ELEC 4700 ASSIGNMENT 2

FINITE DIFFERENCE METHOD

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Introduction

For this assignment we were given a task to solve basic electrostatic problems modelled as meshes of voltages and resistances using finite difference method and Laplace's equations. For the first aspect of the assignment, we had to model the voltage in a rectangular device. The second part of the assignment involved modelling voltages in a device with insulator bottlenecks. Lastly, we were required to calculate the current and other behaviors as other parameters and variables are changed.

Question 1: Finite Difference Method with Boundary Conditions a.

For this part the voltage was increased linearly from 0 (at x = W) to 1V (at x = 0). Figure 1 below shows the modelled voltage: plot in

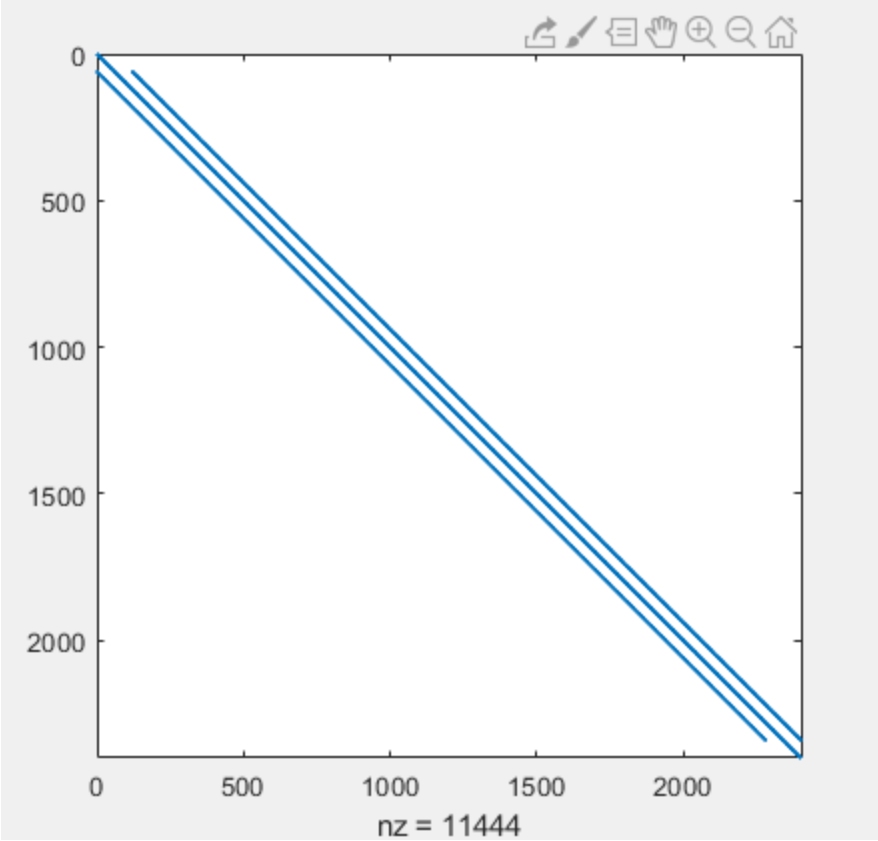

Figure 1 Plot of spy(g_matrix)

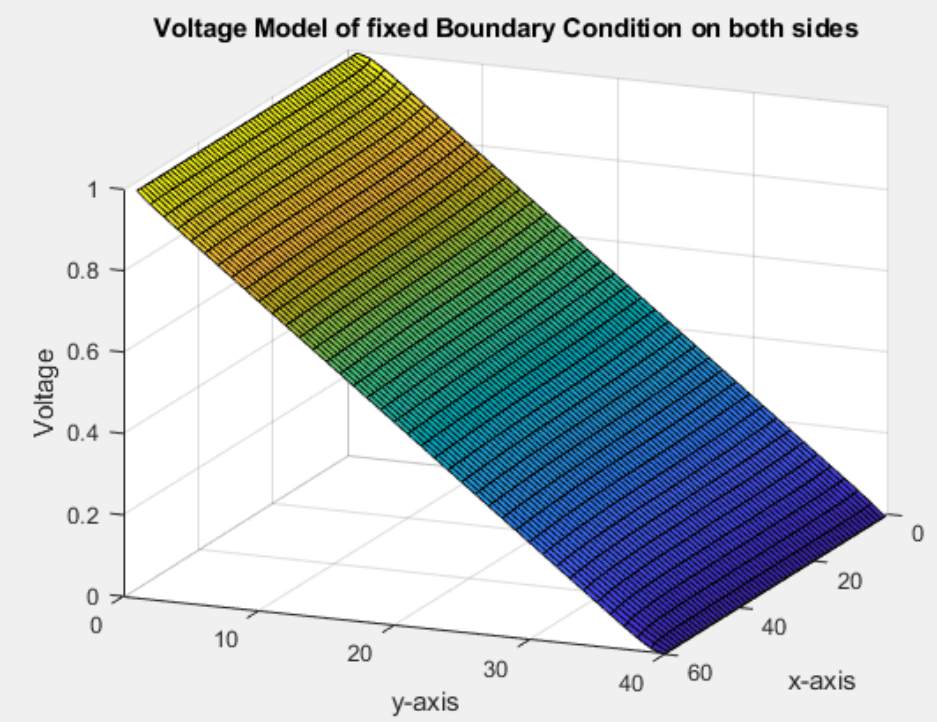

Figure 2 Voltage Model of fixed Boundary Condition on both sides

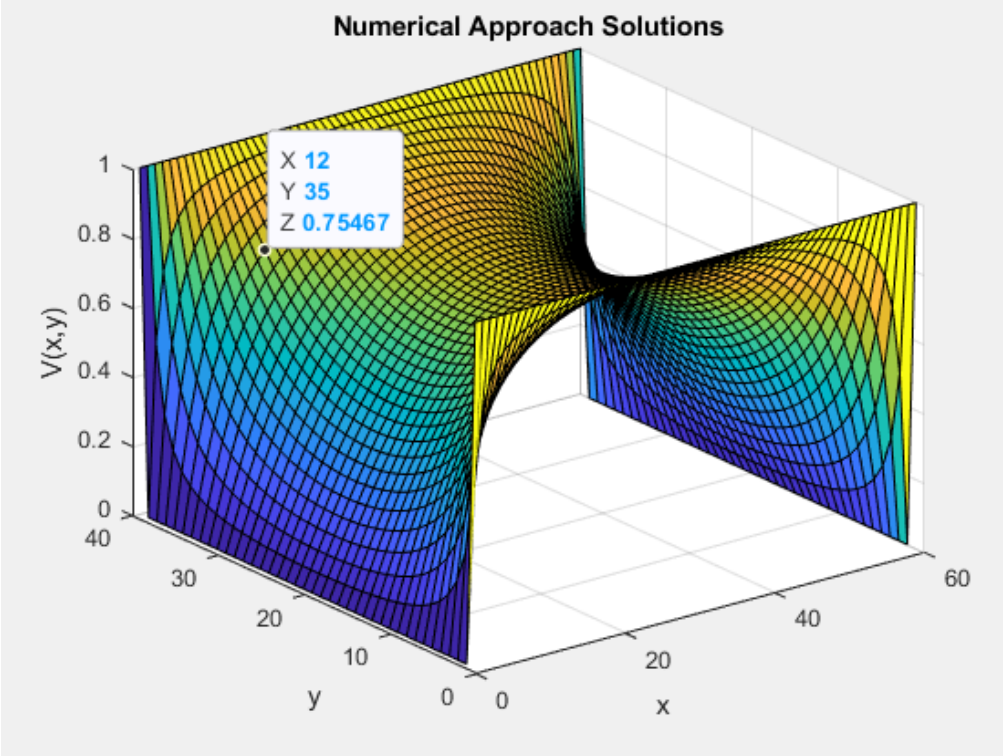

Figure 3 Numerical Approach Solution

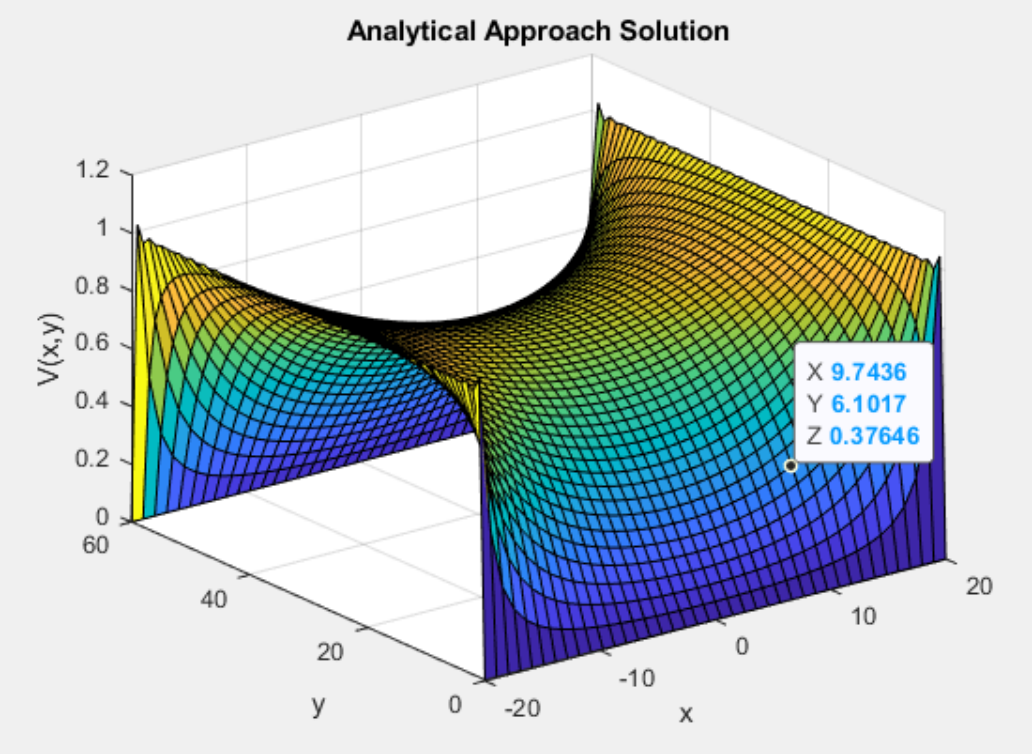

Figure 4 Analytical Approach Solution

Figure 3 and figure 4 prove that both approaches give identical results but both approaches have their pros and cons such as; The pros of using numerical solution approach is that because smaller steps are used, the given solution is more accurate than that of the analytical approach. The con of the numerical approach is that because approximations were used, the results can have some uncertainty. The pros of using the analytical approach is that because an actual equation was used, there are not as many approximations which means there are less uncertainty in the solution. The con of using the analytical approach is that because several summations were done, it is difficult for to know when to stop the summations and might require some trial and error. In the end of this part of the assignment, it can be seen that the mesh method is a good enough solution to solve the problem but the analytical approach will be better if memory and time is abundant and a much more accurate solution is needed.

Question 2: Finite Difference Method with Boundary Conditions and Added Bottleneck

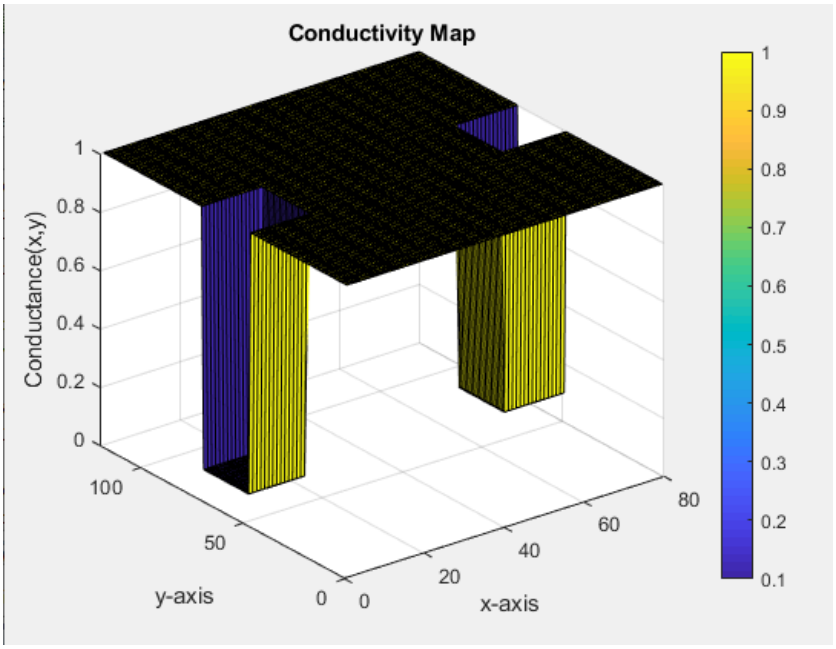

Figure 5 Conductivity Plot

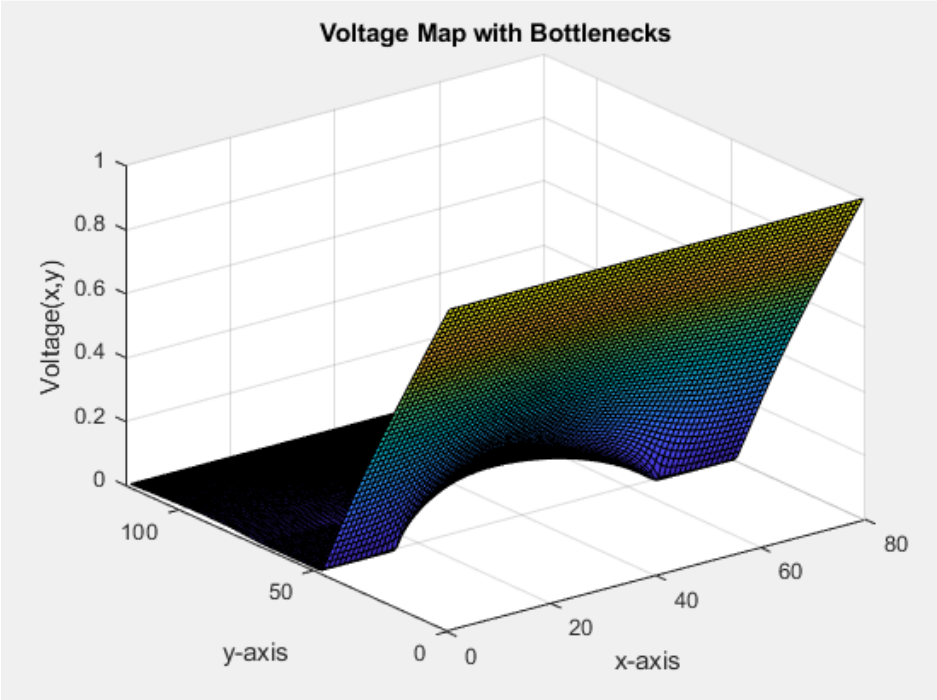

Figure 6 Plot of Voltage Mapping

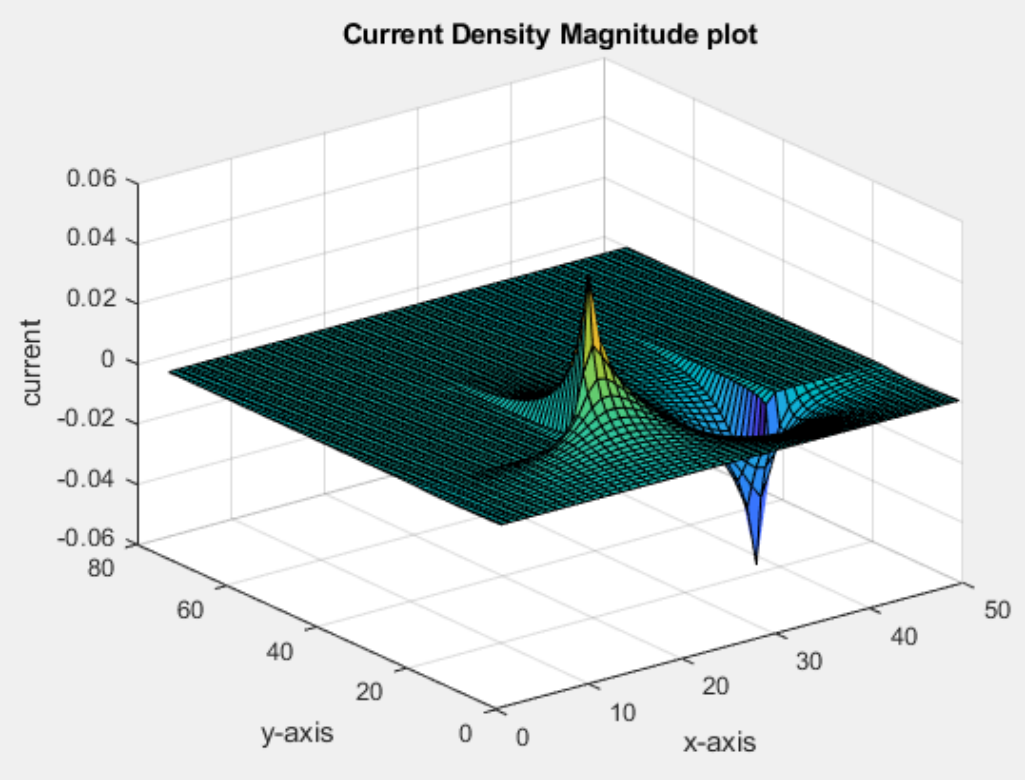

Figure 7 Magnitude of Current Density

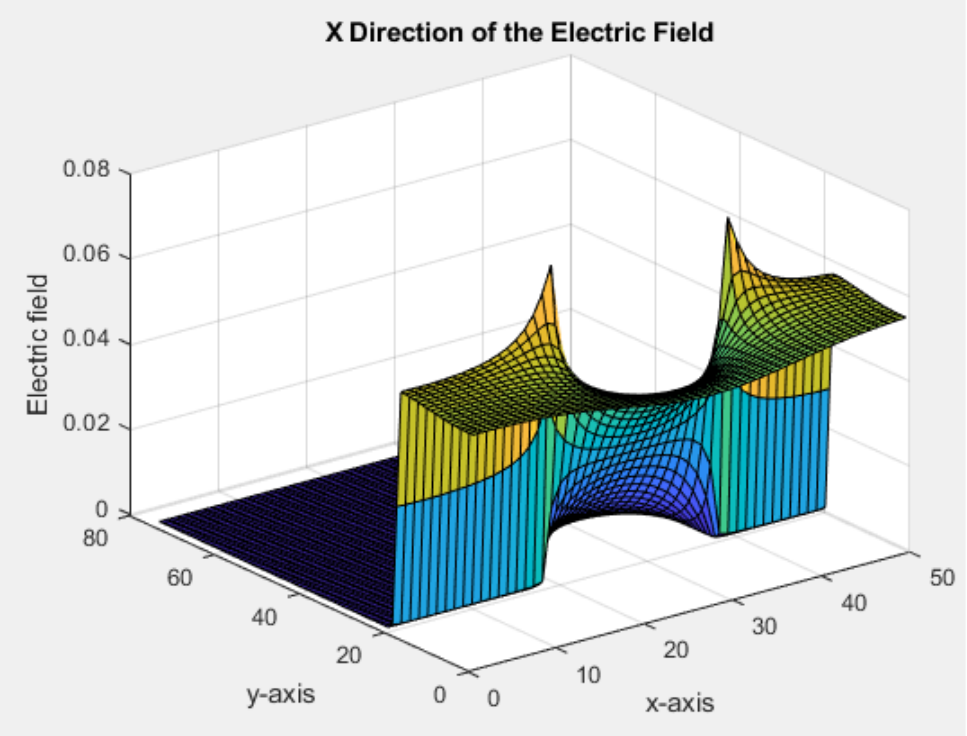

Figure 8 Electric field in the x direction

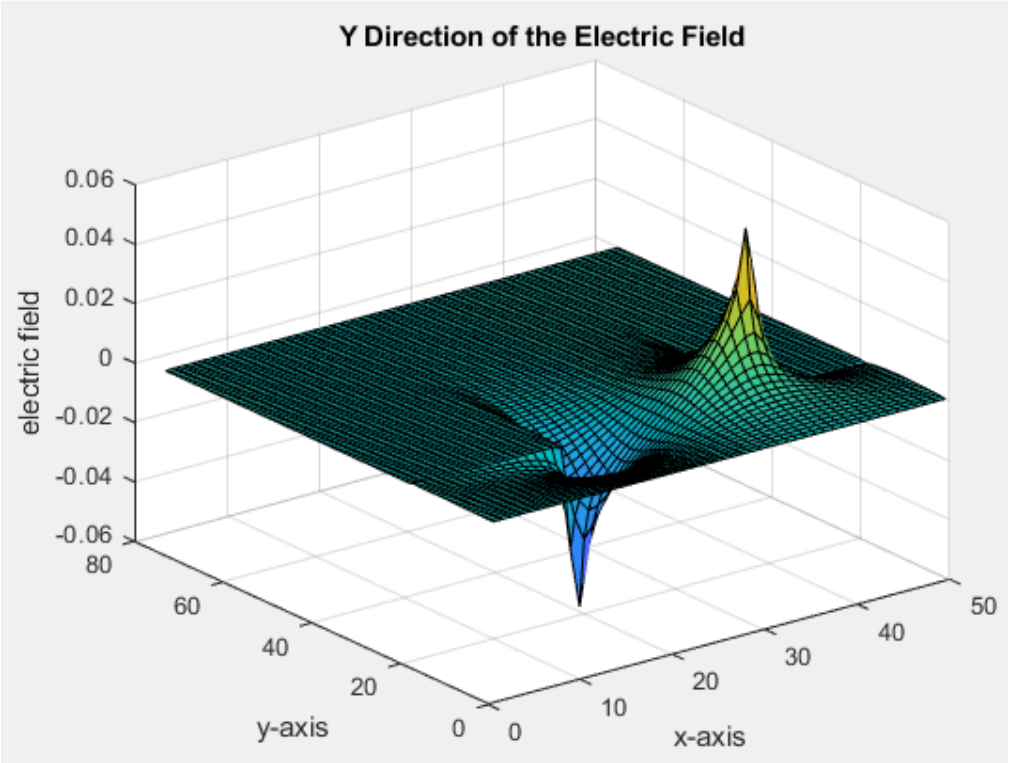

Figure 9 Electric Field in the Y direction

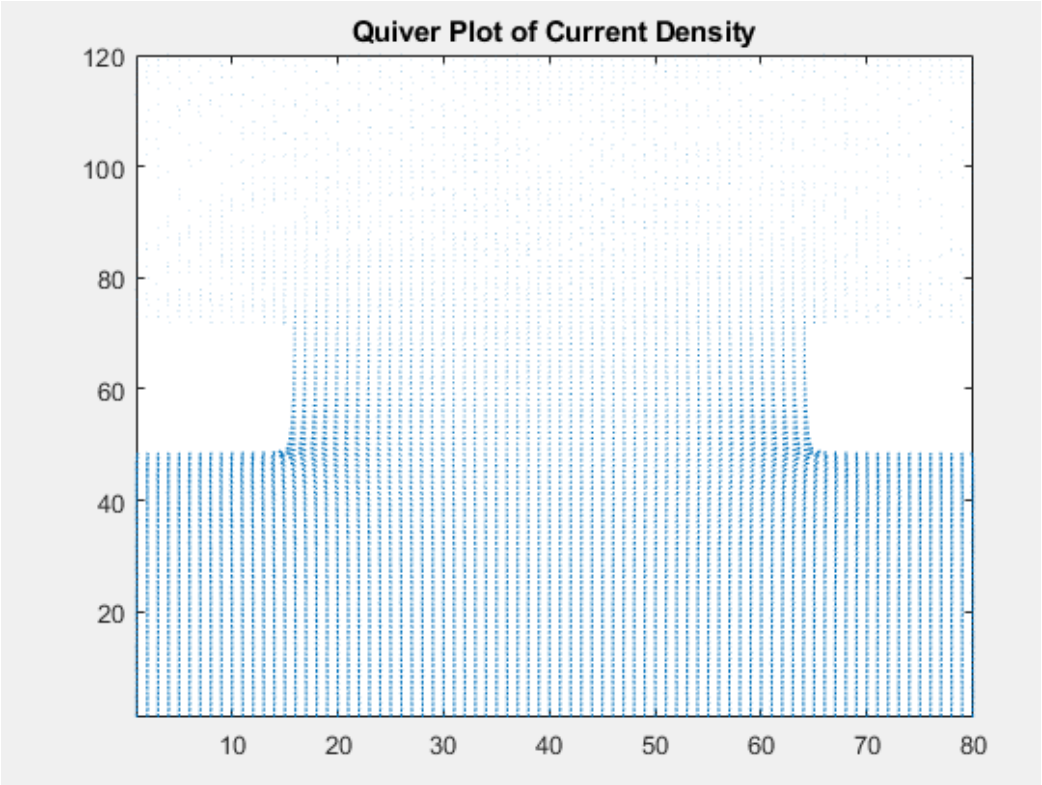

Figure 10 Quiver of current density in the material bottleneck

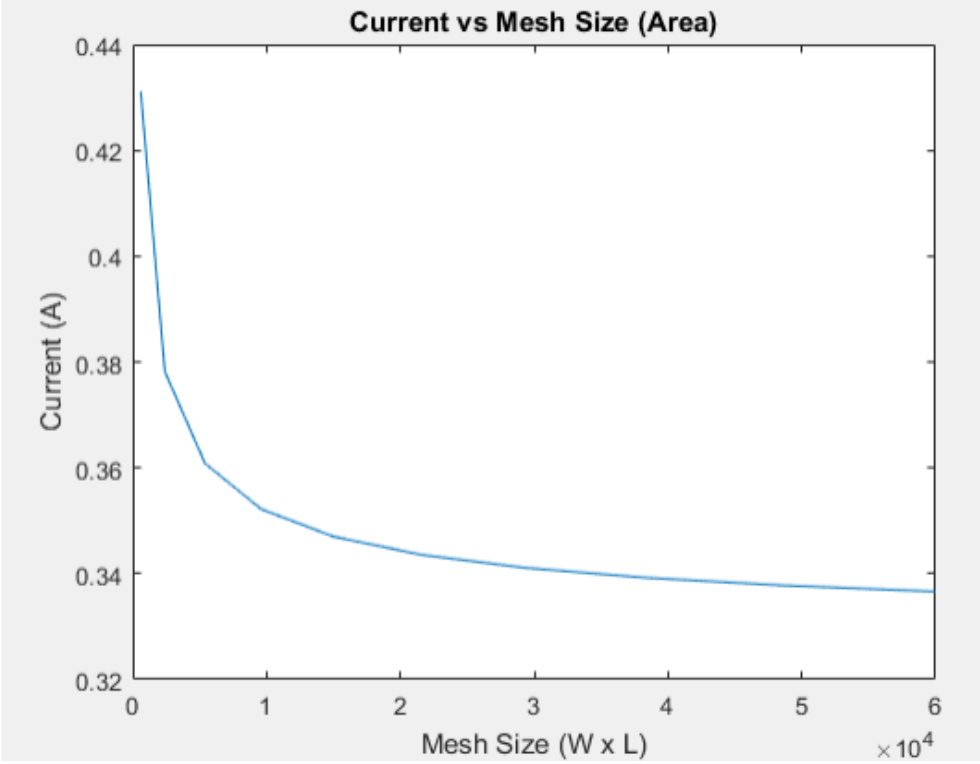

Figure 11 Current vs mesh size

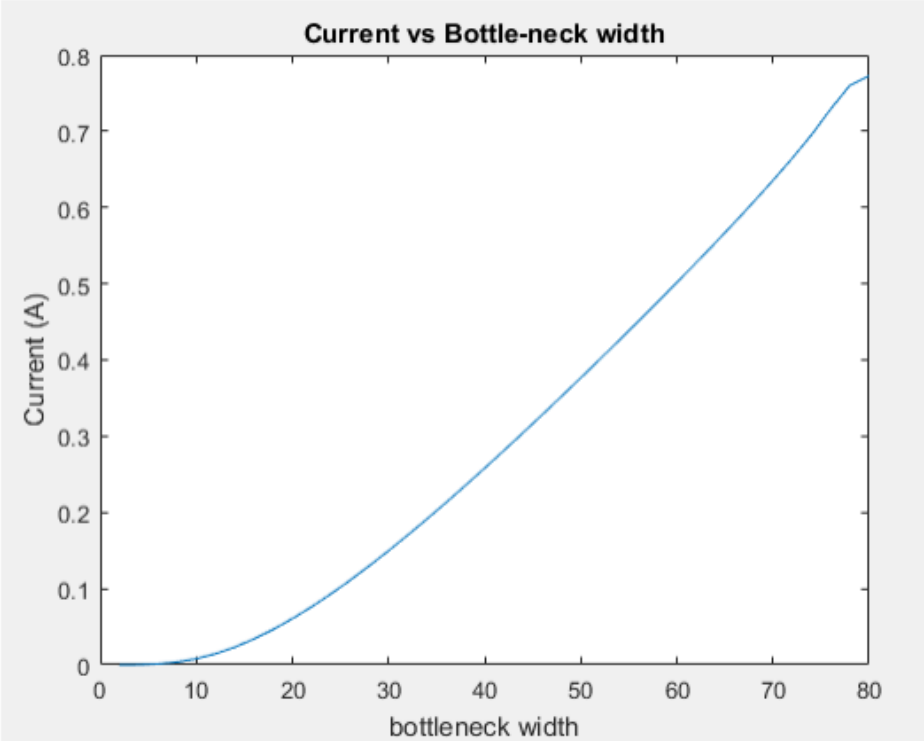

Figure 12 current vs bottle-neck width

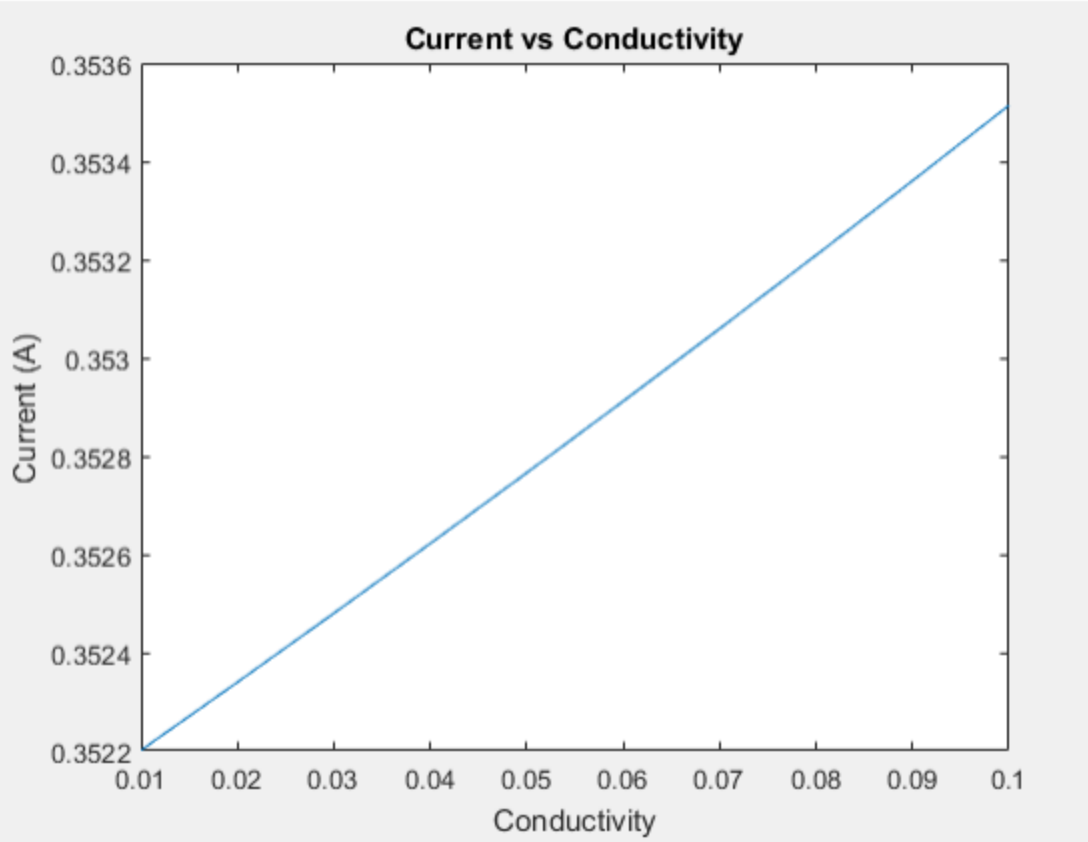

Figure 13 Current vs conductivity

Figure 13 shows that the current increased linearly with conductivity.

Conclusion

In the end of the assignment, all the plots attained had reasonable values and results and proved to be very educational about when to use which type of solution (analytical or numerical) depending on the accuracy needed.