```
% Reset Everything

%In part 2c) we are investigating narrowing of the bottle neck, this
 is
%done by changing the y valyes of the box that we used in parts a and
 b.
%Again, we are going to loop through values to multiply the y values
 and
%observe the effects this has on current. stay tuned for more

for bottleneck = 0.1:0.01:0.9

 %setting up variable matrices like in part 1
    nx = 50;
    ny = nx*3/2;
    G = sparse(nx*ny);
    Op = zeros(1, nx*ny);

    Sigmatrix = zeros(ny, nx); % a sigma matrix is required for this
 part
    Sig1 = 10^-2;                % sigma value given outside the box
    Sig2 = 1;                     % sigma value given inside the box


    %The bottleneck is incrementally "narrowed" by modifying the y
 values
    %of the box
    box = [nx*2/5 nx*3/5 ny*bottleneck ny*(1-bottleneck)];

    %filling in the G matrix
    for i = 1:nx

        for j = 1:ny

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

            if i == 1

                G(n, :) = 0;
                G(n, n) = 1;
                Op(n) = 1;

            elseif i == nx

                G(n, :) = 0;
                G(n, n) = 1;
                Op(n) = 0;

            elseif j == 1

                if i > box(1) && i < box(2)
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```
                    G(n, n) = -3;
                    G(n, n+1) = Sig1;
                    G(n, n+ny) = Sig1;
                    G(n, n-ny) = Sig1;

                else

                    G(n, n) = -3;
                    G(n, n+1) = Sig2;
                    G(n, n+ny) = Sig2;
                    G(n, n-ny) = Sig2;

                end

            elseif j == ny

                if i > box(1) && i < box(2)
                    G(n, n) = -3;
                    G(n, n+1) = Sig1;
                    G(n, n+ny) = Sig1;
                    G(n, n-ny) = Sig1;

                else

                    G(n, n) = -3;
                    G(n, n+1) = Sig2;
                    G(n, n+ny) = Sig2;
                    G(n, n-ny) = Sig2;

                end

            else

                if i > box(1) && i < box(2) && (j < box(3)||j >
box(4))

                    G(n, n) = -4;
                    G(n, n+1) = Sig1;
                    G(n, n-1) = Sig1;
                    G(n, n+ny) = Sig1;
                    G(n, n-ny) = Sig1;

                else

                    G(n, n) = -4;
                    G(n, n+1) = Sig2;
                    G(n, n-1) = Sig2;
                    G(n, n+ny) = Sig2;
                    G(n, n-ny) = Sig2;

                end
            end
        end
    end
```

```
    for Length = 1 : nx

        for Width = 1 : ny

            if Length >= box(1) && Length <= box(2)
                Sigmatrix(Width, Length) = Sig1;

            else
                Sigmatrix(Width, Length) = Sig2;

            end

            if Length >= box(1) && Length <= box(2) && Width >= box(3)
&& Width <= box(4)

                Sigmatrix(Width, Length) = Sig2;
            end
        end
    end


    Voltage = G\Op';


    sol = zeros(ny, nx, 1);

    for i = 1:nx

        for j = 1:ny

            n = j + (i-1)*ny;
            sol(j,i) = Voltage(n);

        end
    end

    %The electric field can be derived from the surface voltage using
a
    %gradient
    [elecx, elecy] = gradient(sol);

    %J, the current density, is calculated by multiplying sigma and
the
    %electric field together.

    J_x = Sigmatrix.*elecx;
    J_y = Sigmatrix.*elecy;
    J = sqrt(J_x.^2 + J_y.^2);

   %plotting bottleneck vs current
    figure(1)
    hold on
```

```
    if bottleneck == 0.1

        Curr = sum(J, 2);
        Currtot = sum(Curr);
        Currold = Currtot;
        plot([bottleneck, bottleneck], [Currold, Currtot])

    end

    if bottleneck > 0.1

        Currold = Currtot;
        Curr = sum(J, 2);
        Currtot = sum(Curr);
        plot([bottleneck-0.01, bottleneck], [Currold, Currtot])
        xlabel("Bottleneck");
        ylabel("Current Density");

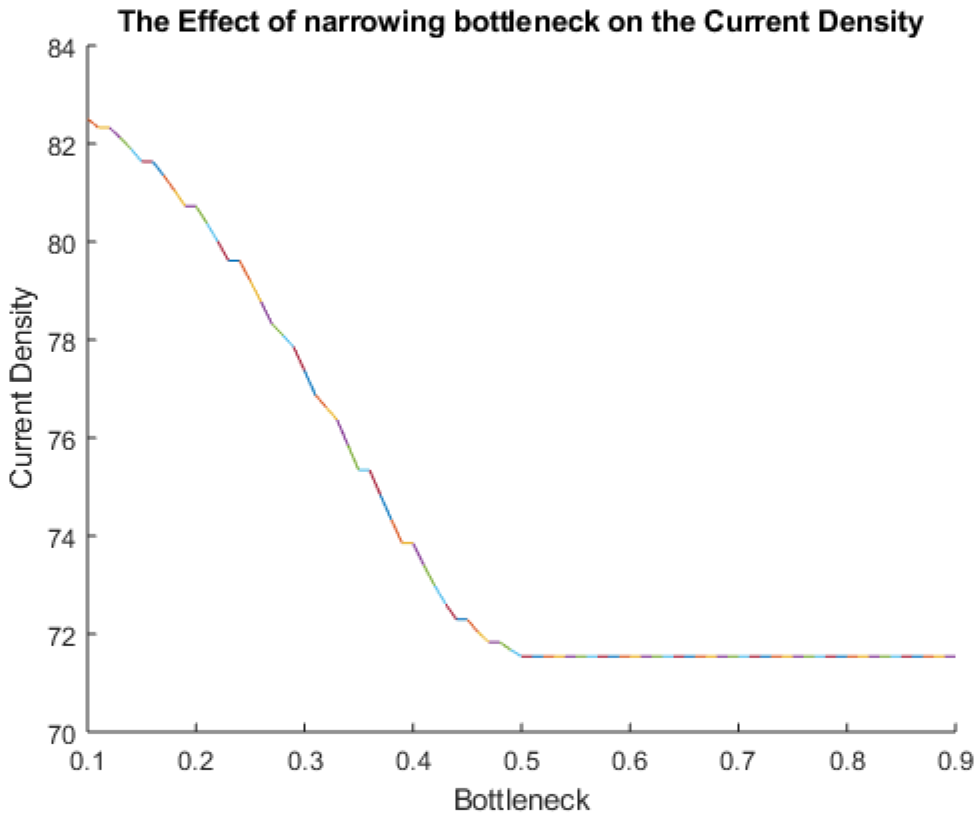
    end

    title("The Effect of narrowing bottleneck on the Current Density")

end

%DISCUSSION%

%Observing the plot, we see that narrowing the bottleneck
 incrementally
%leads to a decrease in the current value, However, after a certain
 point,
%when the value of narrowing reaches 0.5, the current stagnates and
 does
%not decrease any more and stays fixed at about 71.5. Note that the
%relationship is not a linear decrease, but resembles an exponential
%decrease before current density   stops decreasing.
```



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