

# Lab 2: Electric Field

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## 1 Assignment

In this lab, your team will be investigating the relationship between electric potential ( $V$ ) and electric field ( $\vec{E}$ ). At your lab station, there are several conductive metal shapes. You can apply a charge to these shapes with a DC power supply and measure the resulting electric potential with a probe that has been attached to the CNC.

Your team has been tasked with determining the electric field produced for each of the configurations listed in Section 4.3 when a voltage is applied to the configuration. To complete this task, your team will scan every configuration (see Section 4.1) and then calculate the field from the scan output.

## 2 Deliverables

For your lab report, 10% of the grade will be for following the guidelines in the lab report template. Another 10% will be allocated for the Abstract and Introduction of your report. The remaining percentage will be based on your inclusion of the following:

1. [10%] a description of the process your team used to calculate electric field from the electric potential data
2. [60% total, 15% for each configuration] for each configuration scanned:
  - [5%] a plot showing the electric potential
  - [5%] a plot showing the electric field
  - [5%] the value of the largest electric field magnitude observed in the scan
3. [10%] your team's conclusion of how electric field lines interact with the surface of a conductor. This conclusion should be supported by data that *your team collected* during the lab.

## 3 Hazard Assessment

- Your team will be using a DC power supply in this lab. Always ensure the supply is **off** when plugging into or unplugging from the supply. The current output from the supply should not be over **0.1 A** during this lab.
- The conductive metal shapes have very sharp edges. Wear the provided cut gloves when handling these shapes.

## 4 Technical Information

### 4.1 Performing a scan

To use the voltage probe attached to the CNC to measure the electric potential, there is a script in the `examples/scanning` directory called `run_voltage_scan.py` that you may run. This script will record voltage readings in a grid of scan locations and write the resulting data out to a .csv file. Before running the script, you will need to set the parameters in the code for:

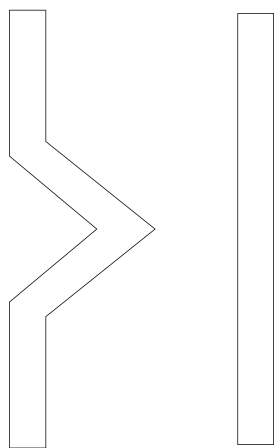
- `x_center`: the x value specifying the center of the region you wish to scan, in *mm*
- `y_center`: the y value specifying the center of the region you wish to scan, in *mm*
- `x_steps`: the number of scanning steps to take in the x direction
- `y_steps`: the number of scanning steps to take in the y direction
- `step_size`: the size (in *mm*) of each scan step

## 4.2 Plotting field

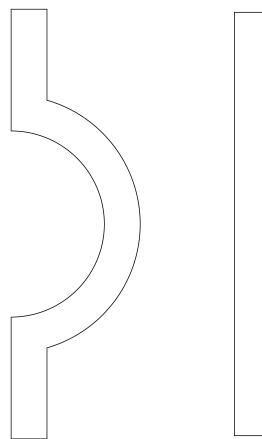
You are expected to provide some plots of electric field in your final report. You may produce these plots in any way you wish, but there is a Python script in the `examples/plotting` directory available. The script `vector_plot.py` will ask for two .csv files to be specified: one containing x component data and one containing y component data. These .csv files must be the same size and shape to be used by the script. There are some example .csv files in the `examples/plotting` directory to use as a reference.

## 4.3 Configurations

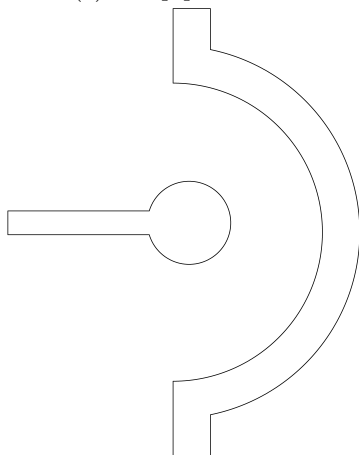
Below are shown the different configurations of shapes you are to investigate in this lab. For each, you may assume that the high voltage is applied to the shape on the left and that ground is attached to the shape on the right.



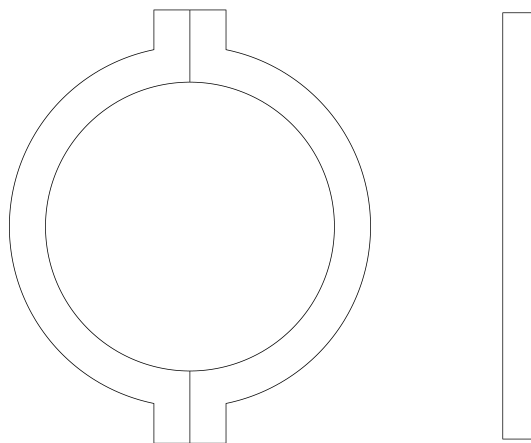
(a) Sharp point and bar



(b) Round edge and bar



(c) Radial capacitor



(d) Circular conductor