Elec 4700

Assignment – 2

FINITE DIFFERENCE METHOD

Due: Sunday, Feb. 23, 2020 23:59

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Introduction

We used finite difference method to find the electrostatic potential and the current flow in an inhomogeneous solid. In part 1 we solved for the electrostatic potential in the rectangular for a region L x W. We solved for but the numerical and analytical and experiment to find get the accurate model. In part 2 we used finite difference to model a bottle-neck and find the current flow. And calculation of current of the device and the changes of the current with the bottle-neck.

Part1

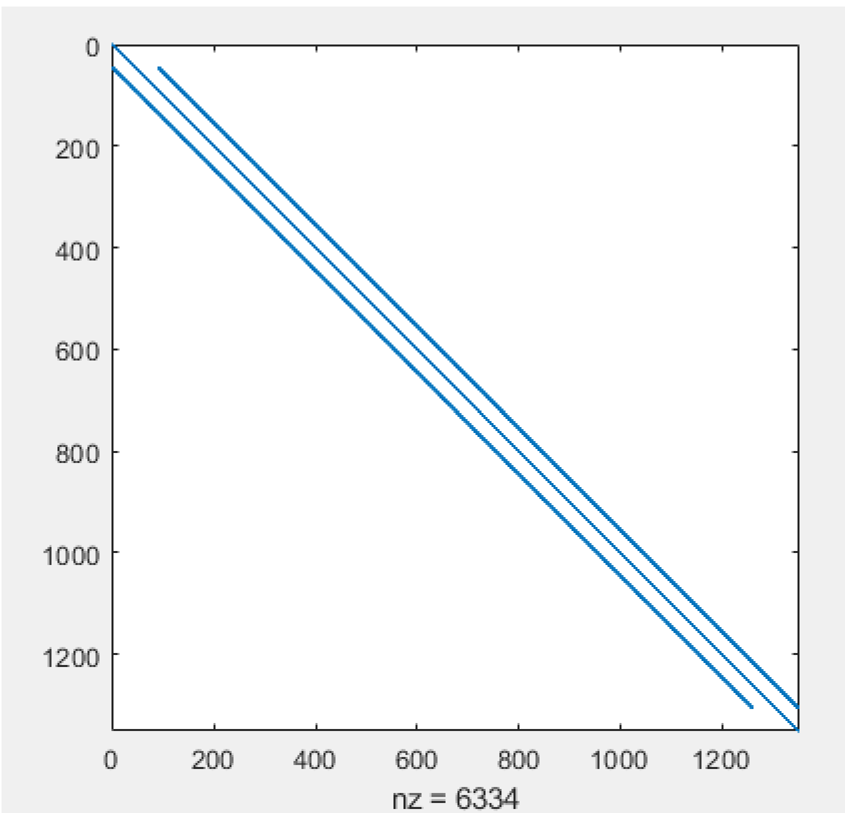

Figure 1: Free Edge

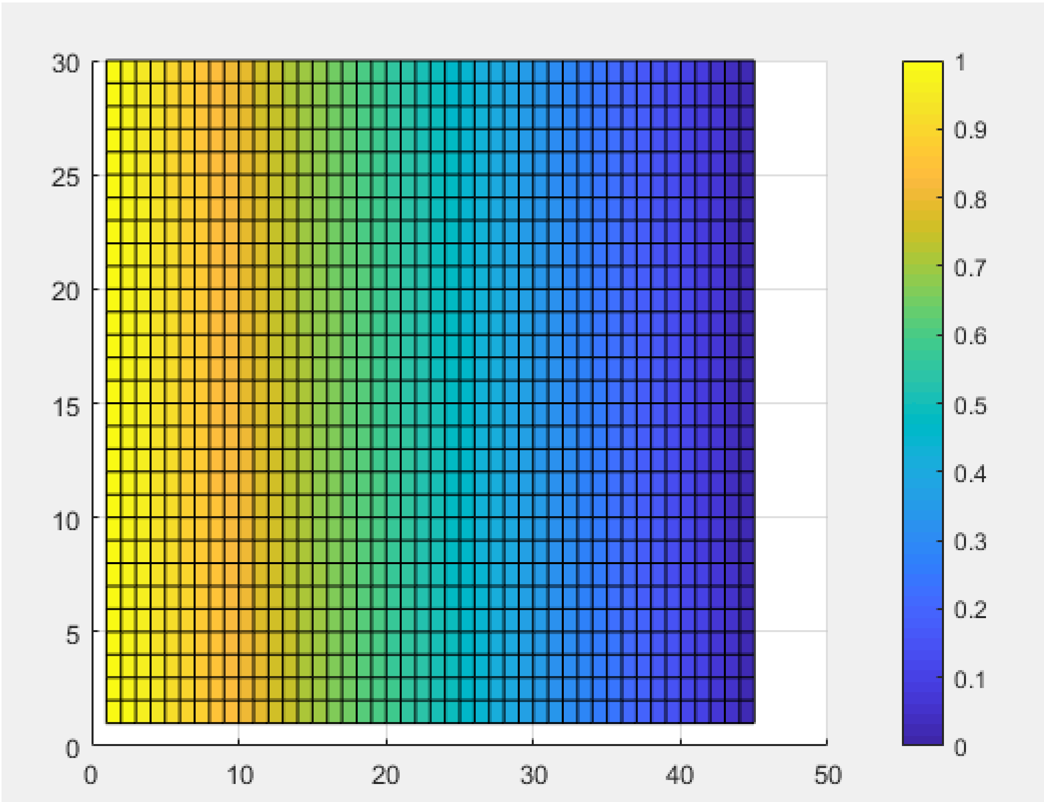

Figure 2: the voltage model for a laplace solution to 1-D

The voltage distribution over the plate. Because it is a 1-D solution because we defined at 0 we want 1v and at the other side zero.

Solve the top/bottom BC with a 3/2 for L/W. For a predefined length and width to model the voltage. We used the Gmatrix in the second part for the 2-D plot of the voltage.

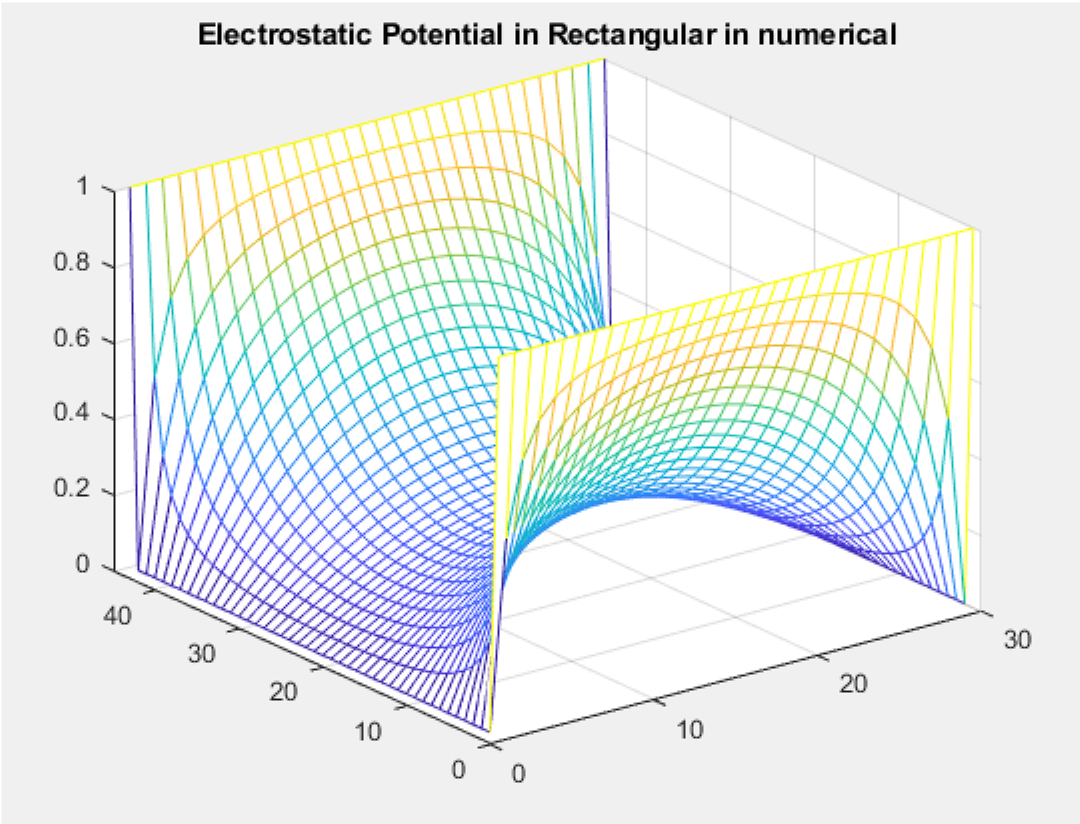

Figure 3: A Electrostatic potential for four side numerical

We used two methods to compare the solution for some mesh sizes and analytical series solution.

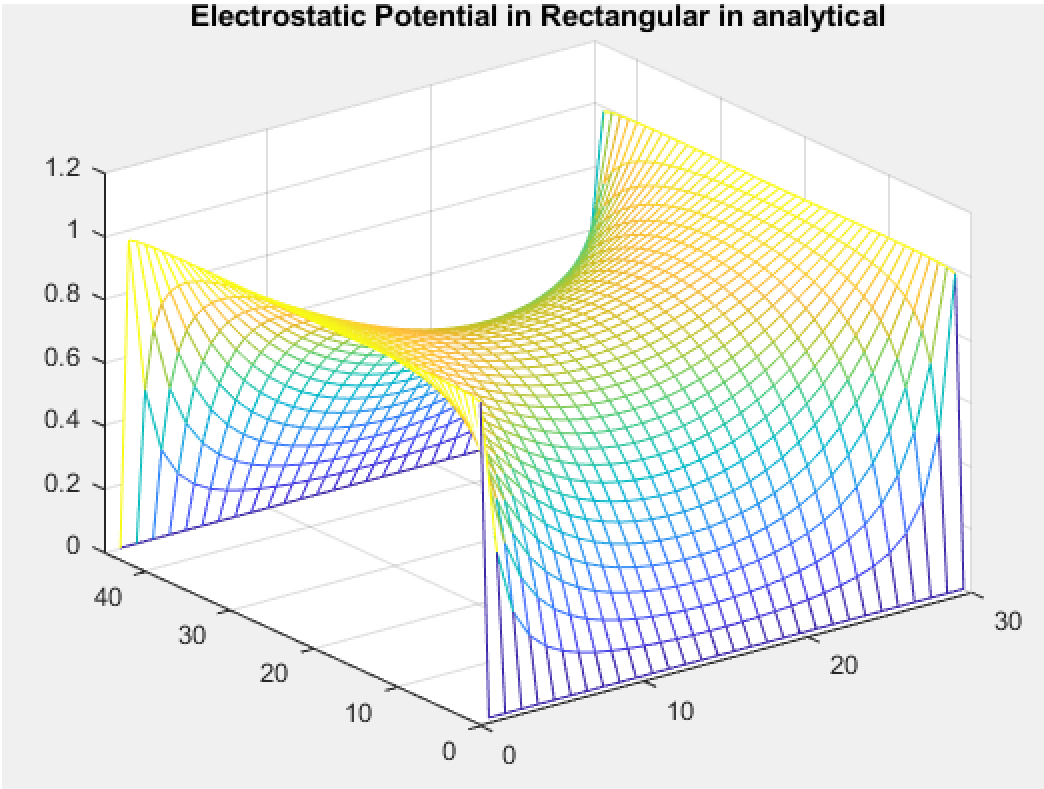

Figure 4:: A Electrostatic potential for four side analytical

Using the analytical method equation given to us in the lab Manuel. Mesh was the best approached, both methods are meant to give you the same solution but since we can not go up till infinite some modelling with a finite value and the plot will never be the same. The mesh method uses more memory but faster than analytical but the analytical method is less prone to error.

The difference between is analytical is goes to infinite but numerical has a finite value. Also analytical is more time consuming and more accurate than the numerical methods.

Part2 Added Bottleneck

The flow at the contact was measure the sum of the magnitude of the current in between the two contacts. Used a bottleneck method used in lab1 to set up boundary’s in the rectangle. We used a mesh of (L,W) = (75,50) and we solve to get the current value.

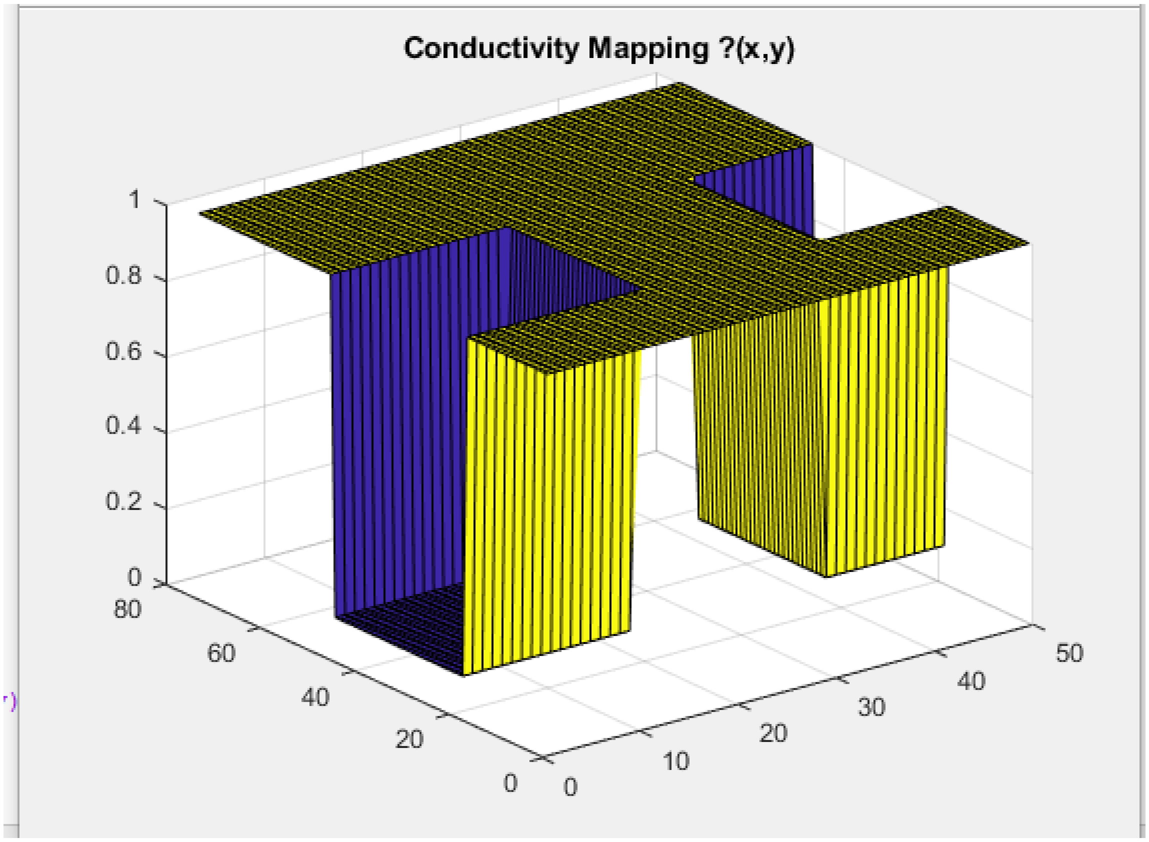

Figure 5: Conductivity map

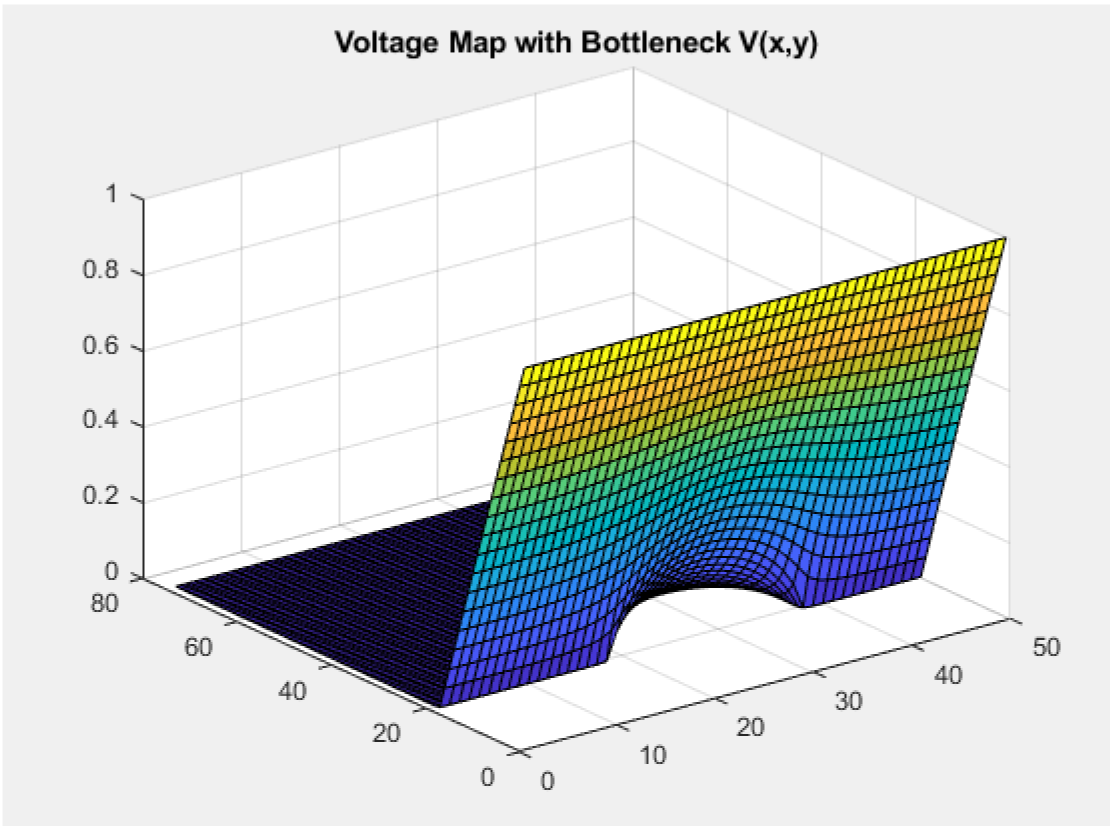

Figure 6: voltage mapping

We noticed the voltage decreases to 0 when it comes in contact with the bottle neck boundary. We used gradient of the voltage map and plotted.

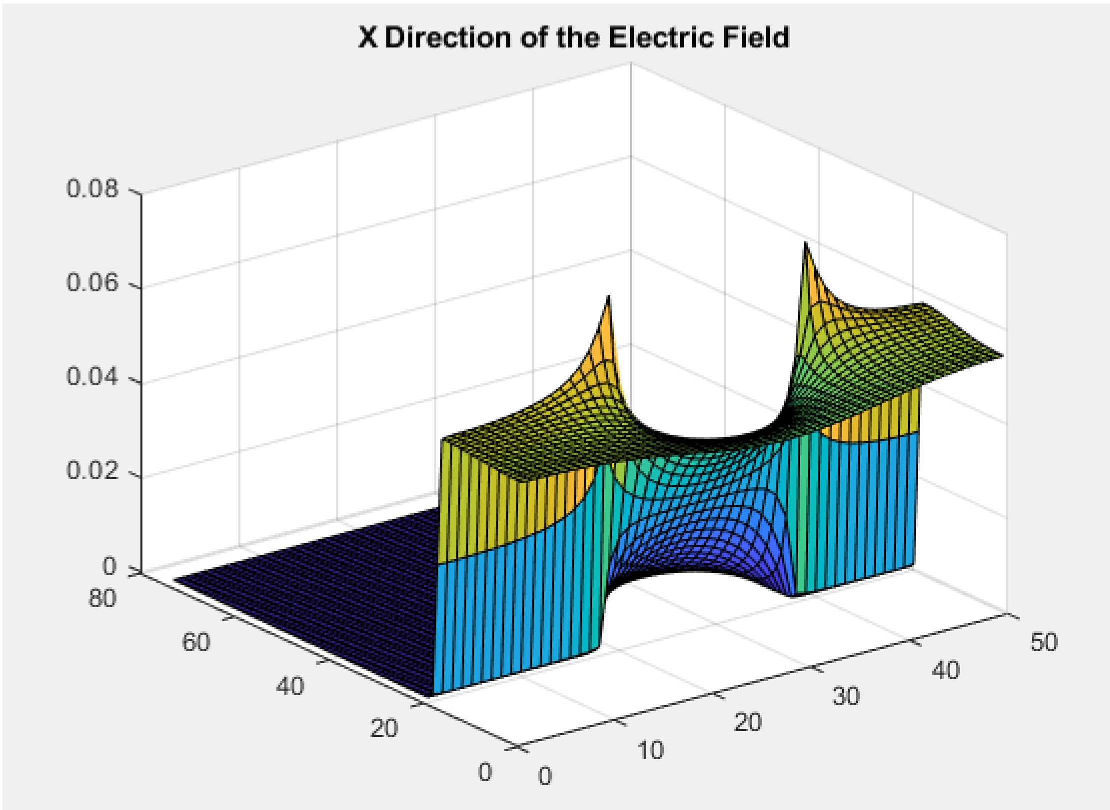

Figure 7: X Direction of electric field

The Electric field for both the X and Y direction in mesh was plotted to give us an understanding of the behaviour of the electric field in the boundary with the bottle neck.

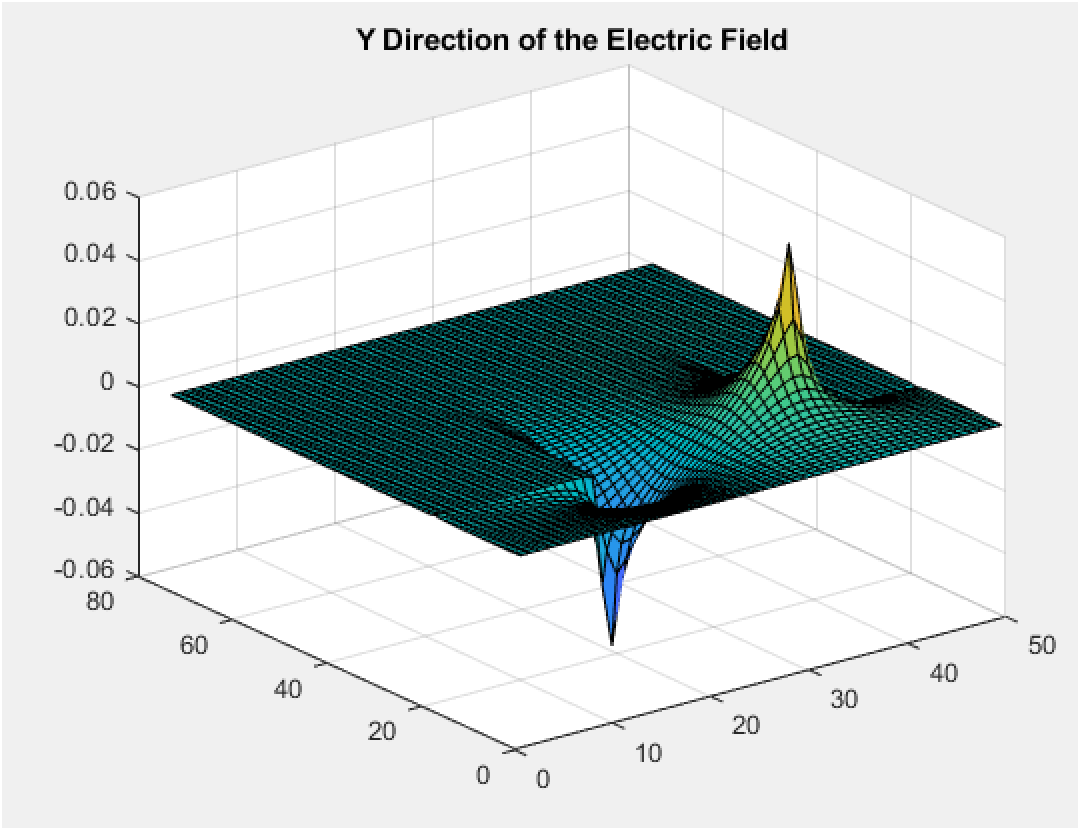

Figure 8:Y Direction of electric field

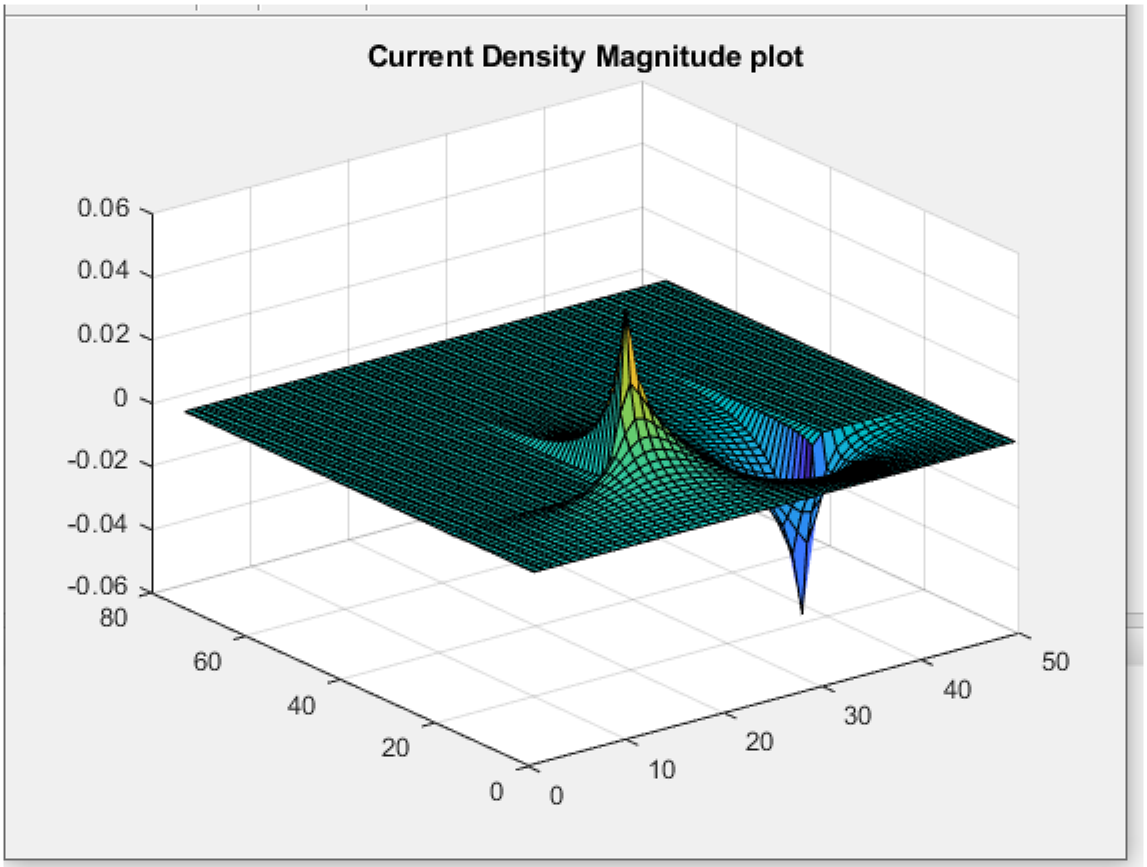

Figure 9: Current Density Magnitude plot

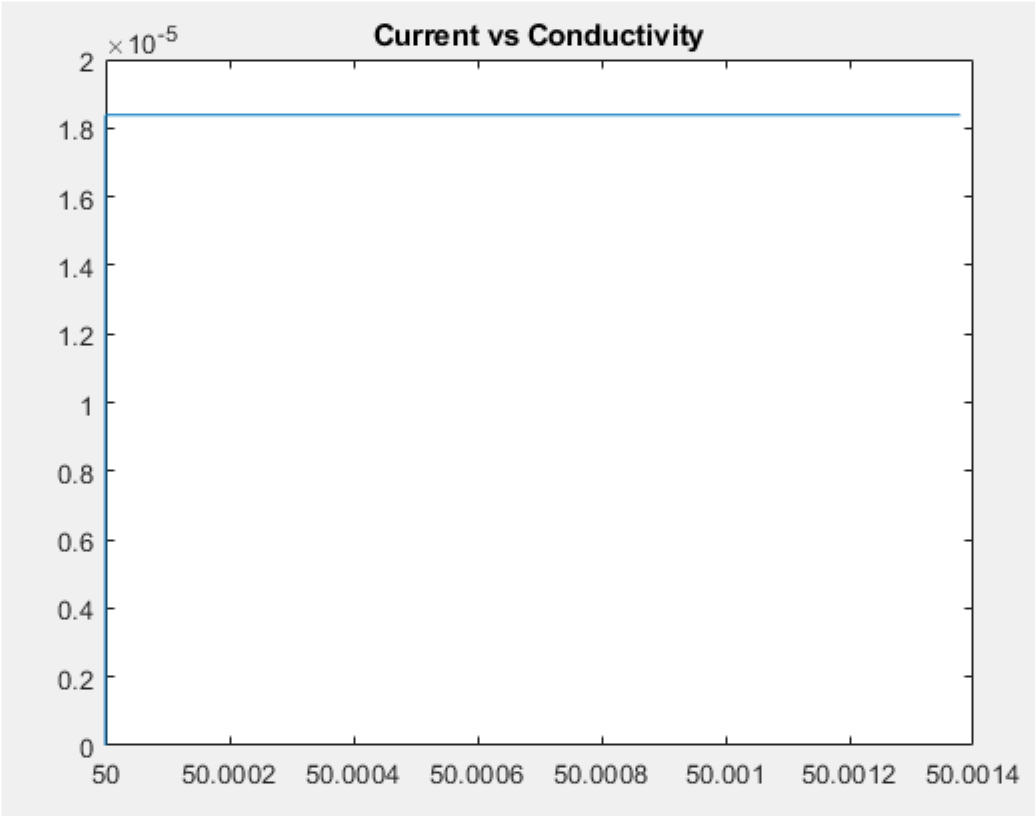

Figure 10: Current Vs Conductivity

The plot of the current vs conductivity in my report is wrong. It is meant to be a linear graph but due to coding error I was unable to achieve that and I got this instead.

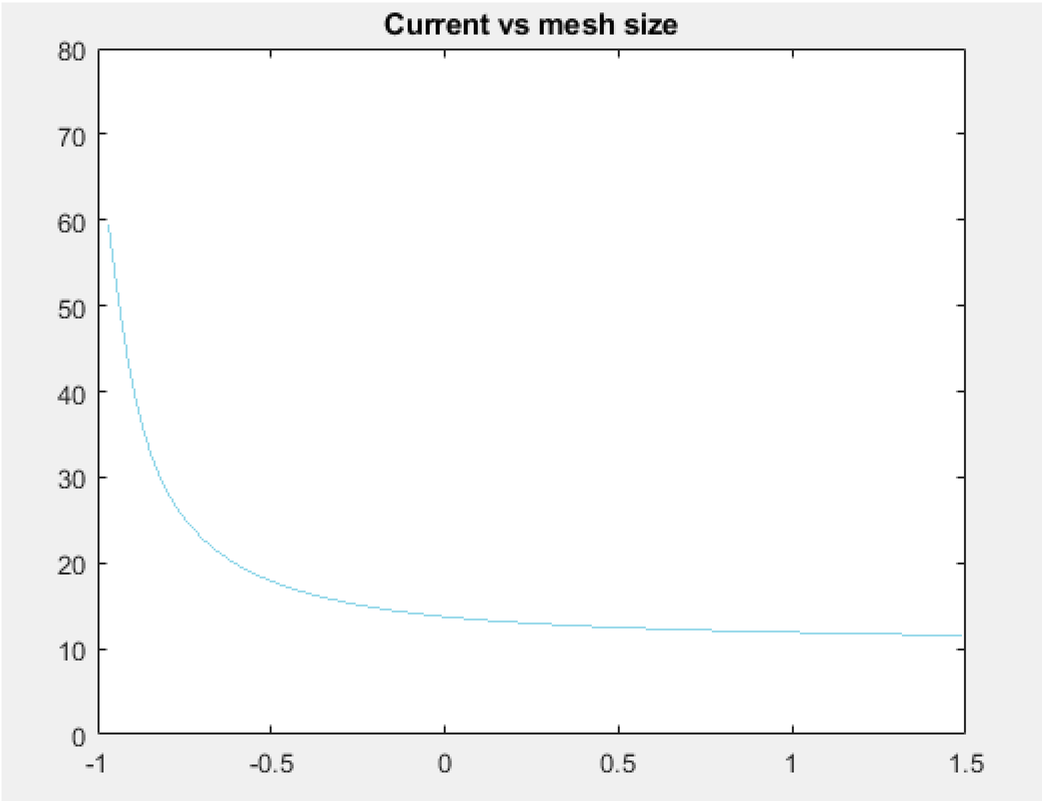

Figure 11: Current Vs mesh size of L

The mesh size matters a lot in amount of current density. If the mesh size is small we get a small increase in the current density. If the mesh size increase to a significant amount we will see a the current density will decrease as mesh size increase.

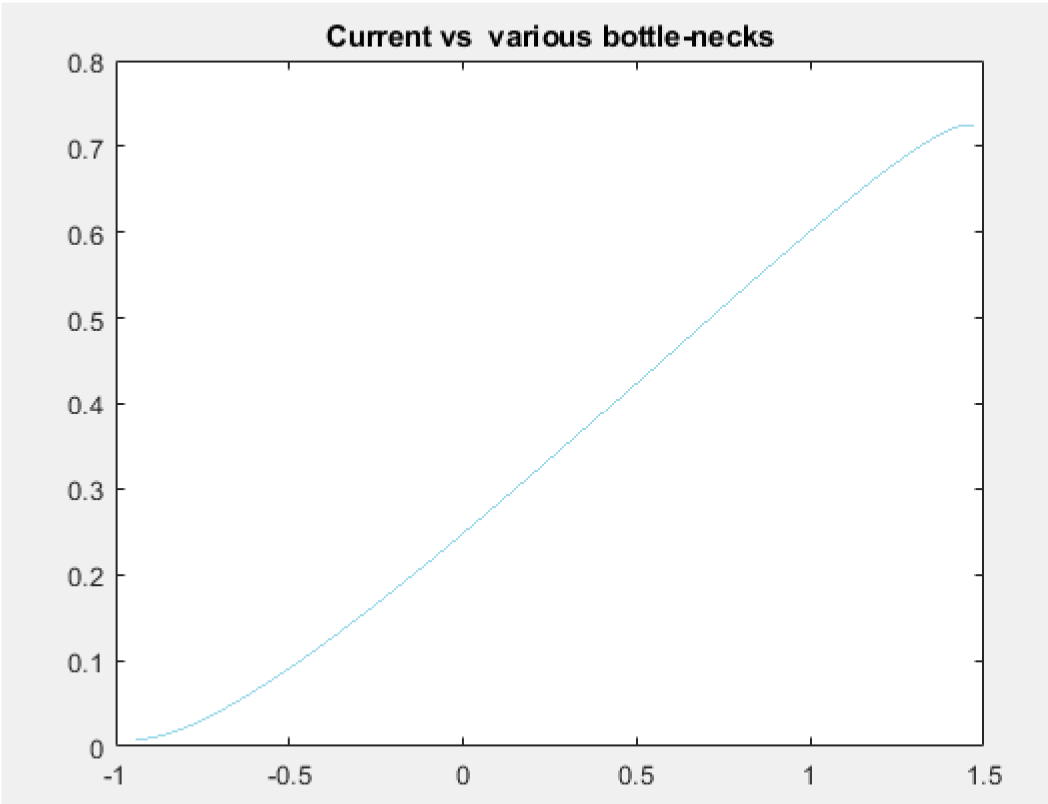

Figure 12: Graph of current vs various Bottle-neck

The bottle-neck region increases around the neck of the two defined regions, which also shows that the average current density decreases. The reduction in the bottle neck size allow less current to flow.

Conclusion

All of the deliverables for part1 was were achieved but not all of the deliverables were achieved for part2. The numerical solution was more accurate than the analytical solution since we could not go up till infinity. Matlab was the simulation tool used for the propose of this lab and it was fast and gave us expected values for our simulation. We introduced boundary condition to observe the of the simulation.