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%In Part 2d) of the assignment, we are observing the effect of varying
%sigma on the current density. Like in parts c) and d), we are
 iterating
%through a loop using different sigma values and plotting sigma vs
 current
%density, and then drawing a conclusion from the plot.


for sigma = 1e-2:1e-2:0.9


    %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 = 1;                              % sigma value given outside
 the box
    Sig2 = sigma;                           % sigma inside box will be
 modified

    %bottleneck remains the same this time.
    box = [nx*2/5 nx*3/5 ny*2/5 ny*3/5];


    for x = 1:nx

        for y = 1:ny

            n = y + (x-1)*ny;

            if x == 1

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

            elseif x == nx

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

            elseif y == 1

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

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

            else

                G(n, n) = -3;
                G(n, n+1) = Sig1;
                G(n, n+ny) = Sig1;
                G(n, n-ny) = Sig1;

            end

        elseif y == ny

            if x > box(1) && x < box(2)
                G(n, n) = -3;
                G(n, n+1) = Sig2;
                G(n, n+ny) = Sig2;
                G(n, n-ny) = Sig2;

            else

                G(n, n) = -3;
                G(n, n+1) = Sig1;
                G(n, n+ny) = Sig1;
                G(n, n-ny) = Sig1;

            end

        else

            if x > box(1) && x < box(2) && (y < box(3)||y >
box(4))

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

            else

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

            end
        end
    end
end
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```
    for Length = 1 : nx

        for Width = 1 : ny

            if Length >= box(1) && Length <= box(2)
                Sigmatrix(Width, Length) = Sig2;

            else

                Sigmatrix(Width, Length) = Sig1;

            end

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

                Sigmatrix(Width, Length) = Sig1;

            end
        end
    end


    Voltage = G\Op';


    sol = zeros(ny, nx, 1);

    for x = 1:nx

        for y = 1:ny

            n = y + (x-1)*ny;

            sol(y,x) = Voltage(n);

        end
    end


    [elecx, elecy] = gradient(sol);


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


    figure(1)
    hold on
    if sigma == 0.01
        Curr = sum(J, 2);
        Currtot = sum(Curr);
        Currold = Currtot;
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        plot([sigma, sigma], [Currold, Currtot])
    end
    if sigma > 0.01
        Currold = Currtot;
        Curr = sum(J, 2);
        Currtot = sum(Curr);
        plot([sigma-0.01, sigma], [Currold, Currtot])
        xlabel("Sigma")
        ylabel("Current Density")
    end
    title("The Effect of varying the sigma value on Current Density")

end

%the end%

%DISCUSSION%

%From the plot it is noticed that sigma and current density are
%proportional; an increase in simga leads to an increase in current
%density. This relationship is linear, which is to be expected from
 the
%formula J = sigma x electric field.
```

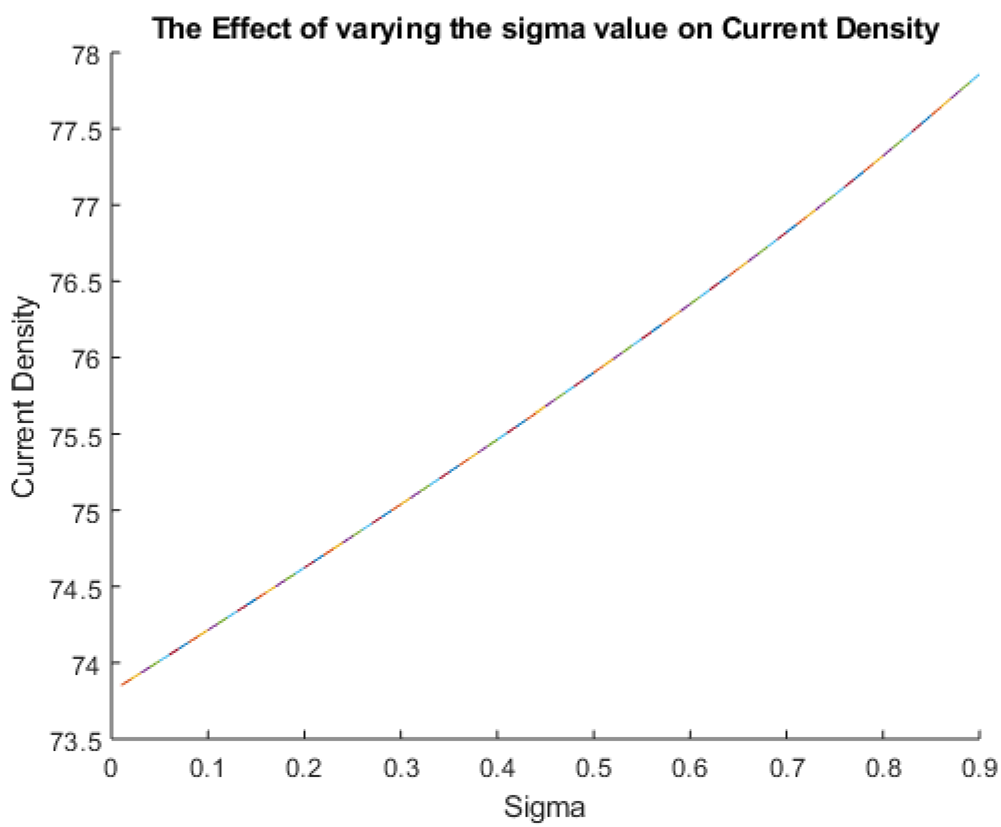

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