ELEC 4700 Assignment 2

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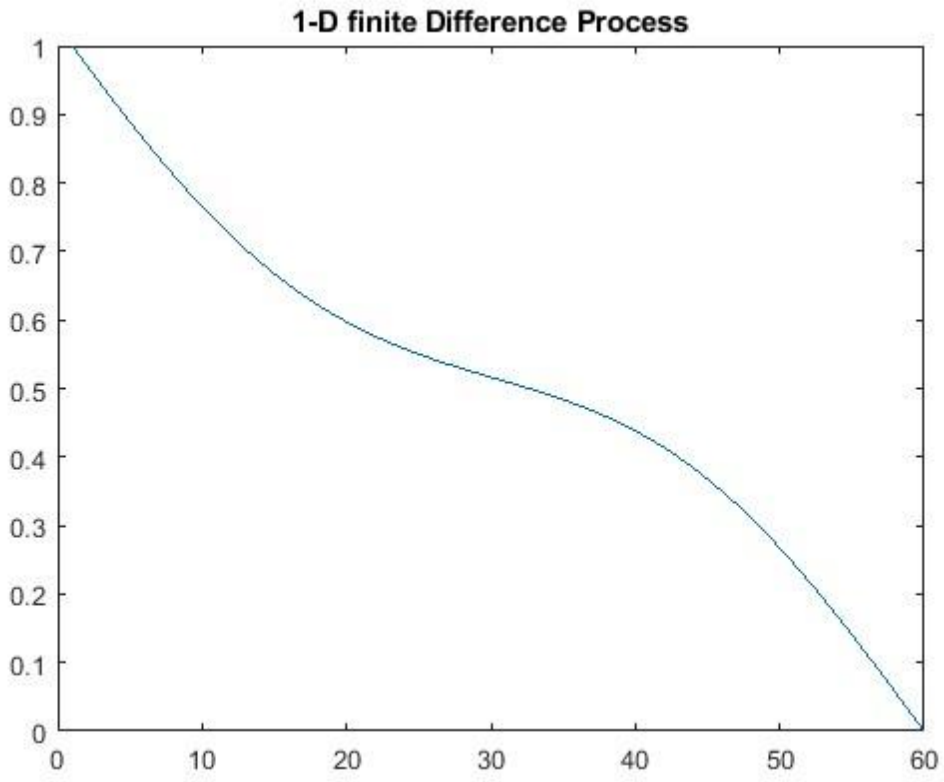
Introduction

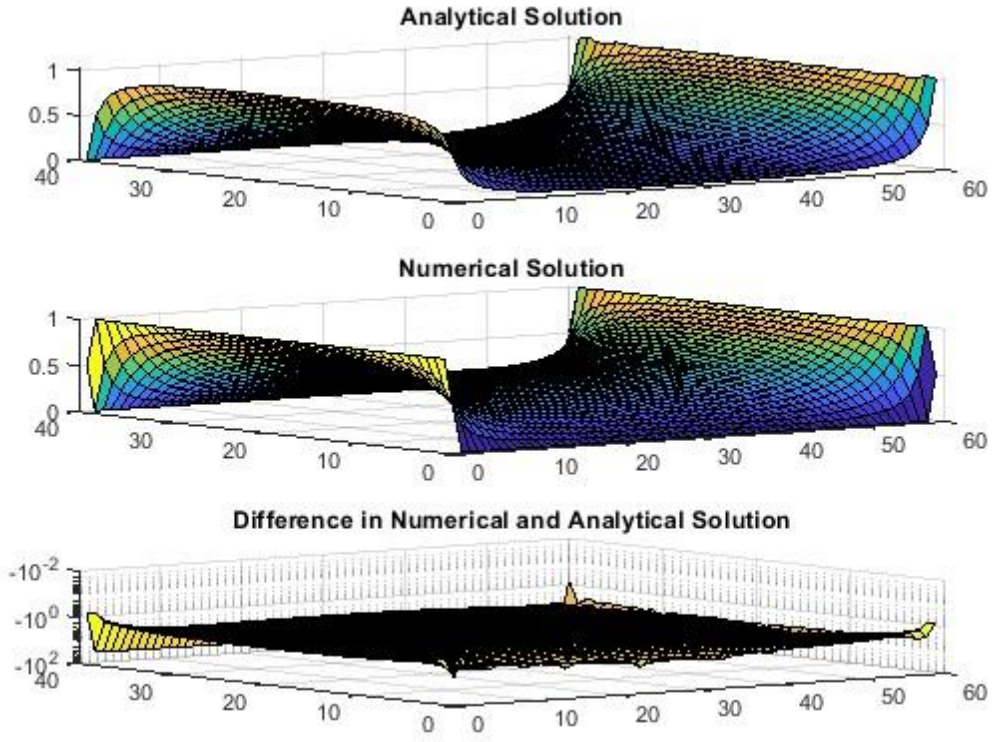
The MATLAB code is design to perform the Finite Difference Method to solve electrostatic potential in rectangular shape region with dimensions L*W where dimensions ratio (L/W) is 3/2. Firstly, the case V=Vo at x=0 & V=0 at x=L. The case is solved using MATLAB code as given below. Then, the next parts are solved for another parameter such as V=Vo at x=0, x=L and V=0 at y=0, and y=W. All these results are calculated with analytical solution. The matrix form is used to solve the problems. The variables are assigned for the boundary conditions so that it can be changed without any major change in the code.

Question 1 - Part (a)



Question 1 - Part (b)

The analytical solution is done and then compared with the meshing.



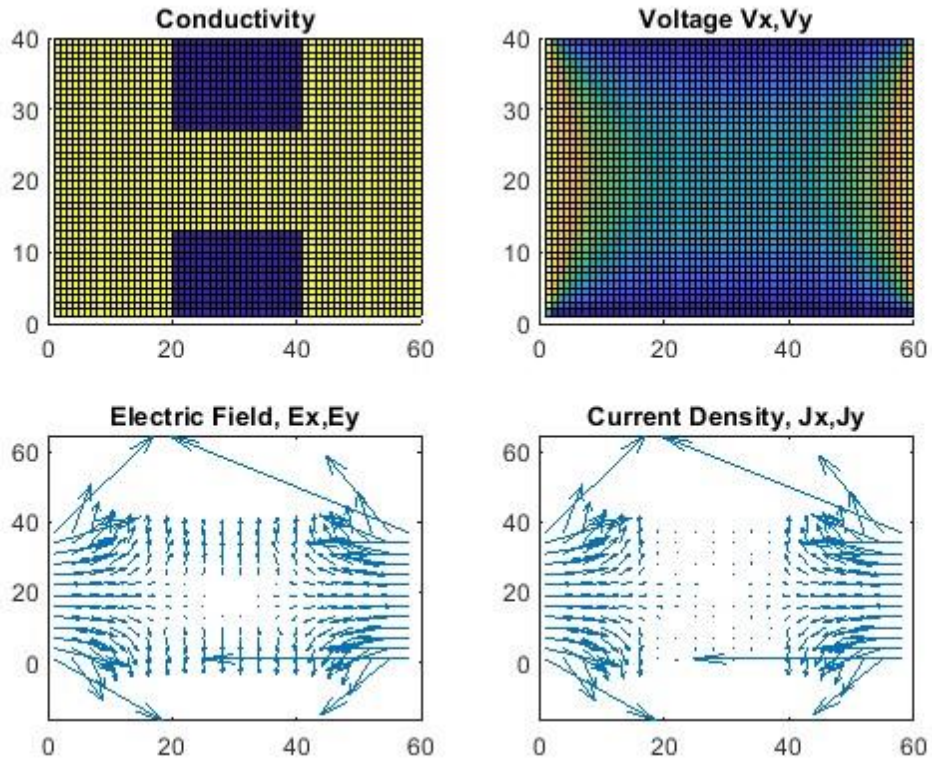
It can be seen from the results that; the iteration method gives the same result as the analytical method in 100 iterations. The error between the both methods is around -10E-2 that is error range to stop the analytical method. The results have also been tested for the iterations more than 100 but the results remain almost same without any big change. Thus, the numerical value is easier because this approximates to the actual result for the complex analytical problems. The process of meshing is also simple, but it takes more time. The disadvantage of numerical method includes this process is difficult for the non-rectangular and non-uniform geometric shapes.

Question 2

Finite Difference Method is used to solve current flow in rectangular shape having different resistivity and having higher resistivity outside as compared to the inside resistivity. The plots have been done for sigma (x, y), V(x, y) Ex, Ey, & J(x,y).

Bottle neck length is about 1/3 of total rectangular region length while width is around 2/8 of total width.

Part (a)

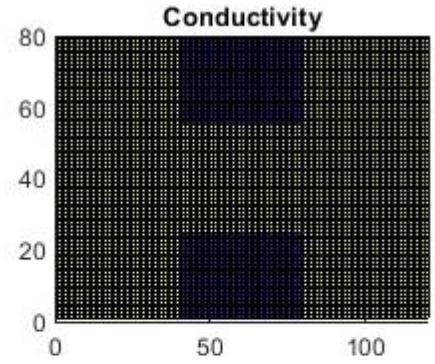


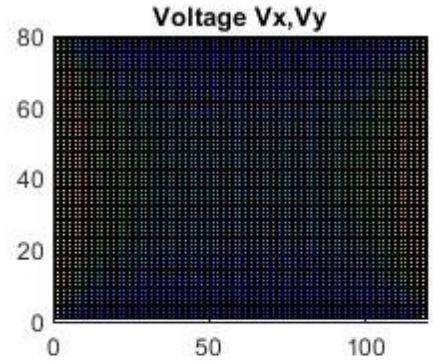
Part (b)

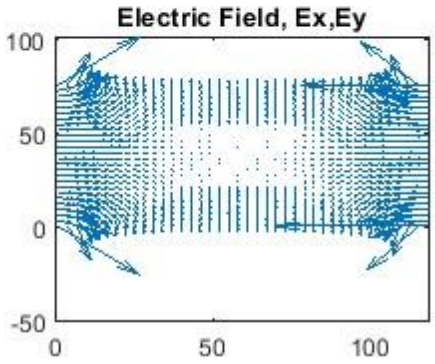
The function has been created to take inputs and meshing is also changed to check the effect on results. Mesh density is passed through the functions to plot results.

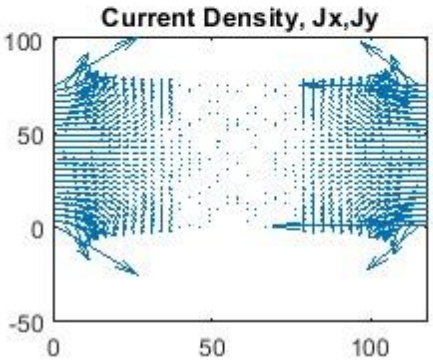
```
% It is with the meshing size double of standard set.
Plotconductivity(40, 10e-2, 3);
```

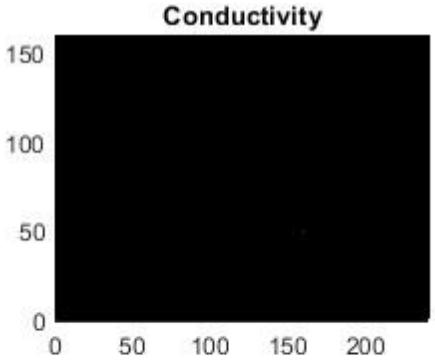
```
% It is meshing size triple of standard set.
Plotconductivity(80, 10e-2, 3);

% It is meshing size half of standard set.
Plotconductivity(10, 10e-2, 3);
```

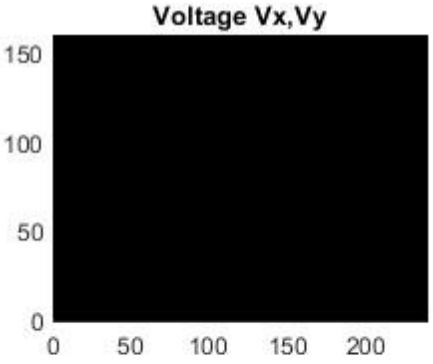

Conductivity
80
60
40
20
0
0
50
100

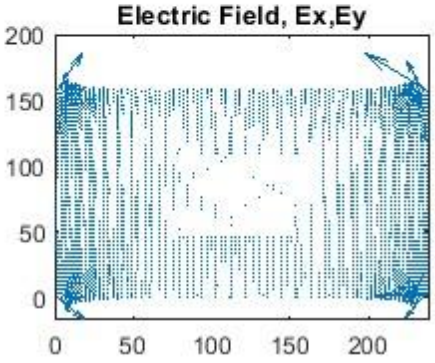

Voltage Vx,Vy
80
60
40
20
0
0
50
100

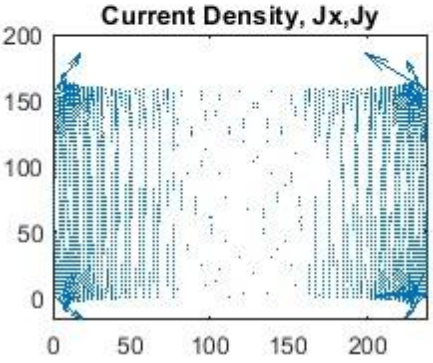

Electric Field, Ex,Ey
100
50
0
-50
0
50
100

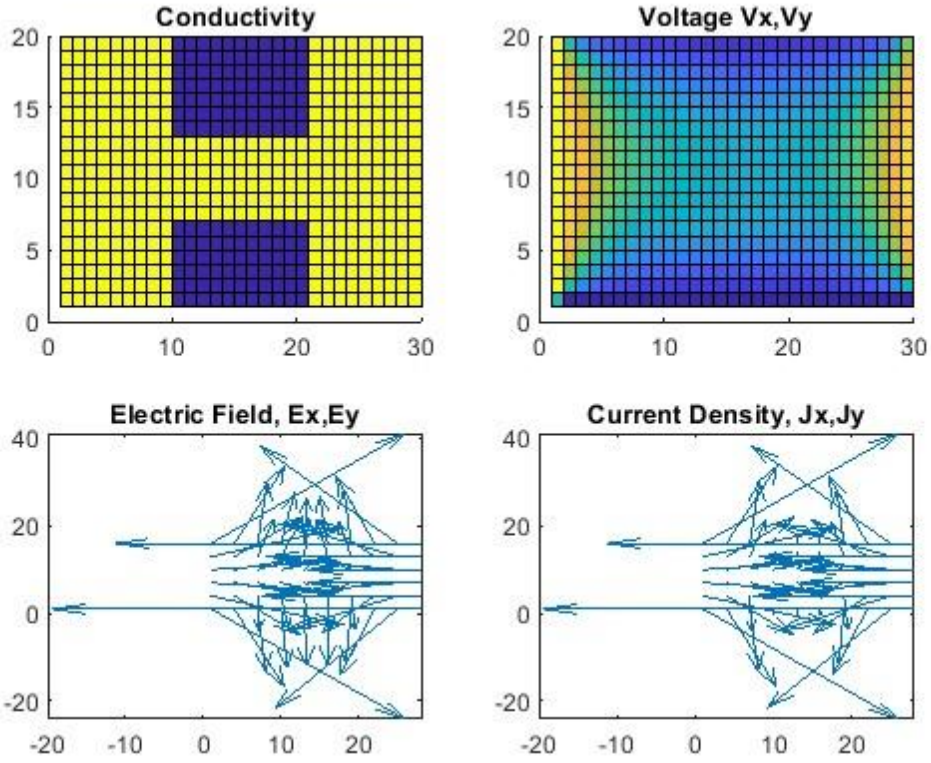

Current Density, Jx,Jy
100
50
0
-50
0
50
100


Conductivity
150
100
50
0
0
50
100
150
200


Voltage Vx,Vy
150
100
50
0
0
50
100
150
200


Electric Field, Ex,Ey
200
150
100
50
0
0
50
100
150
200

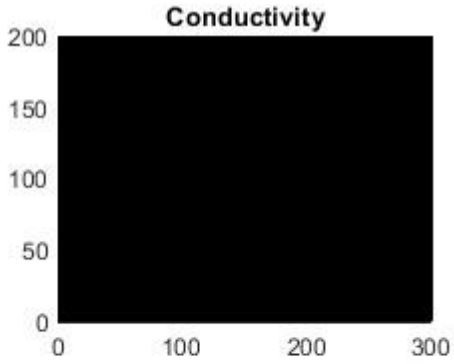

Current Density, Jx,Jy
200
150
100
50
0
0
50
100
150
200

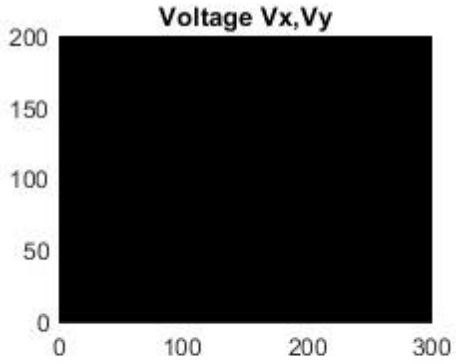


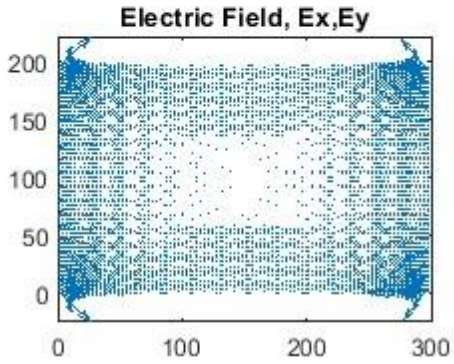
Part (c)

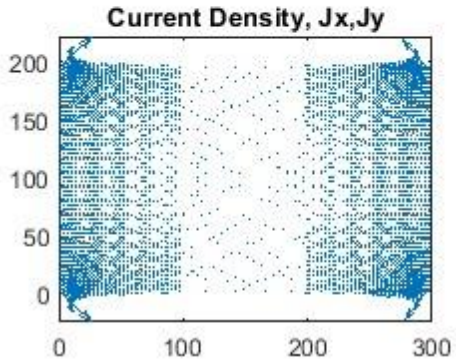
The bottle neck size and conductivity will be same but different dimensions. The plot is done for different sizes of bottle neck such as normal, longer, and narrower bottle necks. This is done by passing the values to functions as done in the following.

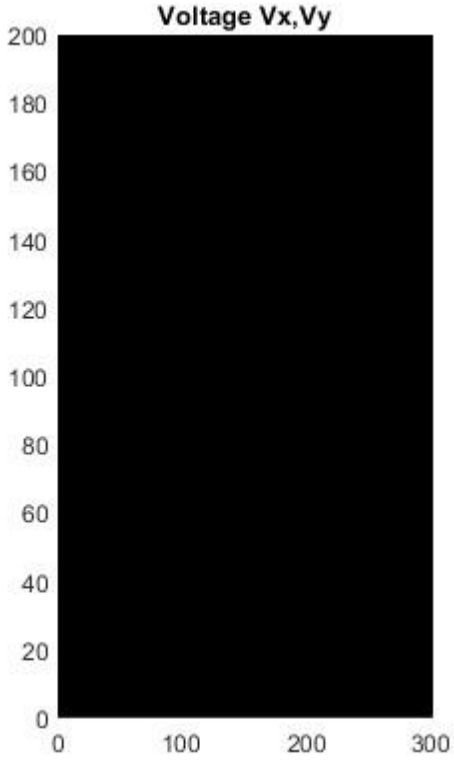
```
Plotconductivity(100, 10e-2, 3);

% It has longer bottle neck

Plotconductivity2(100, 10e-2, 3, 0.5, 0.375);

% It has narrower bottle neck
Plotconductivity2(100, 10e-2, 3, 0.3333, 0.5);
```

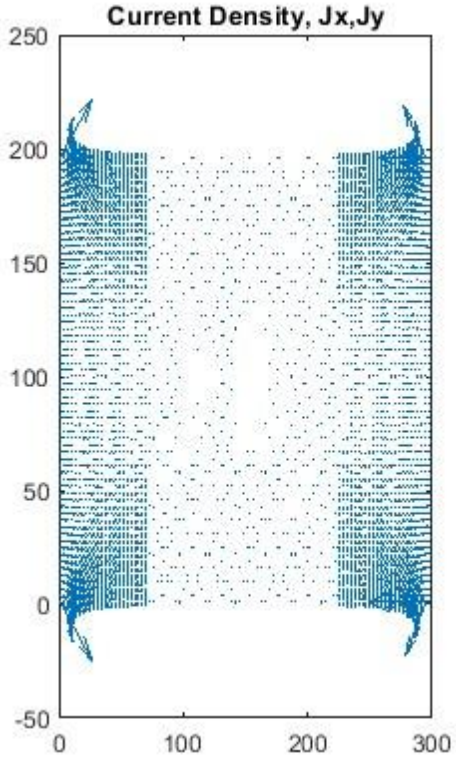

Conductivity
200
150
100
50
0
0
100
200
300

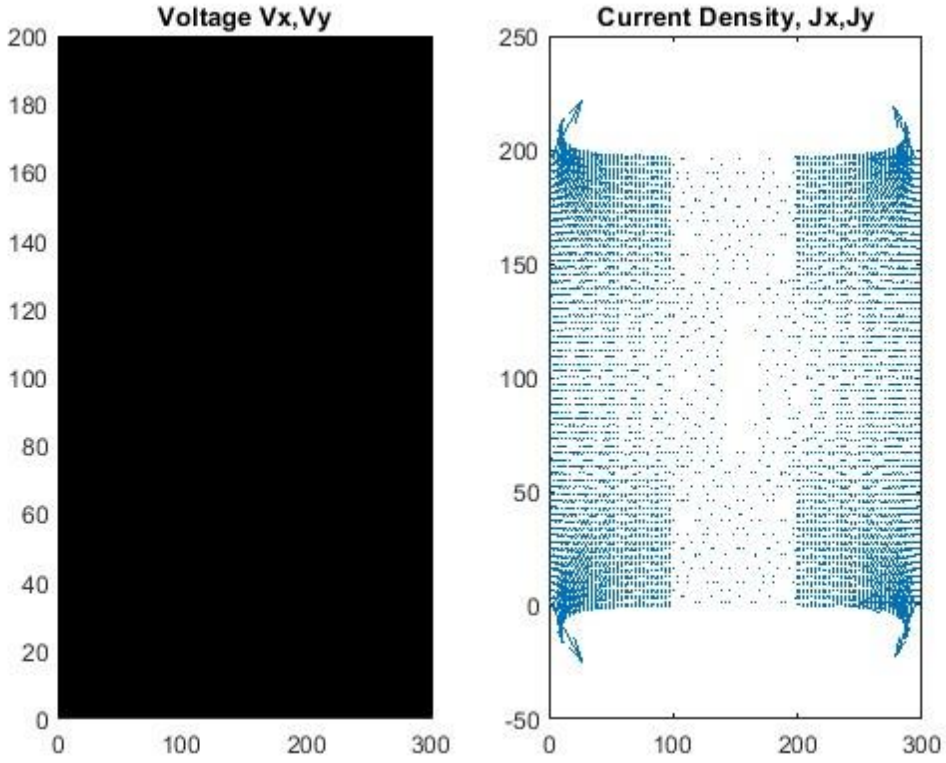

Voltage Vx,Vy
200
150
100
50
0
0
100
200
300


Electric Field, Ex,Ey
200
150
100
50
0
0
100
200
300


Current Density, Jx,Jy
200
150
100
50
0
0
100
200
300


Voltage Vx,Vy
200
180
160
140
120
100
80
60
40
20
0
0
100
200
300

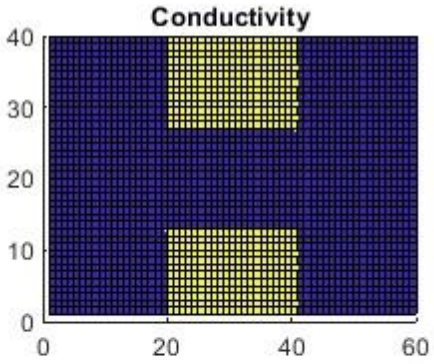

Current Density, Jx,Jy
250
200
150
100
50
0
-50
0
100
200
300

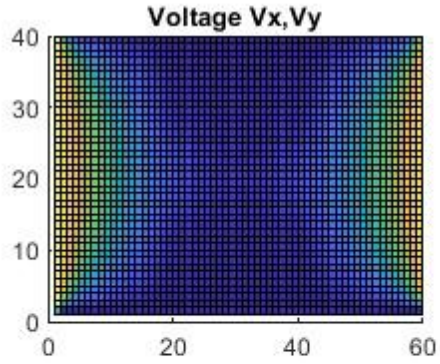


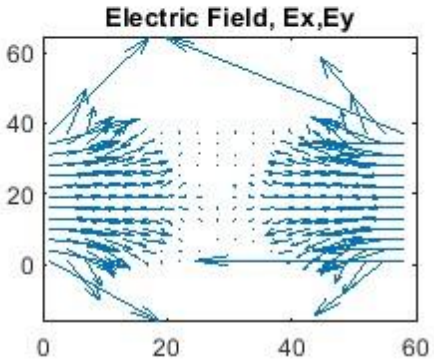
Question 2 - Part (d)

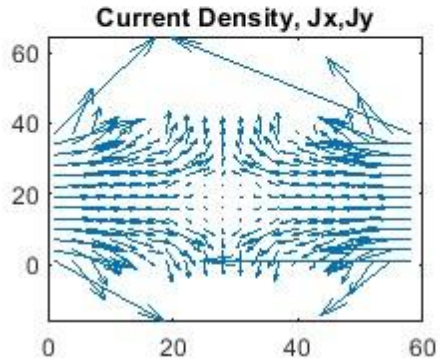
The results with difference resistivity are compared inside of the box. The results obtained by applying difference method are very close as required. The method has tested with different levels of resistivity such as higher and lower resistivity. The function is designed to show shorten code and re-use the code by calling function as done in the following.

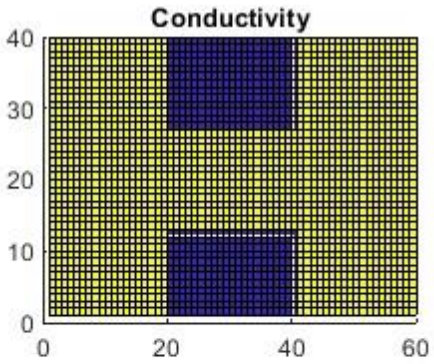
```
% It is with higher resistivity as compared to the original
Plotconductivity(20, 10, 3);

% It is with lower resistivity as compared to the original
Plotconductivity(20, 10e-5, 3);
```

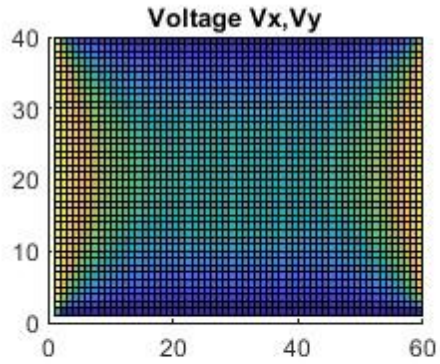

Conductivity
0
10
20
30
40
0
20
40
60

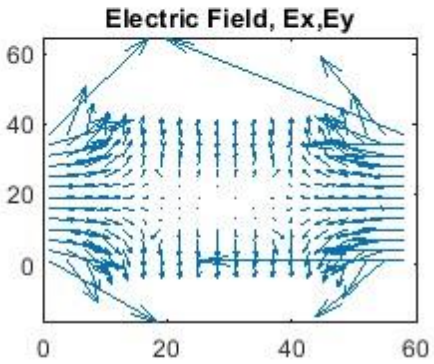

Voltage Vx,Vy
0
10
20
30
40
0
20
40
60

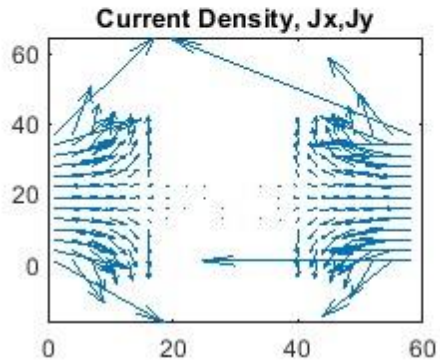

Electric Field, Ex,Ey
0
20
40
60
0
20
40
60


Current Density, Jx,Jy
0
20
40
60
0
20
40
60


Conductivity
0
10
20
30
40
0
20
40
60


Voltage Vx,Vy
0
10
20
30
40
0
20
40
60


Electric Field, Ex,Ey
0
20
40
60
0
20
40
60


Current Density, Jx,Jy
0
20
40
60
0
20
40
60