Finite Difference Method

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Assignment 2
ELEC 4700 A
A2 11:30-1:30pm
1 March 2022

1.0 Ramp and Saddle - FDM

a)

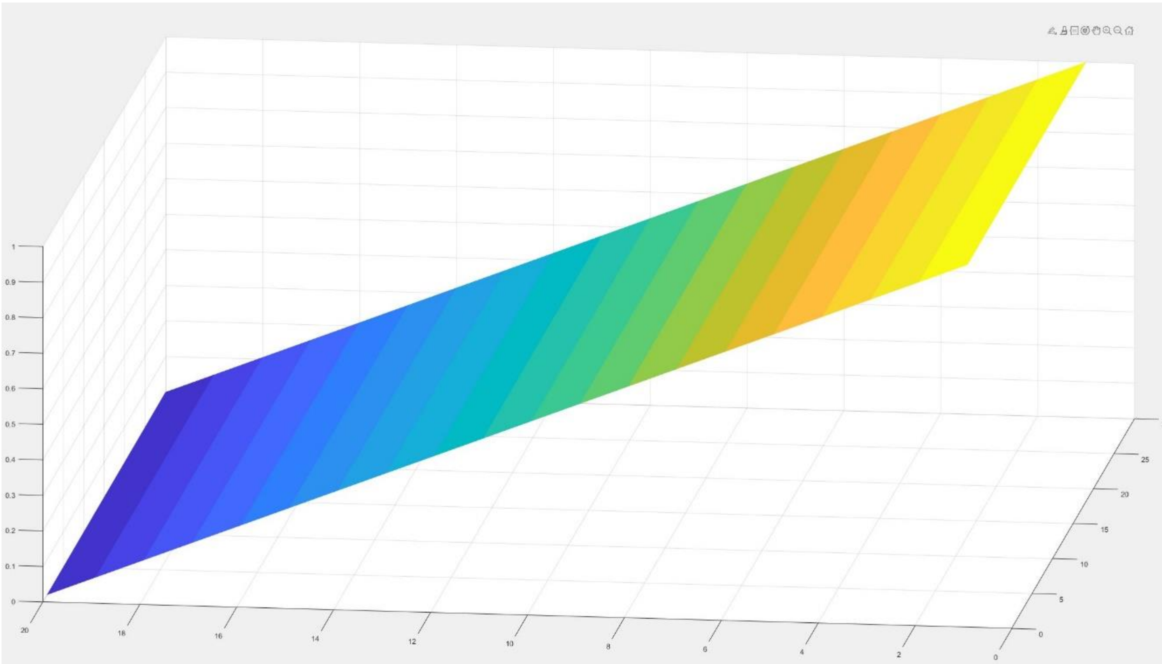

Figure 1: Numerical Solution with y Free Boundary Conditions

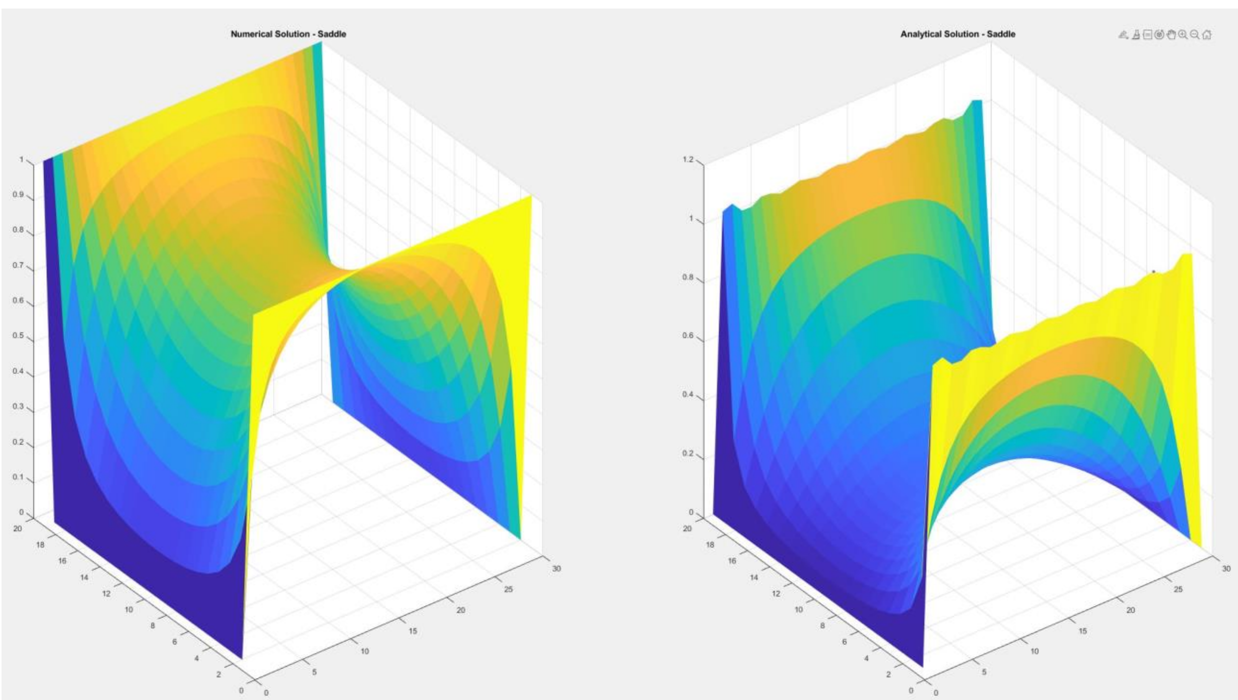

Figure 2: Numerical vs Analytical Saddle Solution

Meshing is obviously very important in these solutions because the finer the mesh, the closer the plots are to their "actual" values. With higher nx and ny values, the top of the analytical solution flattens closer to 1 and the dip/curve in the saddle gets higher (closer to the result from the numerical solution). We can't solve these infinitely so the only way to know when to stop is to stop the simulation when a certain number of decimals stop changing. That value would be dictated by how accurate you want the model. An advantage to analytical solutions would be that they don't involve guessing an initial value and recalculating values to get closer to the answer. They can also be solved via paper and pencil. However, analytical solutions don't always exist, and numerical solutions can be much quicker.

2.0 Collisions with Mean Free Path

a)

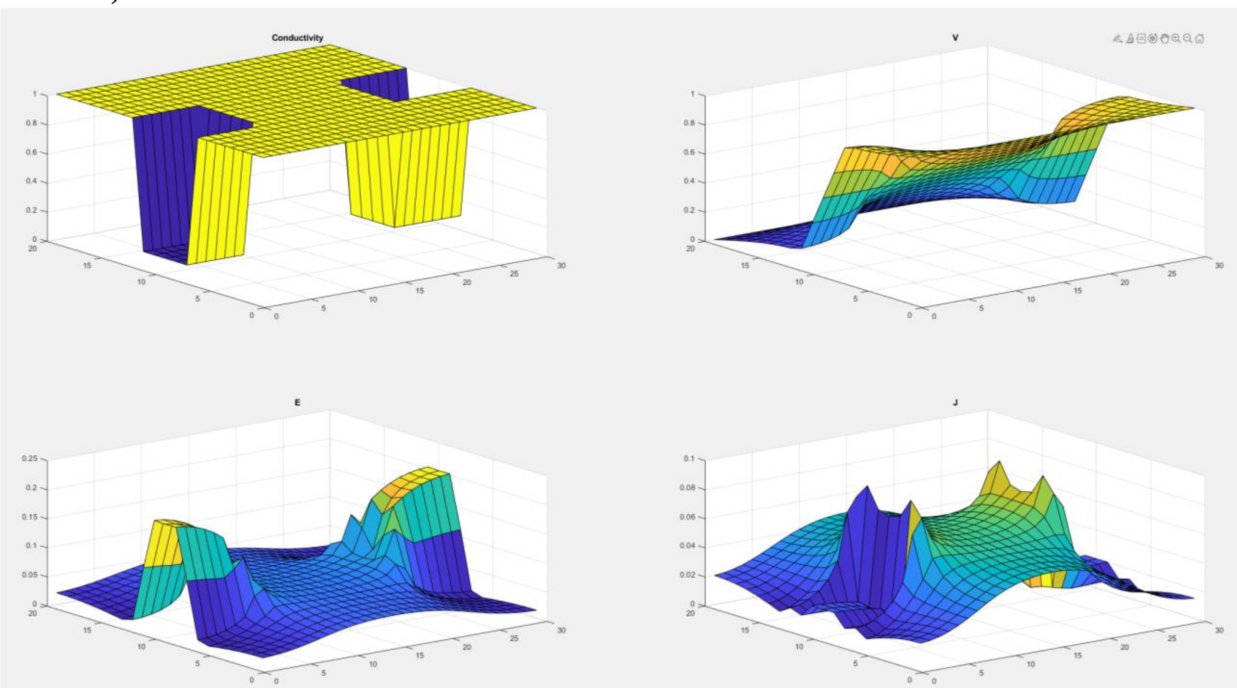

Figure 3: Conductivity, Voltage, Electric Field, and Current Density Plots with (nx,ny)=(20,30) and a gap of 16nm

Comparing figure 3 and 4, we can see that the plots gets more precise and the meshing is thicker when we increase nx and ny. Mathematically, when we increase the size it means that we are calculating smaller or more precise changes in the curves every iteration.

Comparing figures 3 and 5, we can see the that when we decrease the distance separating the contacts, the denser the current gets in the bottle neck. Just as expected since there is now less area for the particles to flow so the area becomes denser.

Looking at figure 6, we can see that by increasing the conductivity to 0.5, the particles will have an easier time crossing through the contact but still not as easy as outside the contacts (that have a conductivity of 1). If we were to increase the contacts to a higher conductivity than the surrounding area, then the particles would move through the contacts instead of the bottleneck.

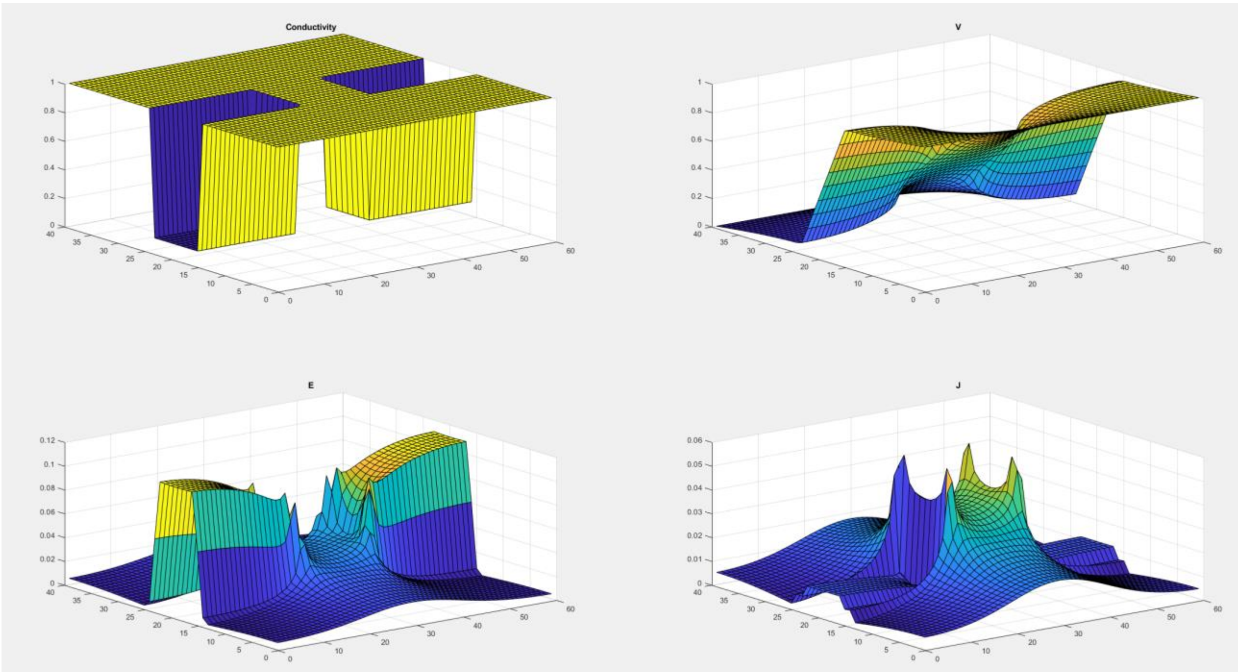

Figure 4: Conductivity, Voltage, Electric Field, and Current Density Plots with (nx.ny) = (40,60) and a gap of 16nm

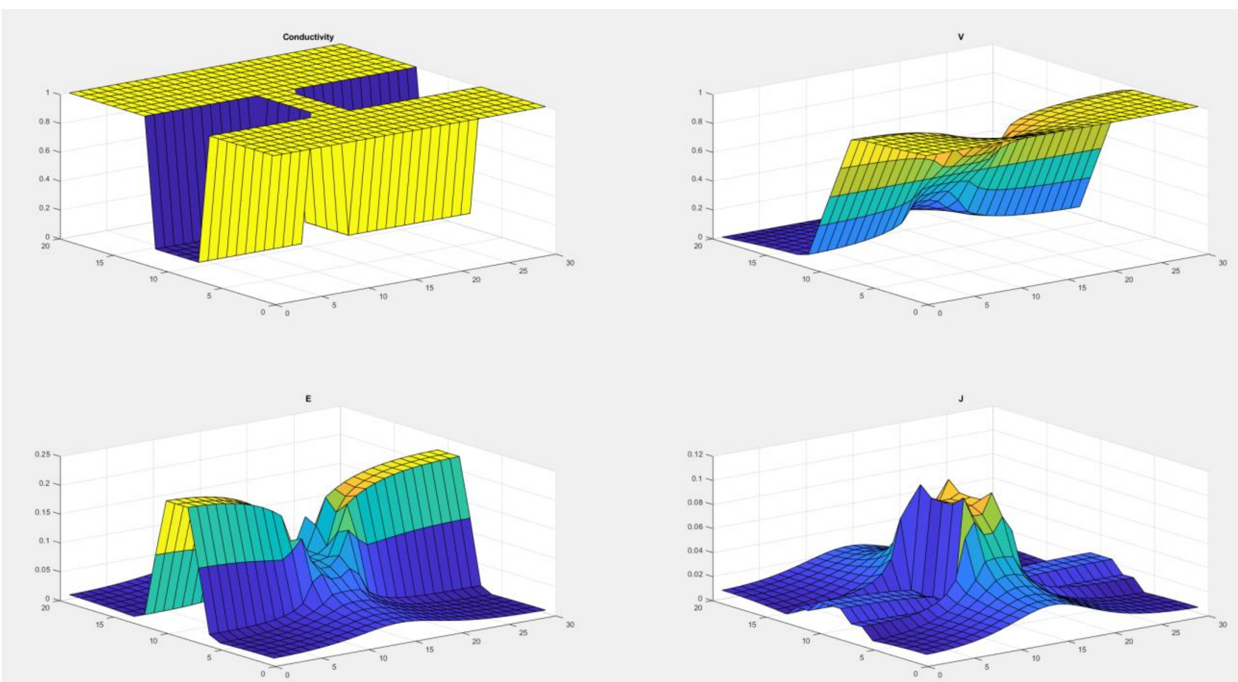

Figure 5: Conductivity, Voltage, Electric Field, and Current Density Plots with (nx.ny) = (20,30) and a gap of 5nm

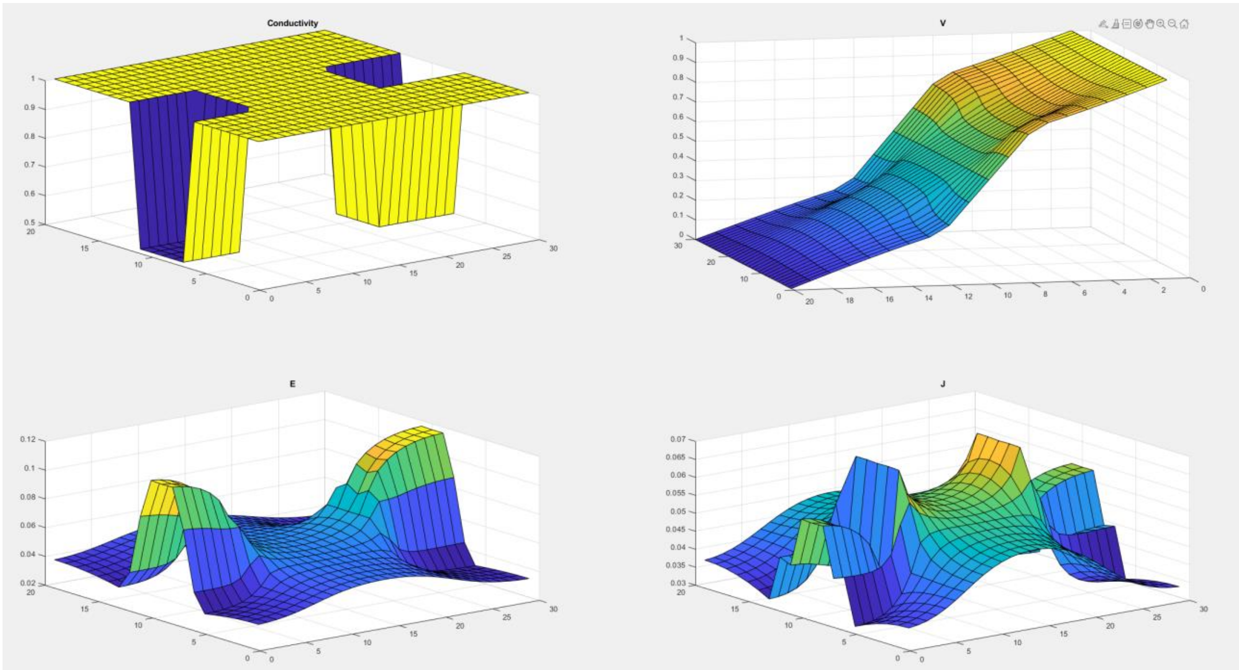

Figure 6: Conductivity, Voltage, Electric Field, and Current Density Plots with (nx.ny) = (20,30), a gap of 16nm, and contact with conductivities of 0.5