EE2703 : Applied Programming Lab
Experiment 5

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March 3, 2020

Abstract

The problem is to Solve for the direction and magnitude of current density at each point of a metal plate connected to different potentials.

Introduction

There is a metal plate in the shape of a square. An electrode of a given radius is connected to the middle of the plate and one edge of the plate is grounded. The electrode is supplied with 1V. We find the potential by solving the Laplace equation. The error for a single iteration is defined as `e[k] = abs((oldphi - phi)).max()`. This error is plotted for each value of k. We try to fit an exponential to this graph. A 3d plot of potential is also made. Then, the current component distributions are found as the partial derivatives of potential. This is plotted using `quiver()` command.

Results

1.Solving for potential

The phi matrix is initialized with zeros and boundary conditions are established (1V in the middle). We copy the values to a new matrix and pad it with edge values to preserve potential at the floating ends. Then we update the potential using the following line of code `phi = 0.25 * (oldphi[:-2, 1:-1] + oldphi[1:-1, 2:]  + oldphi[2:, 1:-1] + oldphi[1:-1, :-2])`. This is done `Niter` times. We finally end up with a good approximation of the actual potential values.

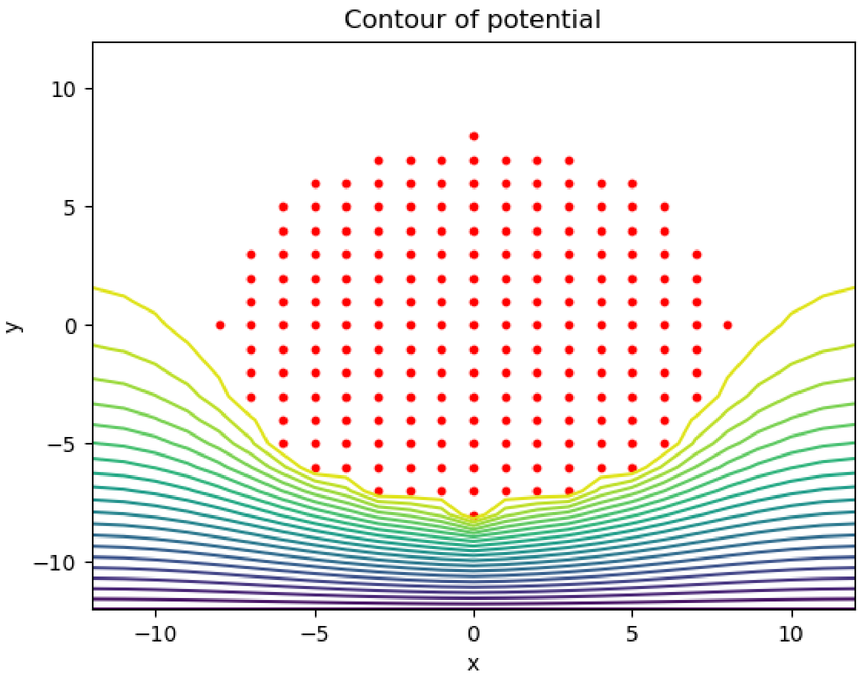

Figure 1: contour plot

2.Making a 3d plot of the potential

The potential obtained is visualized in 3d using the command `plot_surface()`

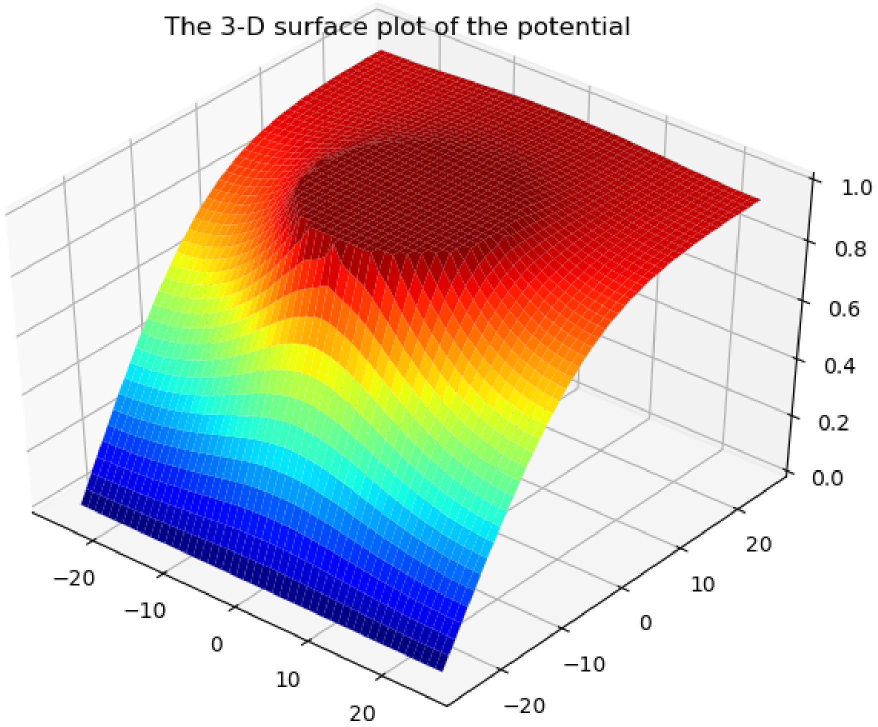

Figure 2: 3d surface plot

3.Fitting the errors

The error for each iteration is computed as `e[k] = abs((oldphi - phi)).max()`. This error is then plotted in a graph.

The values of error after the 500_{th} iteration are fitted to an exponential of the form Ae^{Bx}. This is again done using `lstsq()`. The fit obtained is shown in the graph below.

fit 1 : considering values above iteration 500
fit 2 : considering all values

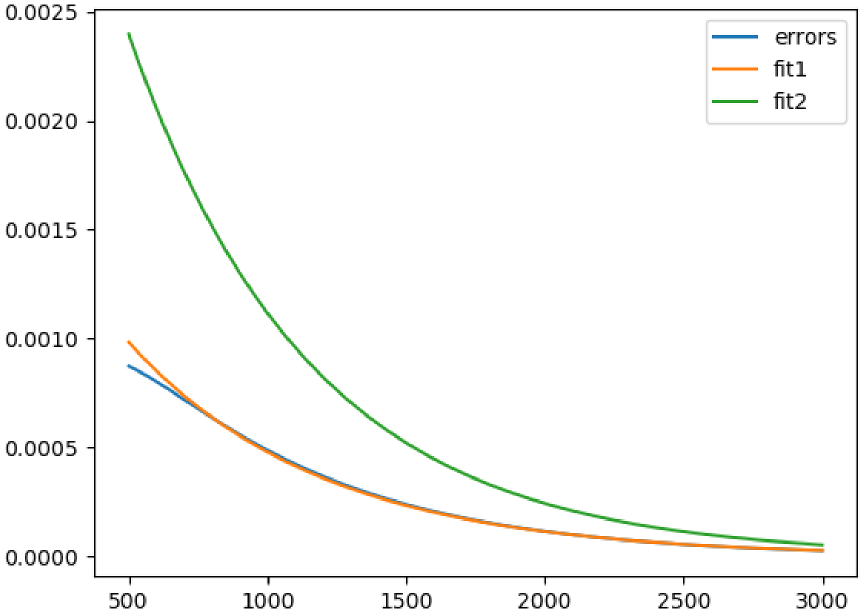

Figure 3: Error fit

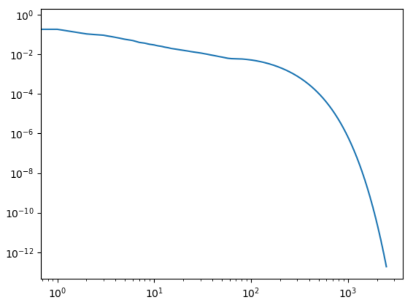

Figure 4: loglog

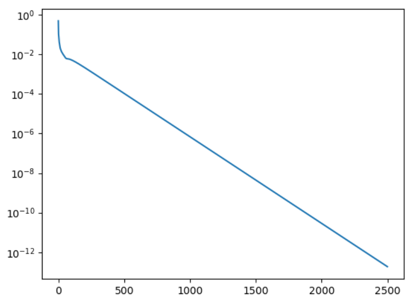

Figure 5: semilog

4.Current densities

The components of current density are derived as the partial derivatives of the potential along x and y axes respectively. These components are used to visualize the flow of current through the conductor. This is done using the `quiver()` command.

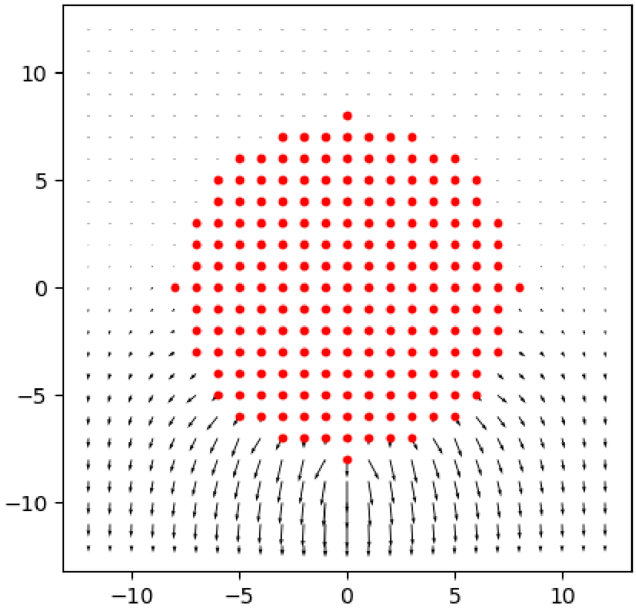

Figure 6: Current densities

Conclusions

The resistor problem is successfully solved and the current density at each point is obtained and plotted. The heat produced is maximum in the region where the current is maximum.