```
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Part 2 c)

We want to decrease the bottleneck size and see how the current changes with respect to it

```
clear
clc

for bottleneck = 0.1:0.01:0.9

    nx = 50;
    ny = 1.5 * nx; % Since we want the region to be a rectangle and
 ratio is 3/2

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

    sM = zeros (ny,nx); % sigma matrix

    %the two resistive boxes will become smaller with each iteration
    box = [nx*2/5 nx*3/5 ny* bottleneck ny* (1-bottleneck)];

    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;
                B(n) = 0;

            elseif j == 1

                if i > box(1) && i < box(2)
                    G(n, n) = -3;
                    G(n, n+1) = 0.01;
                    G(n, n+ny) = 0.01;
                    G(n, n-ny) = 0.01;

                else

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

                end

            elseif j == ny

                if i > box(1) && i < box(2)

                    G(n, n) = -3;
                    G(n, n+1) = 0.01;
                    G(n, n+ny) = 0.01;
                    G(n, n-ny) = 0.01;

                else

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

                end

            else

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

                    G(n, n) = -4;
                    G(n, n+1) = 0.01;
                    G(n, n-1) = 0.01;
                    G(n, n+ny) = 0.01;
                    G(n, n-ny) = 0.01;

                else

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

                end
            end
        end
    end

    for i = 1 : nx

        for j = 1 : ny

            if i >= box(1) && i <= box(2)
                sM(j, i) = 0.01;

            else
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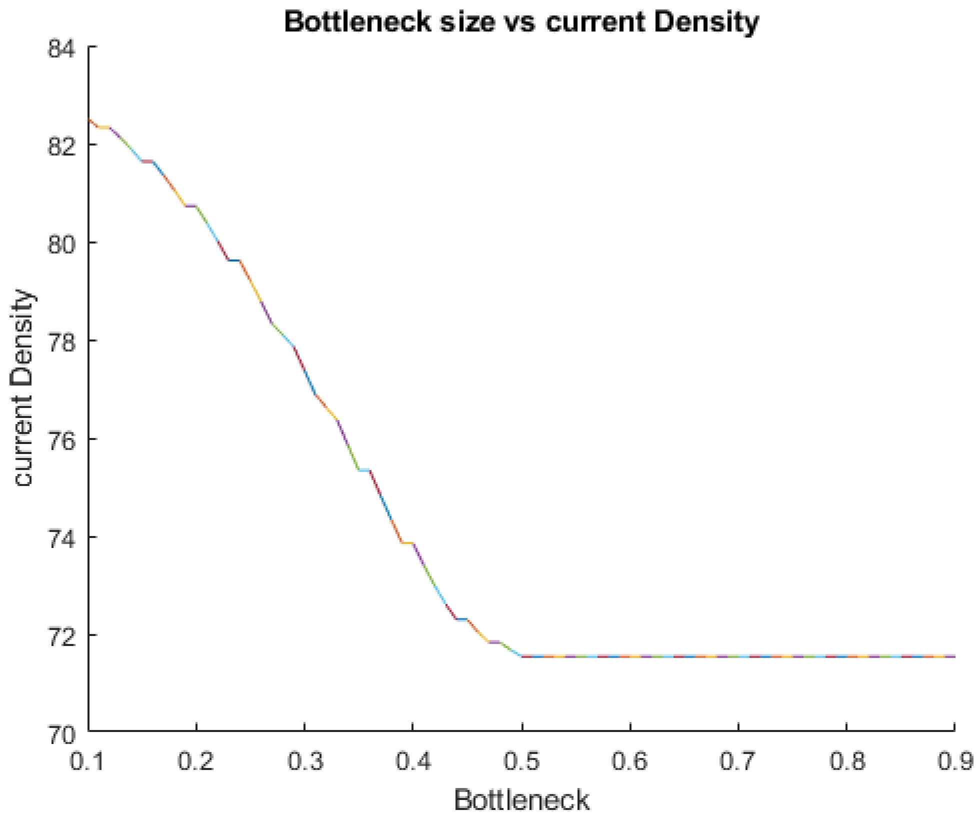
```
                sM(j, i) = 1;

            end

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

                sM(j, i) = 1;

            end
        end
    end


    V = G\B';

    m = zeros(ny,nx,1);

    for i = 1:nx

        for j = 1:ny

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

        end
    end

    [Ex,Ey] = gradient(m);

    Jx = sM .* Ex;
    Jy = sM .* Ey;

    J = sqrt(Jx.^2 + Jy.^2);

    figure(1);
    hold on;

    if bottleneck == 0.1

        curr = sum(J, 2);
        currSum = sum(curr);
        currTemp = currSum;
        plot([bottleneck, bottleneck], [currTemp, currSum])


    end
    if bottleneck > 0.1

        currTemp = currSum;
        curr = sum(J, 2);
        currSum = sum(curr);
```

```
        plot([bottleneck-0.01, bottleneck], [currTemp, currSum])
        xlabel("Bottleneck");
        ylabel("current Density");

    end

    title("Bottleneck size vs current Density");

end
```



Conclusion

From the plot, it can be see that narrowing the bottleneck decreases the curent density. However, it is not linear but exponential. When it is narrowed by 50%, the current does not change very much.

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