LAB 2: ELECTRIC FIELD

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Abstract: *The purpose of this report is to discover the electric field of conductive shapes and how it relates to electric potential. Using the visualization studio's moving arm to record the voltages at set intervals that could be adjusted to fit the proper dimensions of each set of shapes, then used these voltages and our set step size to calculate the electric field. This lab provides visuals to help understand how an electric field is connected to electric potential and how it flows from a positive to a negative charge.*
Keywords: *Voltage, Electric Field, Electric Potential*

Introduction

tIn this experiment we were tasked to find the electric potential along a conductor and calculate and map the electric field vector lines. To measure the electric potential we used a python script to gather the electric potential as we moved along the conductor. To find the electric field we found the negative gradient of the electric potential with respect to y and then we found the negative gradient of the electric potential with respect to x.

$$E_x = -\frac{\vartheta V}{\vartheta x} = -\frac{(V_{xy} - V_{(x+1)y})}{\vartheta x}$$ ***Equation 1***

$$E_y = -\frac{\vartheta V}{\vartheta y} = -\frac{(V_{xy} - V_{x(y+1)})}{\vartheta y}$$ ***Equation 2***

1. Experimental Procedure

The black BNC cable was attached to the DAQ and the red cable was connected to the power supply. The voltage was set to 5V and the current to 0.1A. The voltage probe origin was set to the center of the frame conductive paper scanning region though Mobaxterm. Once the center was determined we set the step size, x-steps, y-steps, and velocity to encompass the necessary grid points of the first figure. We then set the voltage probe on the CNC to the correct height setting so that the tip came in contact with the surface of the conductive paper. Then we ran the program to gather the voltage as a heatmap and the csv of the voltage readings for the figure. We repeated this process for all 4 figures, adjusting the x-steps and y-steps respectively each time to keep the correct grid point area within view of the heatmap.

2. Results and Analysis

After we collected the electric potential, shown in ***Figure 1-4*** as a heat map, we used ***Equation 1*** and ***Equation 2*** where ϑx and ϑy were equal to the step size(.01m) to find E_x and E_y . Once we found E_x and E_y We used vector_plotter.py to produce ***Figure 5-8*** .

After looking at ***Figure 5-8*** direction of electric field lines relative to the edges of a conductor we can see that the vector lines look to point to the direction of the conductor.

If we look at ***Figure 5-8*** the electric field looks to be the greatest in magnitude close to the conductor and the electric field looks to be 200N/C..

The electric fields near sharp edges look to be greater in magnitude than electric fields farther away from the sharp edges.

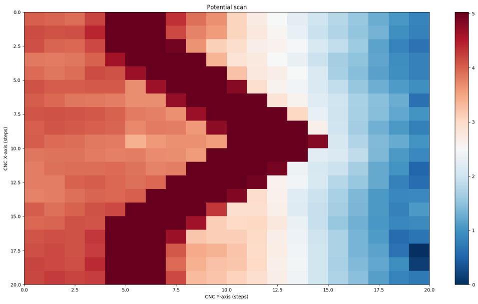

Figure 1: Triangle electric potential heat map

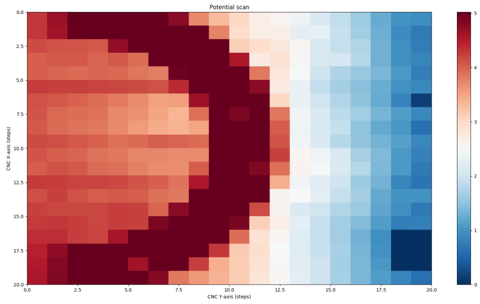

Figure 2: Line half circle electric potential heat map

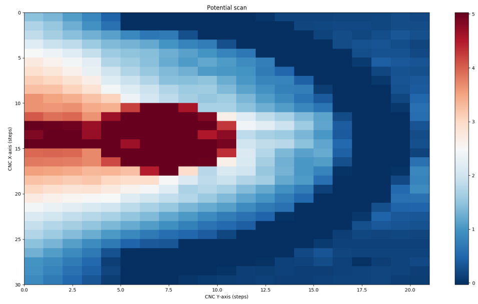

Figure 3: Half circle electric potential heat map

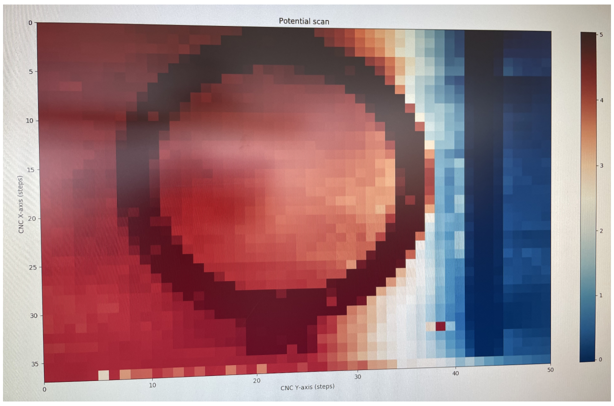

Figure 4: Circle electric potential heat map

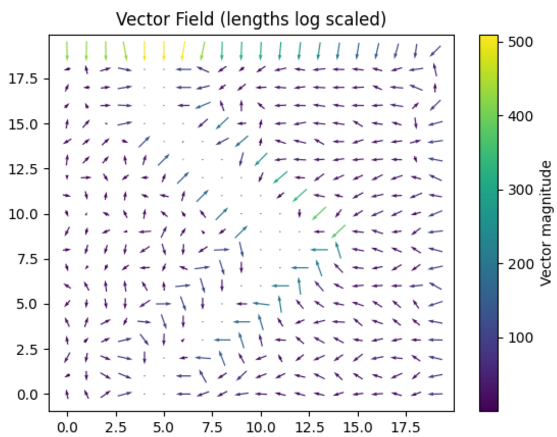

Figure 5: Triangle electric potential as a vector field

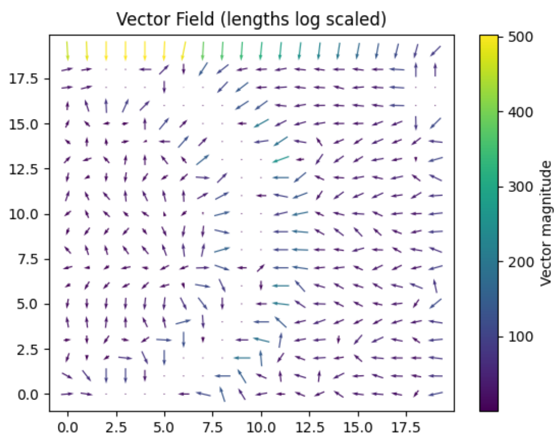

Figure 6: Line half circle electric potential as a vector field

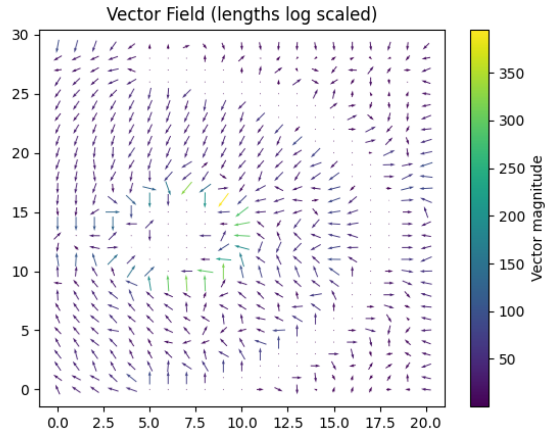

Figure 7: Half circle electric potential as a vector field

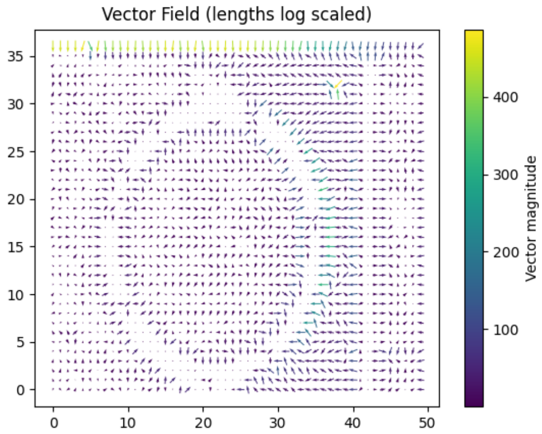

Figure 8: Circle electric potential as a vector field

3. Conclusions

In conclusion, we measured the electric potential across a conductor to observe the relationship between electric field vector lines and their proximity to the conductors. Once we were done gathering data we ended up with 4 .csv and 4 .png. Those 4 .pngs are ***Figure 1-4*** but as you can see ***Figure 4*** is different from the other figures and that is because there was a bug in the python script so we were unable to save ***Figure 4*** so we insead took a photo of it with our phone. Using the electric potential data we gathered during our experiment we were able to calculate the electric field vectors using ***Equation 1*** and ***Equation 2*** where ϑx and ϑy were equal to the step size(.01m) to find E_x and E_y. Once we found E_x and E_y we were able to use vector_plotter.py to produce ***Figure 5-8*** which show that as we approach the conductor the electric field is greater in magnitude and as we approach the sharp edges of the conductor we can see that the vector lines look to point to the direction of the conductor.