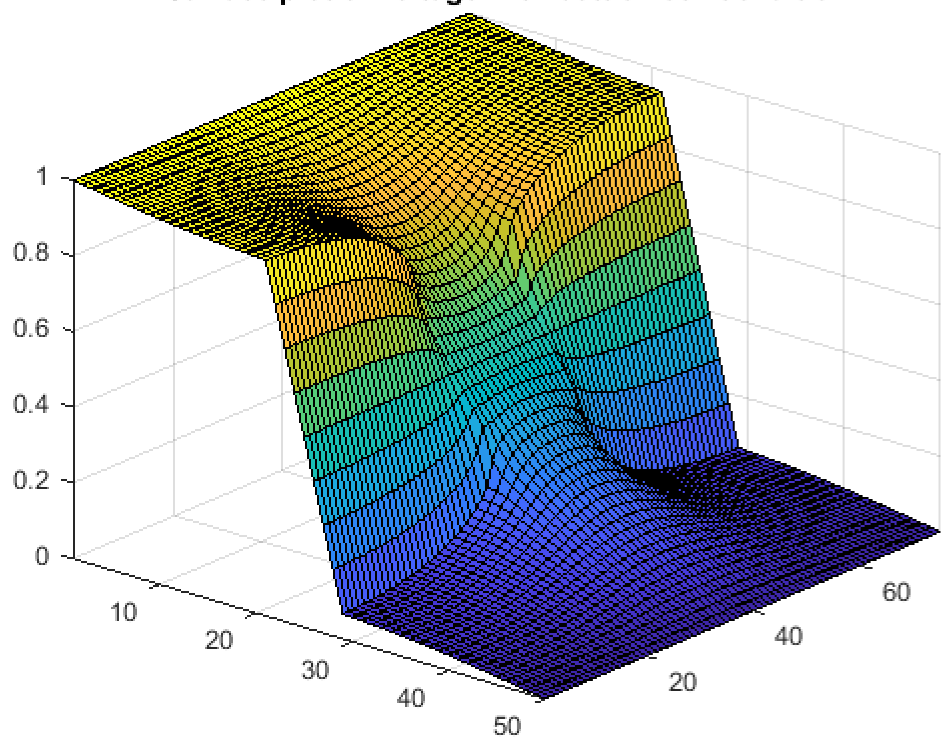
Part 2

In part 2,by calculating the potential with the bottle-neck and making a vector plot for the electric field, we are familiarizing ourselves with assignment 2 again to check if everything we have done is working as intended for the full implementation in the last part of the assignment.

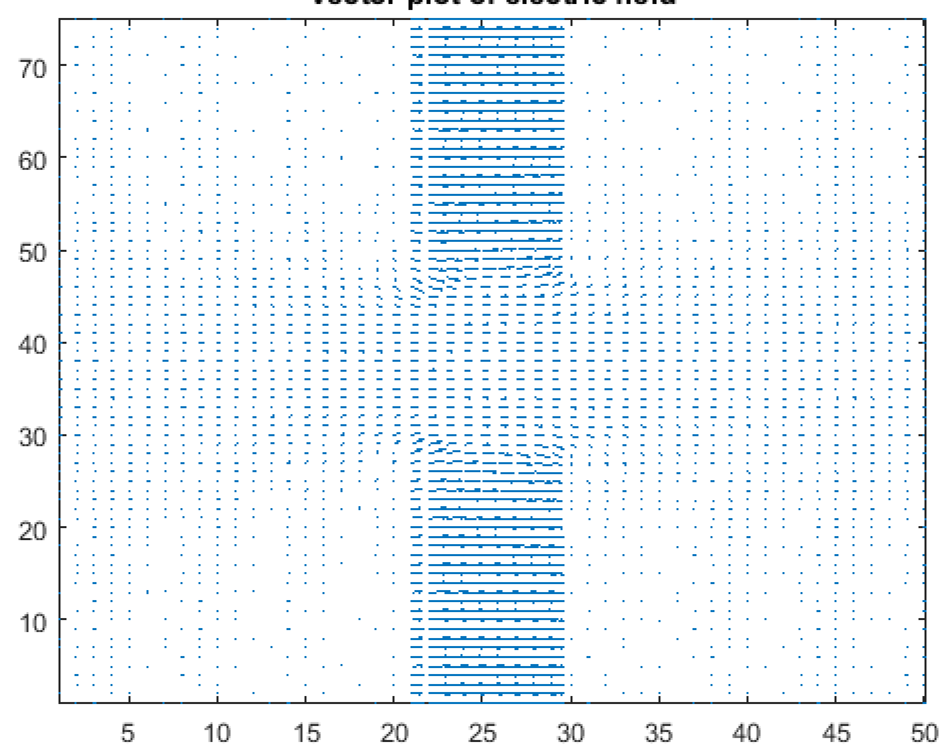
```
% Reset Everything
close all
clear

% Setting variables
nx = 50;                    % Length of the region
ny = nx*3/2;                % Width of the region, 3/2 of length
G = sparse(nx*ny);          % Initialize a G matrix
D = zeros(1, nx*ny);        % Initialize a matrix for G matrix operation
S = zeros(ny, nx);          % Initialize a matrix for sigma
sigma1 = .01;               % Setting up parameter of sigma in different
 region
sigma2 = 1;
box = [nx*2/5 nx*3/5 ny*2/5 ny*3/5]; % Setting up the bottle neck

% Sigma matrix setup
sigma = zeros(nx, ny);
for i = 1:nx
    for j = 1:ny
        if i > box(1) && i < box(2) && (j < box(3)||j > box(4))
            sigma(i, j) = sigma1;
        else
            sigma(i, j) = sigma2;
        end
    end
end

% Implement the G matrix with the bottle neck condition in the region
for i = 1:nx
    for j = 1:ny

        n = j + (i-1)*ny;
        nip = j + (i+1-1)*ny;
        nim = j + (i-1-1)*ny;
        njp = j + 1 + (i-1)*ny;
        njm = j - 1 + (i-1)*ny;

        if i == 1
            G(n, :) = 0;
            G(n, n) = 1;
            D(n) = 1;
        elseif i == nx
            G(n, :) = 0;
            G(n, n) = 1;
            D(n) = 0;
        elseif j == 1
```

```
            G(n, nip) = (sigma(i+1, j) + sigma(i,j))/2;
            G(n, nim) = (sigma(i-1, j) + sigma(i,j))/2;
            G(n, njp) = (sigma(i, j+1) + sigma(i,j))/2;
            G(n, n) = -(G(n,nip)+G(n,nim)+G(n,njp));
        elseif j == ny
            G(n, nip) = (sigma(i+1, j) + sigma(i,j))/2;
            G(n, nim) = (sigma(i-1, j) + sigma(i,j))/2;
            G(n, njm) = (sigma(i, j-1) + sigma(i,j))/2;
            G(n, n) = -(G(n,nip)+G(n,nim)+G(n,njm));
        else
            G(n, nip) = (sigma(i+1, j) + sigma(i,j))/2;
            G(n, nim) = (sigma(i-1, j) + sigma(i,j))/2;
            G(n, njp) = (sigma(i, j+1) + sigma(i,j))/2;
            G(n, njm) = (sigma(i, j-1) + sigma(i,j))/2;
            G(n, n) = -(G(n,nip)+G(n,nim)+G(n,njp)+G(n,njm));
        end
    end
end

% Calculating the voltage
V = G\D';

% Inverting the G matrix
X = zeros(ny, nx, 1);
for i = 1:nx
    for j = 1:ny
        n = j + (i-1)*ny;
        X(j,i) = V(n);
    end
end

% Creating a surface plot for voltage
figure(1)
surf(X)
axis tight
view([40 30]);
title("Surface plot of voltage with bottle neck condition")

% Calculating the electric field from voltage
[Ex, Ey] = gradient(X);

% Vector plot of electric field
figure(2)
quiver(-Ex, -Ey);
axis tight
title("Vector plot of electric field")
```

Surface plot of voltage with bottle neck condition



Vector plot of electric field



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