Assignment 3: Part 2

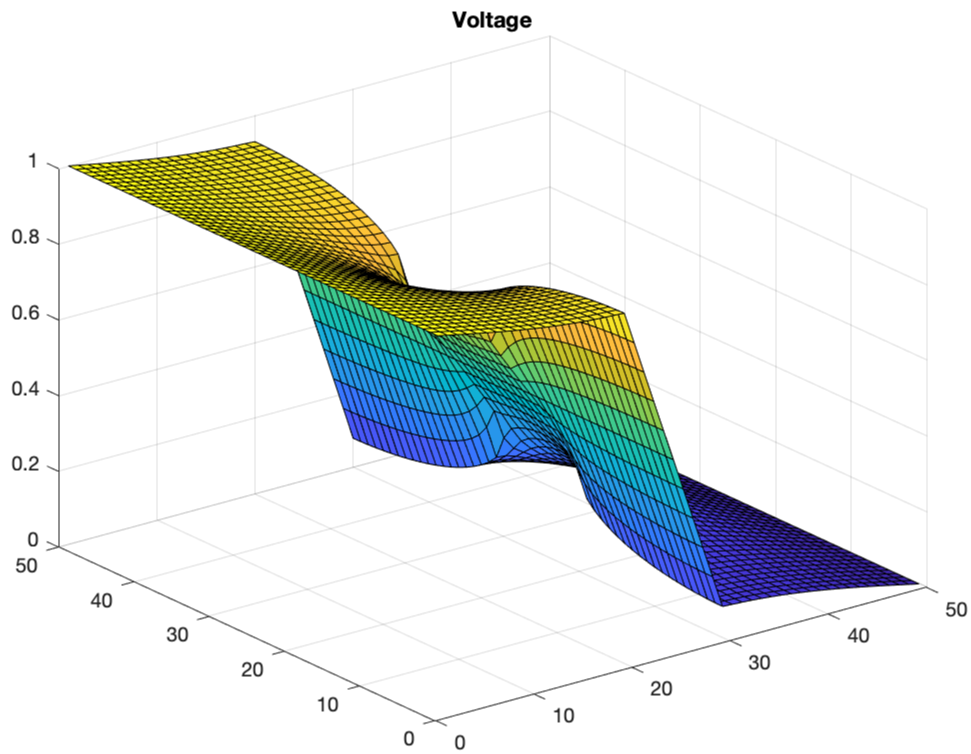
The Finite Difference method was then used to calculate the the potential within a region with a bottle neck inserted. The same approach was taken in assignment 2 part 2. The results can be found below.

```
close all;
clear;

Sigma = 1;

nx = 50;
ny = 50;

G = sparse (nx*ny, nx*ny);
B = zeros(1, nx*ny);

cMap = zeros (nx, ny);

%Loop to assign Conductivity
for i = 1:nx
    for j = 1:ny
        if ((i>=0.4*nx) && (i<=0.6*nx) && (j<=0.4*ny)) || ((i>=0.4*nx)
 && (i<=0.6*nx) && (j>=0.6*ny))
            cMap(i,j) = .01;
        else
            cMap(i,j) = Sigma;
        end
    end
end

for i = 1:nx
    for j = 1:ny
        n = j + (i-1)*ny;

        if i == 1
            G(n, :) = 0;
            G(n, n) = 1;
            B(n)    = 1;
        elseif i == nx
            G(n, :) = 0;
            G(n, n) = 1;
        elseif j == 1
            nxm = j + (i - 2)*ny;
            nxp = j + (i)*ny;
            nyp = j + 1 + (i - 1)*ny;

            rxm = (cMap(i,j) + cMap(i - 1, j))/2;
            rxp = (cMap(i,j) + cMap(i + 1, j))/2;
            ryp = (cMap(i,j) + cMap(i, j + 1))/2;

            G(n, n) = -(rxm + rxp + ryp);
            G(n, nxm) = rxm;
```

```
                G(n, nxp) = rxp;
                G(n, nyp) = ryp;

            elseif j == ny
                nxm = j + (i - 2)*ny;
                nxp = j + (i)*ny;
                nym = j - 1 + (i - 1)*ny;

                rxm = (cMap(i,j) + cMap(i - 1, j))/2;
                rxp = (cMap(i,j) + cMap(i + 1, j))/2;
                rym = (cMap(i,j) + cMap(i, j - 1))/2;

                G(n, n) = -(rxm + rxp + rym);
                G(n, nxm) = rxm;
                G(n, nxp) = rxp;
                G(n, nym) = rym;

            else

                nxm = j + (i - 2)*ny;
                nxp = j + (i)*ny;
                nym = j - 1 + (i - 1)*ny;
                nyp = j + 1 + (i - 1)*ny;

                rxm = (cMap(i,j) + cMap(i - 1, j))/2;
                rxp = (cMap(i,j) + cMap(i + 1, j))/2;
                rym = (cMap(i,j) + cMap(i, j - 1))/2;
                ryp = (cMap(i,j) + cMap(i, j + 1))/2;

                G(n, n) = -(rxm + rxp + ryp + rym);
                G(n, nxm) = rxm;
                G(n, nxp) = rxp;
                G(n, nym) = rym;
                G(n, nyp) = ryp;

            end

        end

    end

    V = G\B';

    vMap = zeros(nx,ny);
    for i=1:nx
        for j=1:ny
            n = j + (i - 1)*ny;
            vMap(i,j) = V(n);
        end
    end

    vMap_T = vMap';
```

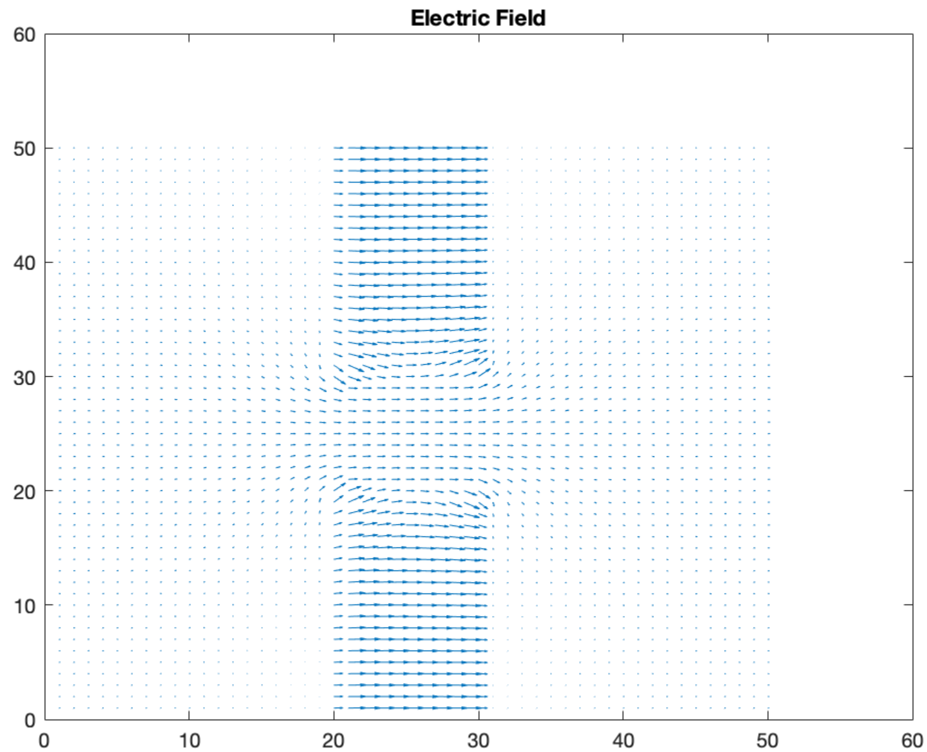
The Finite Difference Method was then applied to solve for the current flow through the region. A voltage map was created for the region and can be seen in the Figure below.

```
%Potential Plot
figure(1)
surf(vMap_T);
title('Voltage');
```



The electric field was then determined for the region. The electric field was found by taking the gradient of the voltage matrix. The electric field of the region can be seen in the Figure below. Note that there was an adjustment on the electric field values which would account for the true area of the region.

```
%Electric Field Plot
[Ex, Ey] = gradient(-vMap_T);
EX = Ex/5E-8;
EY = Ey/5E-8;
figure(2)
quiver(EX, EY);
title ('Electric Field');
```



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