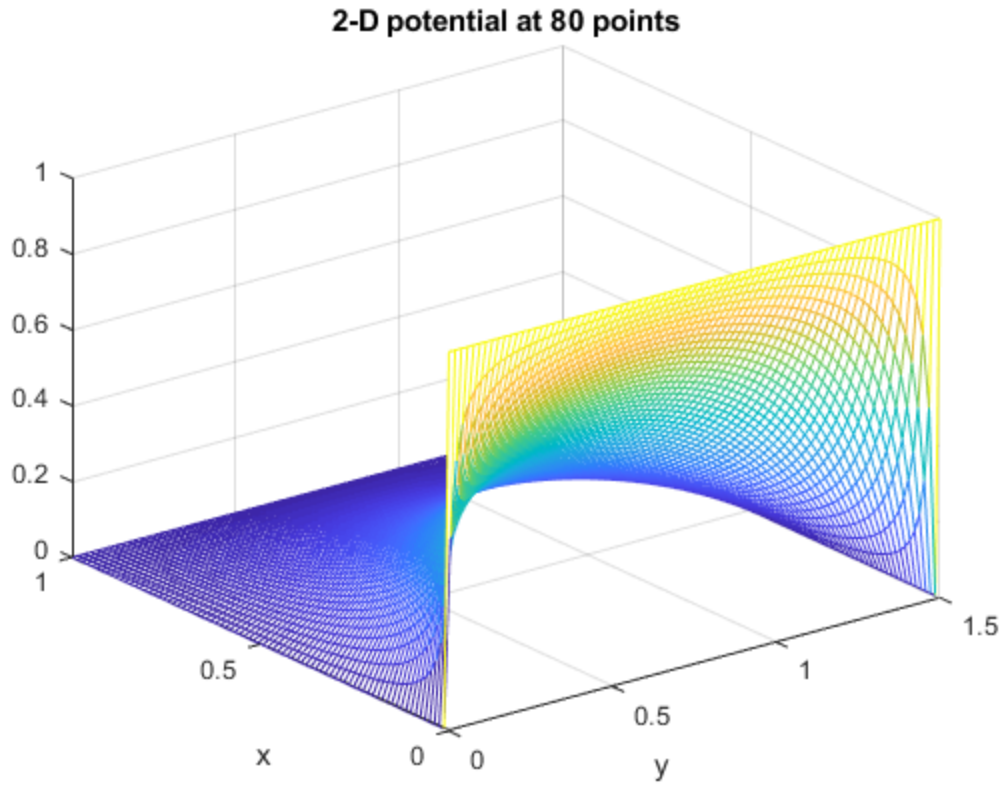
The analytical solution provides some insight on the interior of the feild, and shows the general shape. Around the sides where the boundary conditions are the functional solution we have created shows better information on how the structure behaves.

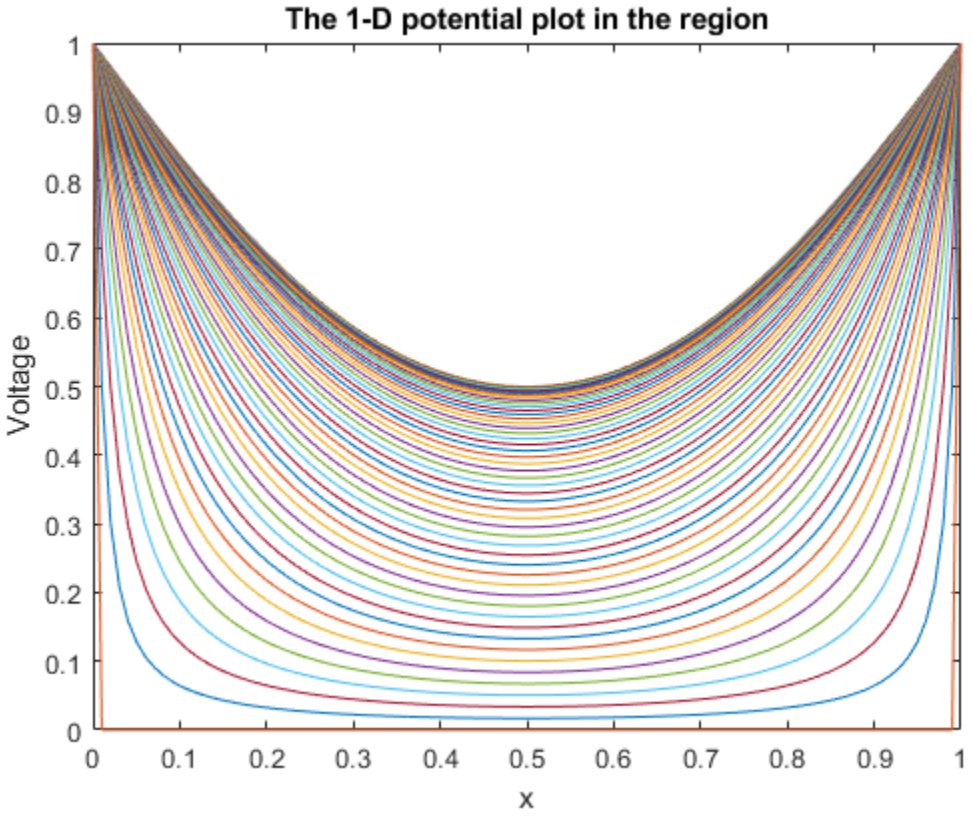
Question 1 code

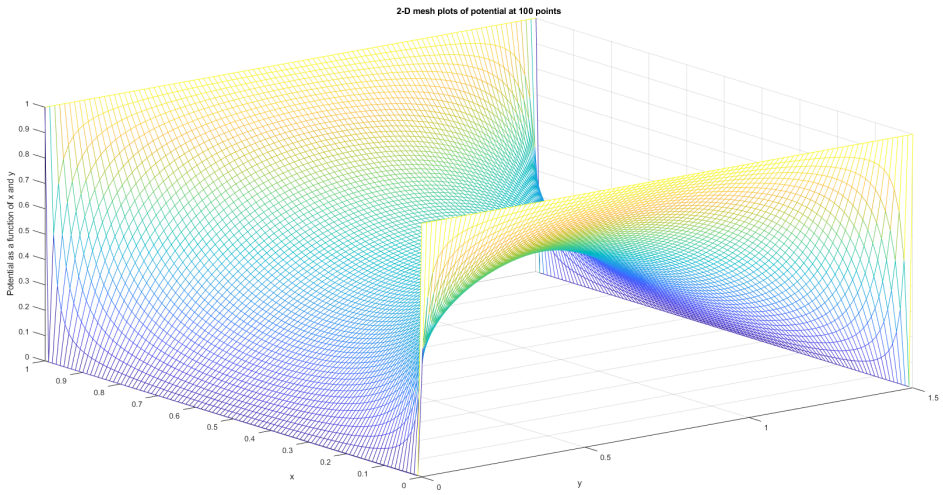
```
global x y V2;

figure(1)
voltageFeild(80,80,1,0);
plot(x,V2);
title('1-D potential at 80 points');
xlabel('x-position');
ylabel('potential');

% The complimentary surface plot for the same mesh size is,
figure(2)
mesh(y, x, V2);
title('2-D potential at 80 points');
xlabel('y');
ylabel('x');

figure(3);
```

```
voltageFeild(100,100,1,1);
plot(x,V2);
title('The 1-D potential plot in the region');
xlabel('x');
ylabel('Voltage');

% The meshed voltage in the x and y directions.
figure(4);
mesh(y,x,V2);
title(['2-D mesh plots of potential at ', num2str(100), ' points']);
xlabel('y');
ylabel('x');
zlabel('Potential as a function of x and y');
```




2-D potential at 80 points
1
0.8
0.6
0.4
0.2
0
1
0.5
x
0
0
0.5
1
1.5
y


The 1-D potential plot in the region
Voltage
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
x



Question 2

a) The Voltage feild V(x,y), the conductivity map, the electric feild, and the curent densisty map are in figures 5-10 respecivly.

b) calculating the density of the meshingvs the current density passing through each end of the feild. By increasing the amount of points per unit the details showed more, creating sharper peaks. The plot of mesh density vs current the current generally increases.

c) Changing only the width of the bottle neck did not significantly change the current through the feild. By turing on the extras, figure 22 would show that the current density around the ends of the bottle neck would be different, but the current it's self would not change.

d) To investigate the changing of the current while the value of the conductivity inside the bottle neck "boxes" changes I used a log scale to change the conductivity from very low values of 0.01 to 10. The resulting graph, figure 30, shows a steady average value around 6.75 fA of current was formed through the material, with rough general increasing trend.

Question 2 Code

```
% to plot each graph set extras to 1.
% a)
extras = 0;
global Ex Ey Jx Jy C;
voltageFeild2(100,100,1,40,30,0.01,1);

figure(5);
mesh(x,y,V2);
title('Potential in a plane');
xlabel('x');
ylabel('Y');
zlabel('Potential');
```

```
figure(6);
mesh(x,y,C);
title('Conductivity Map');
xlabel('x');
ylabel('Y');
zlabel('Conductivity');

figure(7);
mesh(x,y,Ex);
title('Electric feild in the X direction');
xlabel('x');
ylabel('Y');
zlabel('Electrical Potential Energy');

figure(8);
mesh(x,y,Ey);
title('Electric feild in the Y direction');
xlabel('x');
ylabel('Y');
zlabel('Electrical Potential Energy');

figure(9);
quiver(x,y,Ex',Ey');
title('Electric feild in the region');
xlabel('x');
ylabel('Y');

figure(10);
quiver(x,y,Jx',Jy');
title('Current Density in the region');
xlabel('x');
ylabel('Y');

% b)
X = [10 20 30 40 50 75 100 200];
Currents = zeros(length(X),1);

for i = 1:length(X)
   voltageFeild2(X(i), X(i), 1, 0.2*X(i), 0.2*X(i), 0.01, 1);

   if extras
       figure(11);
       subplot(4,4,i);
       mesh(x,y,V2);
       title('Potential in a plane');
       xlabel('x');
       ylabel('Y');
       zlabel('Potential');

       figure(12);
       subplot(3,3,i);
       mesh(x,y,C);
       title('Conductivity Map');
       xlabel('x');
```

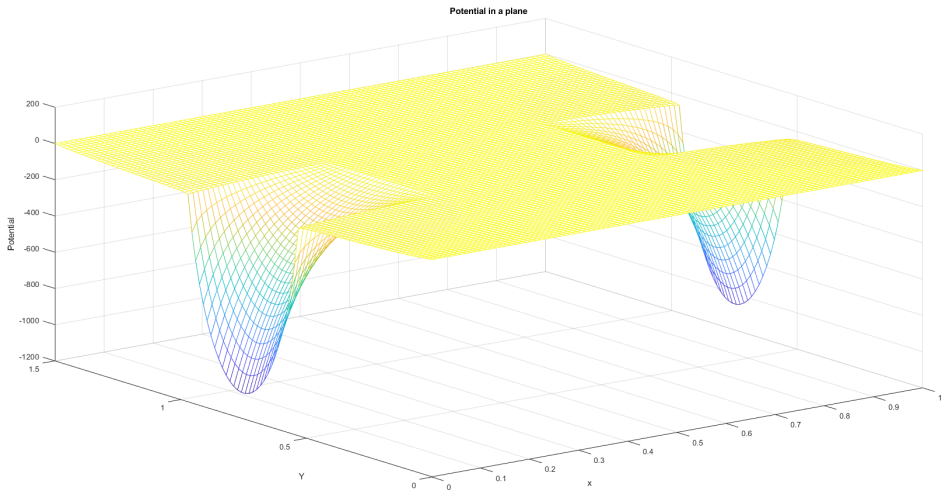
```
        ylabel('Y');
        zlabel('Conductivity');

        figure(13);
        subplot(3,3,i);
        mesh(x,y,Ex);
        title('Electric feild in the X direction');
        xlabel('x');
        ylabel('Y');
        zlabel('Electrical Potential Energy');

        figure(14);
        subplot(3,3,i);
        mesh(x,y,Ey);
        title('Electric feild in the Y direction');
        xlabel('x');
        ylabel('Y');
        zlabel('Electrical Potential Energy');

        figure(15);
        subplot(3,3,i);
        quiver(x,y,Ex',Ey');
        title('Electric feild in the region');
        xlabel('x');
        ylabel('Y');

        figure(16);
        subplot(3,3,i);
        quiver(x,y,Jx',Jy');
        title('Current Density in the region');
        xlabel('x');
        ylabel('Y');
    end

    Currents(i) = curr;
end
meshC = Currents;
figure(17);
plot(X,meshC);
title('Change in Current as Mesh Density Increases');
xlabel('Number of Mesh points');
ylabel('Difference of Current Between Ends');

avgMC = sum(meshC)/length(meshC);
fprintf('the average current due to the changing mesh size: %g
\n',avgMC);

% c)
nx = 100;
W = [nx*0.1 nx*0.15 nx*0.2 nx*0.25 nx*0.3 nx*0.35 nx*0.4 nx*0.45
 nx*0.5 ...
    nx*0.55 nx*0.6 nx*0.65 nx*0.7 nx*0.75 nx*0.8 nx*0.85 nx*0.9
 nx*0.95];
Currents = zeros(length(W),1);
```

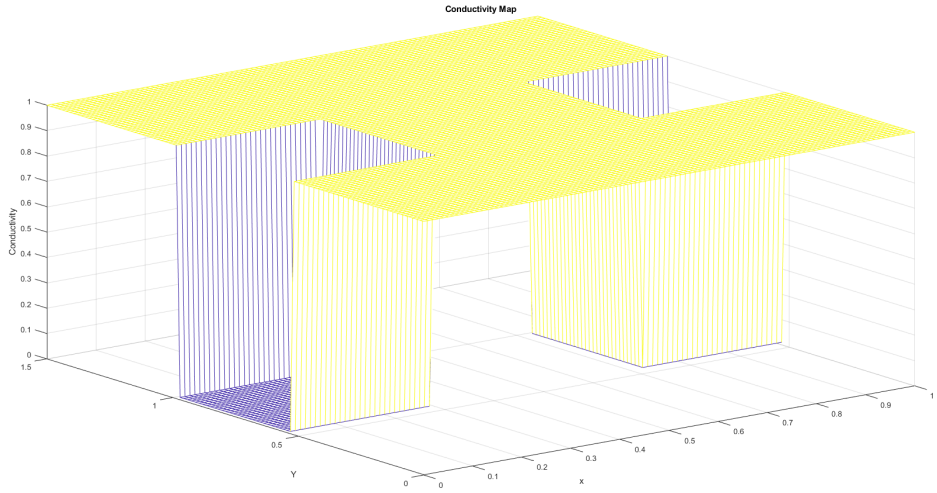
```
for i = 1:length(W)
   voltageFeild2(nx, nx, 1, W(i), 40, 0.01, 1);
   if extras
       figure(18);
       subplot(4,5,i);
       mesh(x,y,V2);
       title('Potential in a plane');
       xlabel('x');
       ylabel('Y');
       zlabel('Potential');

       figure(19);
       subplot(4,5,i);
       mesh(x,y,C);
       title('Conductivity Map');
       xlabel('x');
       ylabel('Y');
       zlabel('Conductivity');

       figure(20);
       subplot(4,5,i);
       mesh(x,y,Ex);
       title('Electric feild in the X direction');
       xlabel('x');
       ylabel('Y');
       zlabel('Electrical Potential Energy');

       figure(10);
       subplot(4,5,i);
       mesh(x,y,Ey);
       title('Electric feild in the Y direction');
       xlabel('x');
       ylabel('Y');
       zlabel('Electrical Potential Energy');

       figure(21);
       subplot(4,5,i);
       quiver(x,y,Ex',Ey');
       title('Electric feild in the region');
       xlabel('x');
       ylabel('Y');

       figure(22);
       subplot(4,5,i);
       quiver(x,y,Jx',Jy');
       title('Current Density in the region');
       xlabel('x');
       ylabel('Y');
   end

   Currents(i) = curr;
end
widthC = Currents;
```

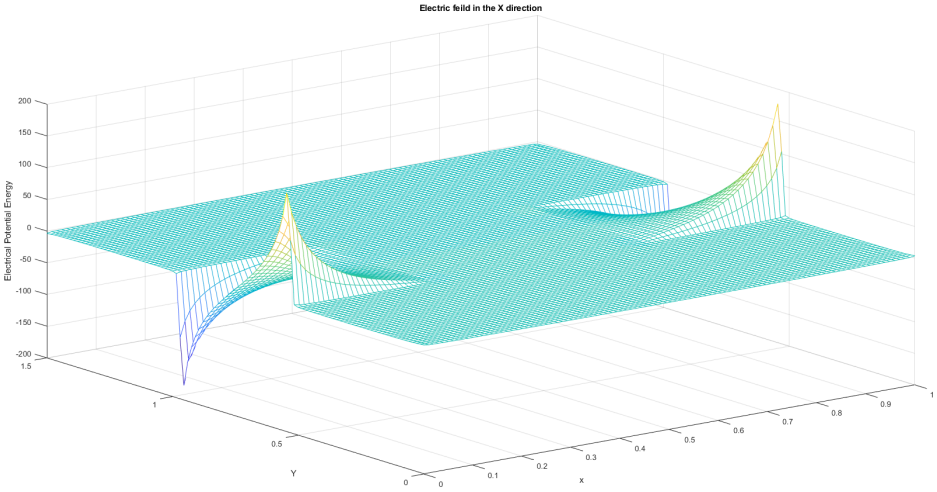
```
figure(23);
plot(W,widthC);
title('Change in Current While Resistive Feature Changes in Size');
xlabel('Change in Width of Apature');
ylabel('Current');

avgWC = sum(widthC)/length(W);
fprintf('the average current for the chaning width: %g\n', avgWC);

% d)
C1 = logspace(-2, 1,20);
Currents = zeros(length(C1),1);

for i=1:length(C1)
   voltageFeild2(nx, nx, 1, 50, 50, C1(i), 1);
   if extras
       figure(24);
       subplot(4,5,i);
       mesh(x,y,V2);
       title('Potential in a plane');
       xlabel('x');
       ylabel('Y');
       zlabel('Potential');

       figure(25);
       subplot(4,5,i);
       mesh(x,y,C);
       title('Conductivity Map');
       xlabel('x');
       ylabel('Y');
       zlabel('Conductivity');

       figure(26);
       subplot(4,5,i);
       mesh(x,y,Ex);
       title('Electric feild in the X direction');
       xlabel('x');
       ylabel('Y');
       zlabel('Electrical Potential Energy');

       figure(27);
       subplot(4,5,i);
       mesh(x,y,Ey);
       title('Electric feild in the Y direction');
       xlabel('x');
       ylabel('Y');
       zlabel('Electrical Potential Energy');

       figure(28);
       subplot(4,5,i);
       quiver(x,y,Ex',Ey');
       title('Electric feild in the region');
       xlabel('x');
       ylabel('Y');
```

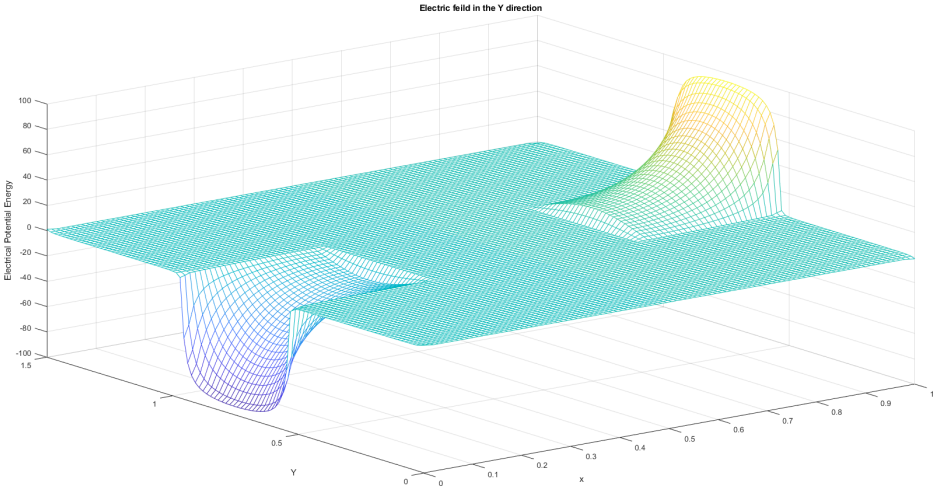
```
        figure(29);
        subplot(4,5,i);
        quiver(x,y,Jx',Jy');
        title('Current Density in the region');
        xlabel('x');
        ylabel('Y');
    end

    Currents(i) = curr;
end
condC = Currents;
figure(30);
semilogx(C1,condC);
title('Current Change in Region While Conductivity Increases');
xlabel('Conductivity in Box Regions');
ylabel('Current');

avgCC = sum(condC)/length(C1);
fprintf('the average current due to changing conductance: %g
\n',avgCC);
```

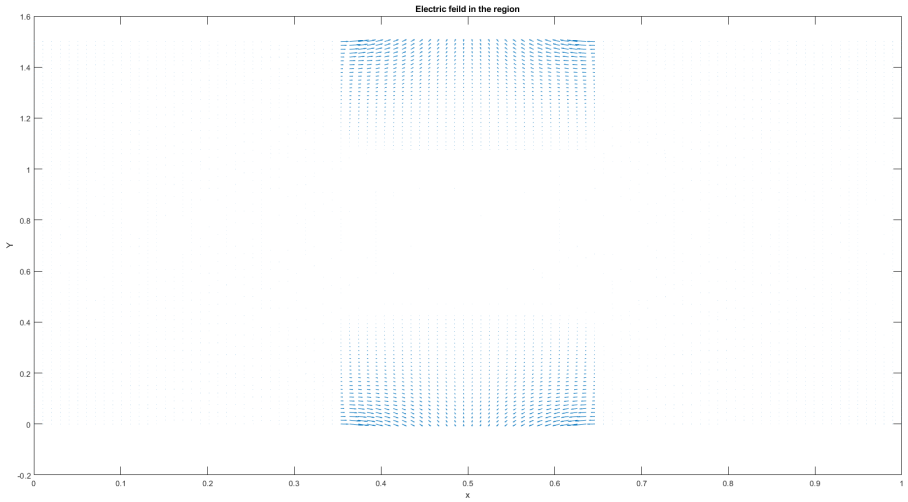
```
the average current due to the changing mesh size: 3.77476e-14
the average current for the chaning width: 1.42109e-14
the average current due to changing conductance: 6.75016e-15
```

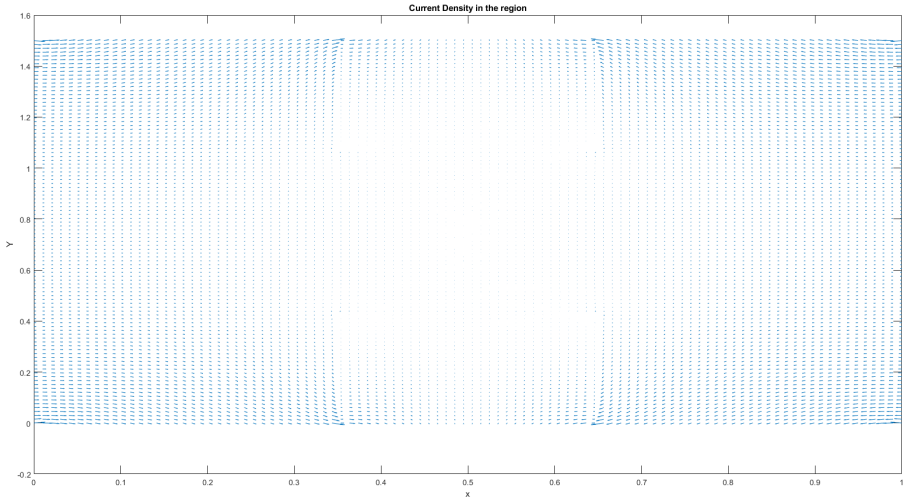


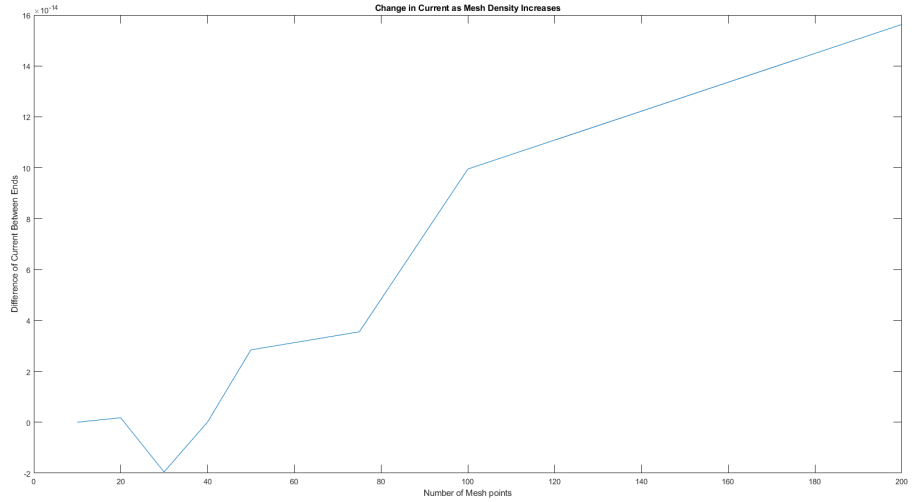

Conductivity Map
Conductivity
Y
x

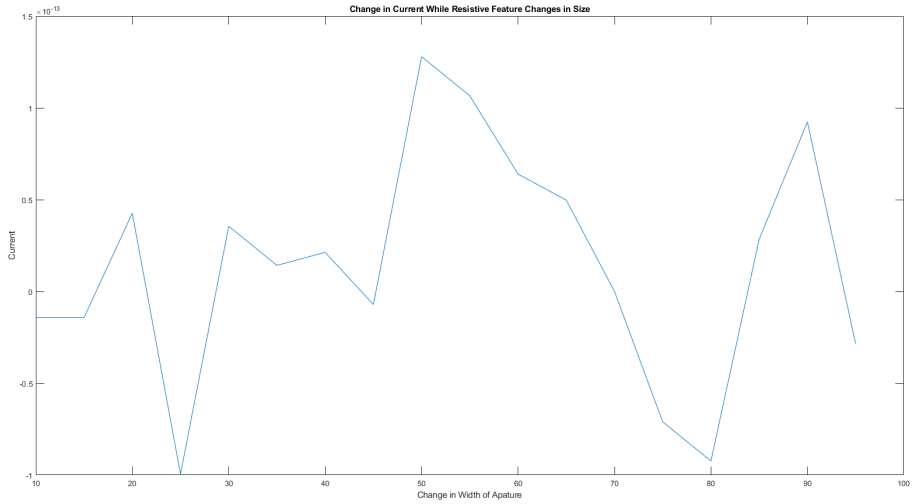

Electric feild in the X direction
Electrical Potential Energy
Y
x

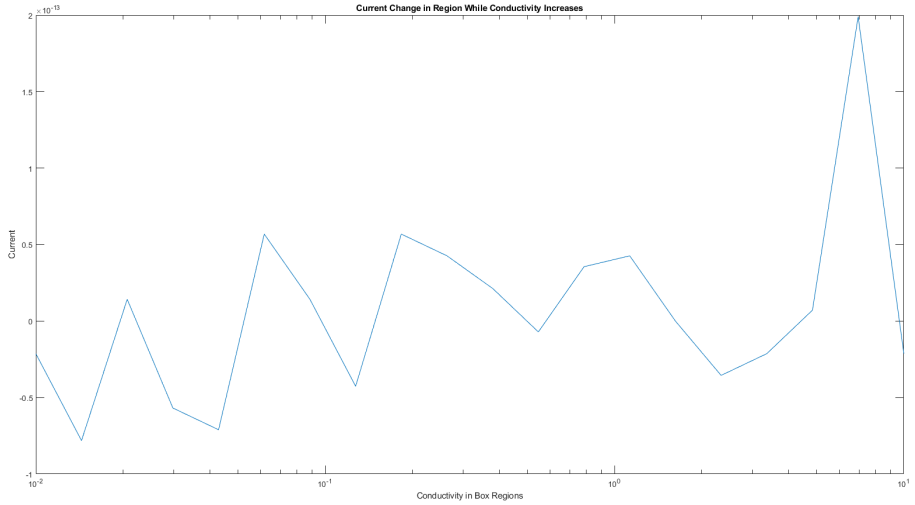

Electric feild in the Y direction
Electrical Potential Energy
Y
x


Electric feild in the region
Y
x


Current Density in the region
Y
x


Change in Current as Mesh Density Increases
Difference of Current Between Ends
Number of Mesh points





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