Carleton University

ELEC 4700 A

Assignment-2: Finite Difference Method

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PART 1A

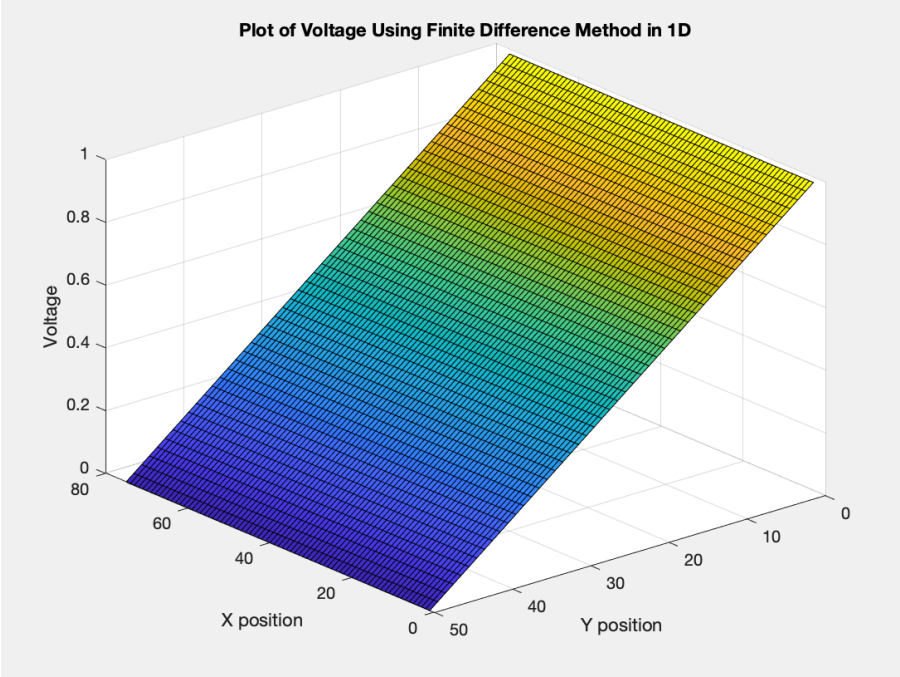

Figure 1. Plot of Voltage Using Finite Difference Method in 1D

PART 1B

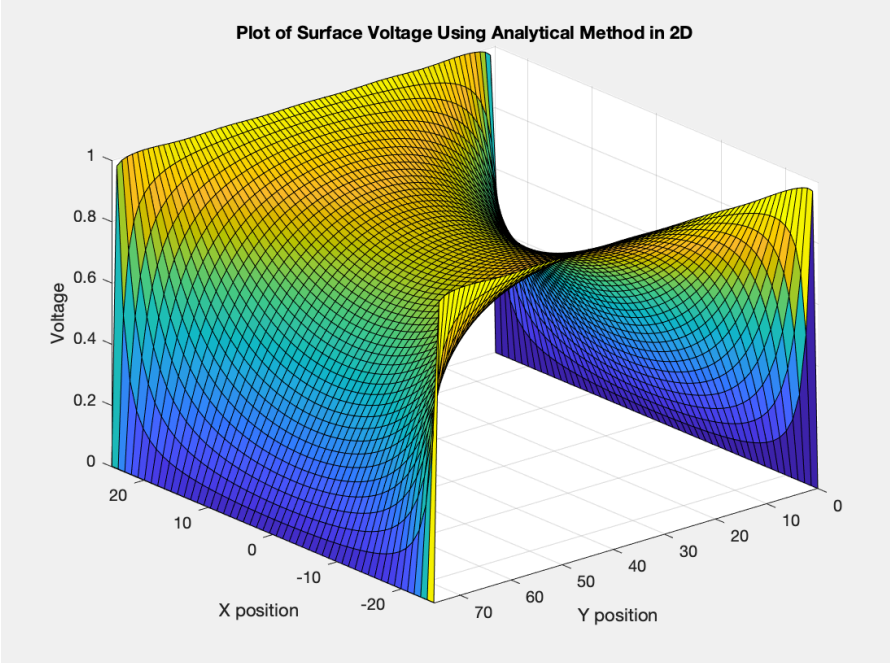

Figure 2. Plot of Surface Voltage Using Analytical Method in 2D

From Figures 1 and 2, it can be seen that the analytical solution used approaches the solution that was created using the Finite Difference method. Moreover, it should be noted that the iterations were limited to 600, for anything above that would result in an incorrect solution. This is because of the cosh and sinh terms which increase towards infinity at that value and therefore, contribute to additional error.

The advantage of a numerical method is that it can be used to find simple solutions; however, the disadvantage is that if the solution is too complex, then the hardware used may not be able to operate efficiently.

The advantage of the analytical method is that it is more efficient than the numerical method at finding simple solutions; however, the disadvantage is that certain values within an iteration may cause the results of the solution to be false.

PART 2A

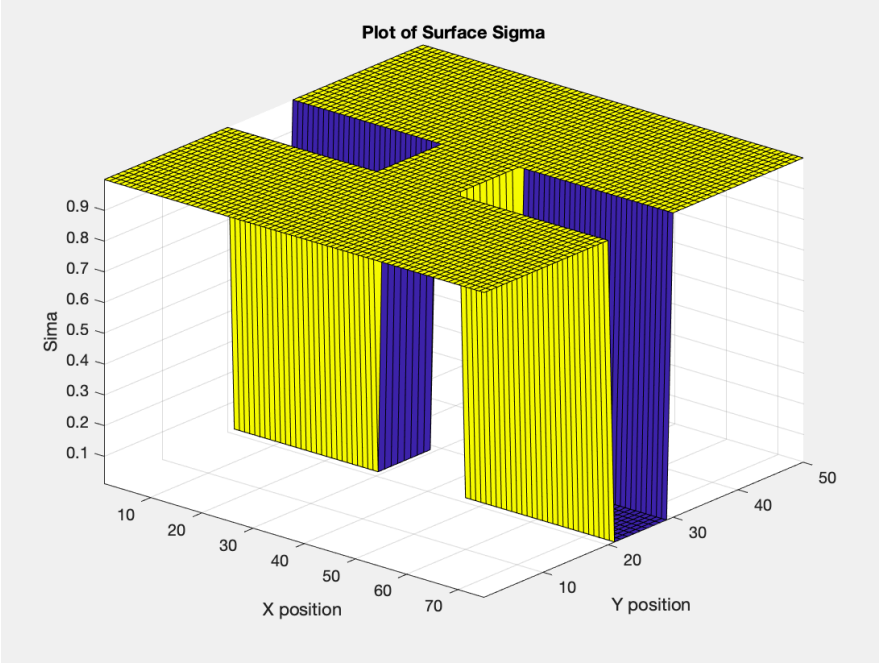

Figure 3. Plot of Surface Sigma

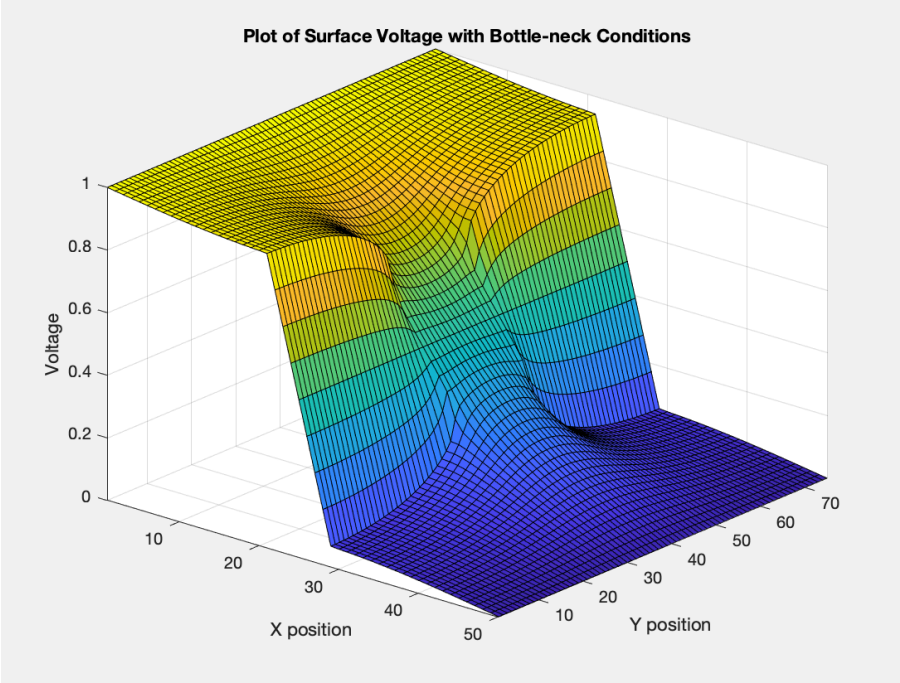

Figure 4. Plot of Surface Voltage with Bottle-neck Conditions

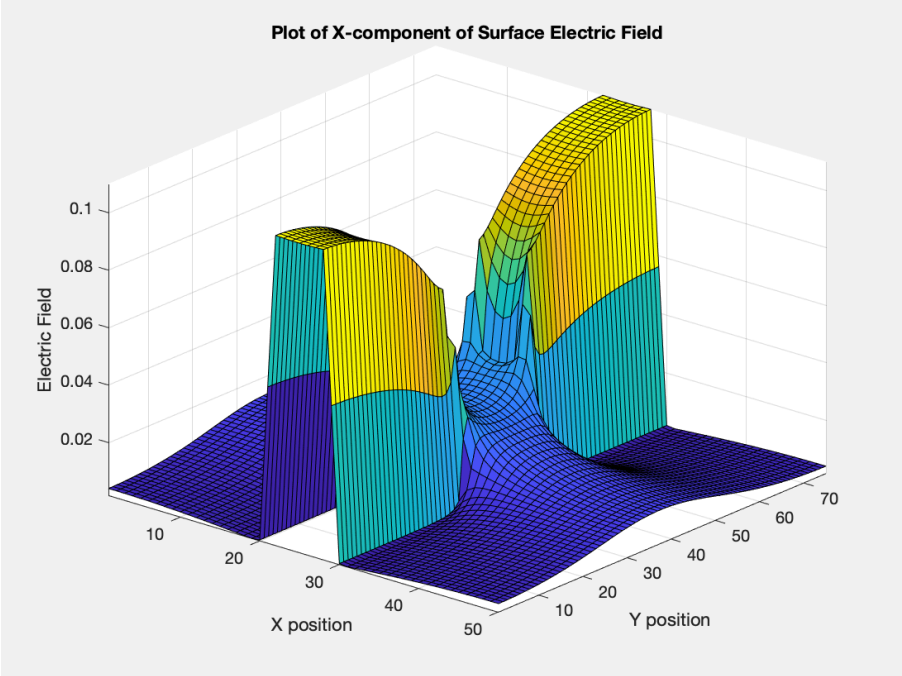

Figure 5. Plot of X-component of Surface Electric Field

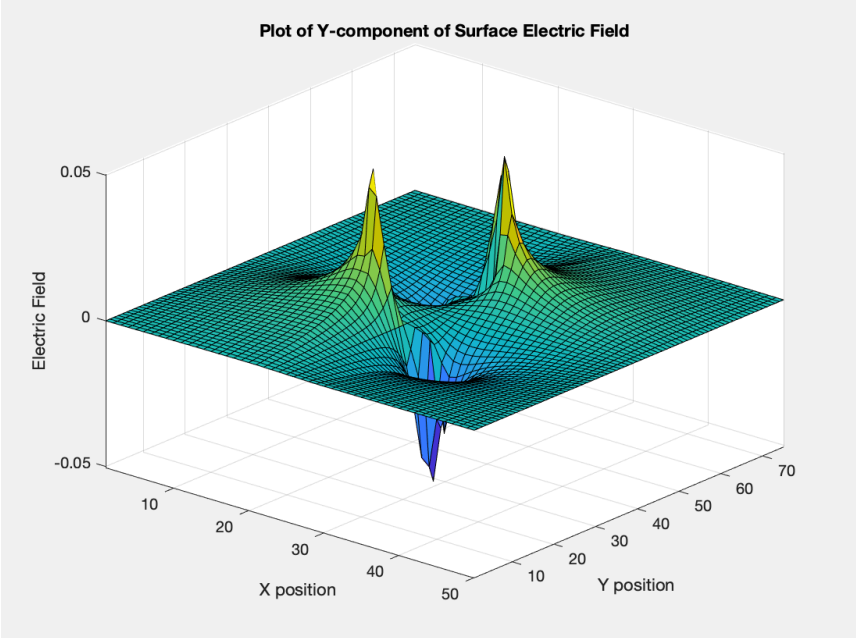

Figure 6. Plot of Y-component of Surface Electric Field

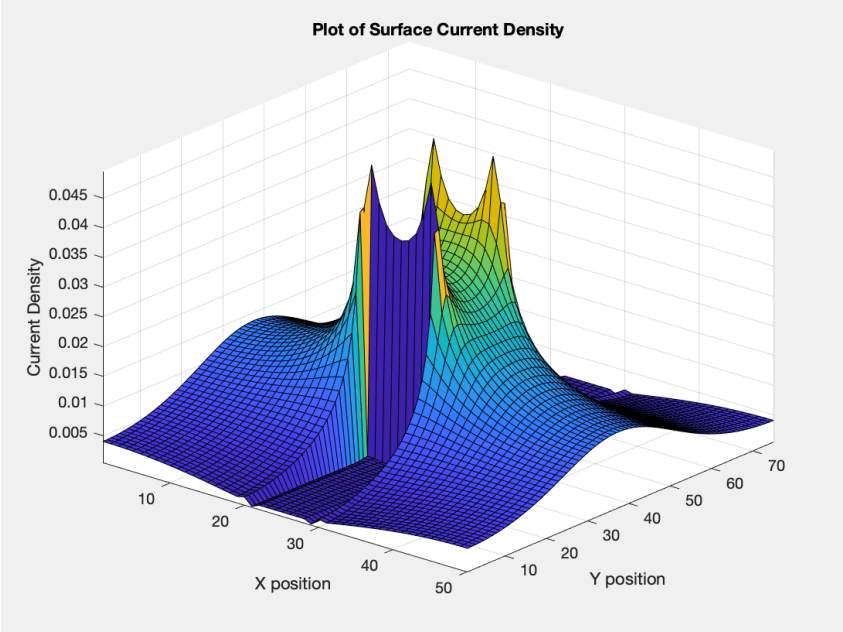

Figure 7. Plot of Surface Current Density

PART 2B

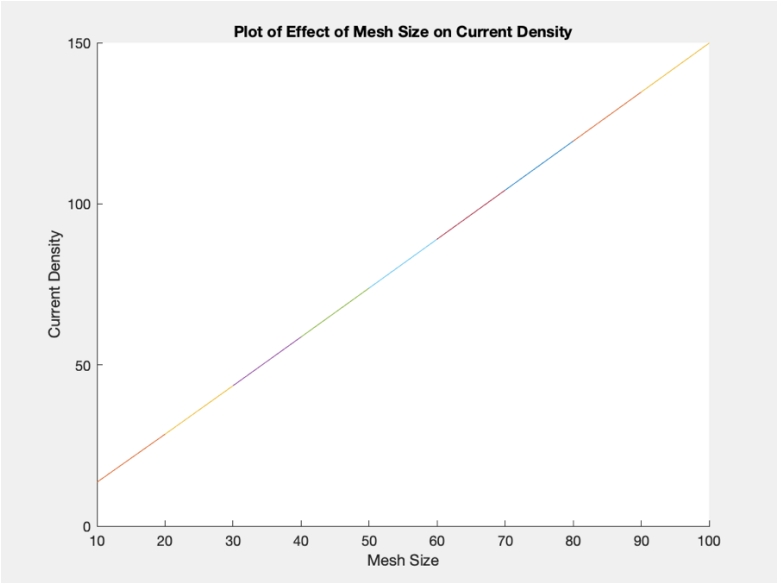

Figure 8. Plot of Effect of Mesh Size on Current Density

From Figure 8, it can be seen that the mesh size and current density are directly proportional to one another. This means that the larger the mesh size, the larger the current density and vice-versa.

PART 2C

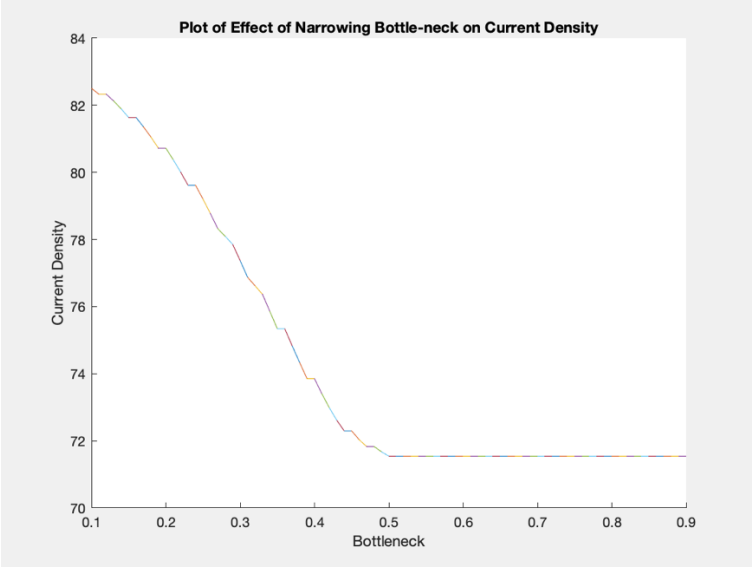

Figure 9. Plot of Effect of Narrowing Bottle-neck on Current Density

From Figure 9, it can be seen that the narrowing of the “bottle-neck” and the current density are inversely proportional to one another. This means that the more the “bottle-neck” is narrowed, the smaller the current density. Moreover, it should be noted that the current density appears to decrease exponentially and does not continue to decrease beyond a narrowing of the “bottle-neck” of approximately 0.5.

PART 2D

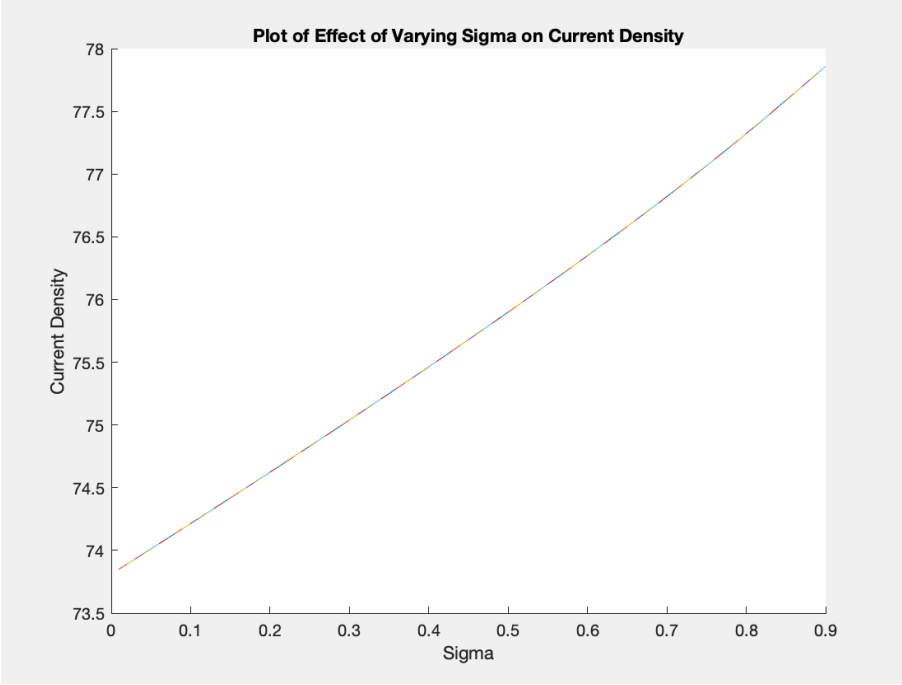

Figure 10. Plot of Effect of Varying Sigma on Current Density

From Figure 10, it can be seen that the sigma and current density are directly proportional. This means that the larger the sigma, the larger the current density. Moreover, it should be noted that the current density appears to increase linearly.