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%          ELEC 4700 - Assignment 3          %
%    Monte-Carlo/Finite Difference Method    %
%            Patrobas Adewumi                %
%            Sunday, March 17, 2019          %

global C

C.q_0 = 1.60217653e-19;                % electron charge
    C.hb = 1.054571596e-34;            % Dirac constant
    C.h = C.hb * 2 * pi;               % Planck constant
    C.m_0 = 9.10938215e-31;            % electron mass
    C.kb = 1.3806504e-23;              % Boltzmann constant
    C.eps_0 = 8.854187817e-12;         % vacuum permittivity
    C.mu_0 = 1.2566370614e-6;          % vacuum permeability
    C.c = 299792458;                   % speed of light
    C.g = 9.80665;

W = 50;
L = W*3/2;

centreX = L/2;
centreY = W/2;


G = zeros(L*W,L*W);
B = zeros(L*W,1);

%   Conductivity
s1 = 1;
s2 = 0.01;

%   Resistive regions size
rL = L*1/4;
rW = W*2/5;

%   Create sigma map
Smap = zeros(L,W);
for i = 1:1:L
    for j = 1:1:W
        if((i > centreX -(rL/2) && i < centreX + (rL/2)) && ...
                    (j > centreY+(rW/2) || j < centreY - (rW/2)))
            Smap(i,j) = s2;
        else
            Smap(i,j) = s1;
        end
    end
end



for i = 1:1:L
    for j = 1:1:W
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            n = j +(i-1)*W;
            nxm = j + (i-2)*W;
            nxp = j + i*W;
            nyp = j + 1+ (i-1)*W;
            nym = j - 1+ (i-1)*W;

            if(i==1)
                G(n,:) = 0;
                G(n,n) = Smap(i,j);
                B(n) = 1;
            elseif(i==L)
                G(n,:) = 0;
                G(n,n) = Smap(i,j);
                B(n) = 0;
            elseif(j==1)
                G(n,:) = 0;
                G(n,nxm) = (Smap(i-1,j)+Smap(i,j))/2;
                G(n,nxp) = (Smap(i+1,j)+Smap(i,j))/2;
                G(n,nyp) = (Smap(i,j+1)+Smap(i,j))/2;
                G(n,n) = -(G(n,nxm)+G(n,nxp)+G(n,nyp));
            elseif(j==W)
                G(n,:) = 0;
                G(n,nxm) = (Smap(i-1,j)+Smap(i,j))/2;
                G(n,nxp) = (Smap(i+1,j)+Smap(i,j))/2;
                G(n,nym) = (Smap(i,j-1)+Smap(i,j))/2;
                G(n,n) = -(G(n,nxm)+G(n,nxp)+G(n,nym));
            else
                G(n,:) = 0;
                G(n,nxm) = (Smap(i-1,j)+Smap(i,j))/2;
                G(n,nxp) = (Smap(i+1,j)+Smap(i,j))/2;
                G(n,nyp) = (Smap(i,j+1)+Smap(i,j))/2;
                G(n,nym) = (Smap(i,j-1)+Smap(i,j))/2;
                G(n,n) = -(G(n,nxm)+G(n,nxp)+G(n,nyp)+G(n,nym));
            end
        end
    end

    V = G\B;
    Vmap = zeros(L,W);
    for i = 1:1:L
        for j =1:1:W
            n = j +(i-1)*W;
            Vmap(i,j) = V(n);
        end
    end

    [MX,MY] = meshgrid(1:1:W,1:1:L);
    [Ey,Ex] = gradient(Vmap);

    figure(5)
    surf(Vmap)
    colorbar
    title('Voltage map'),xlabel('X direction'),ylabel('Y
     direction'),zlabel('Voltage')
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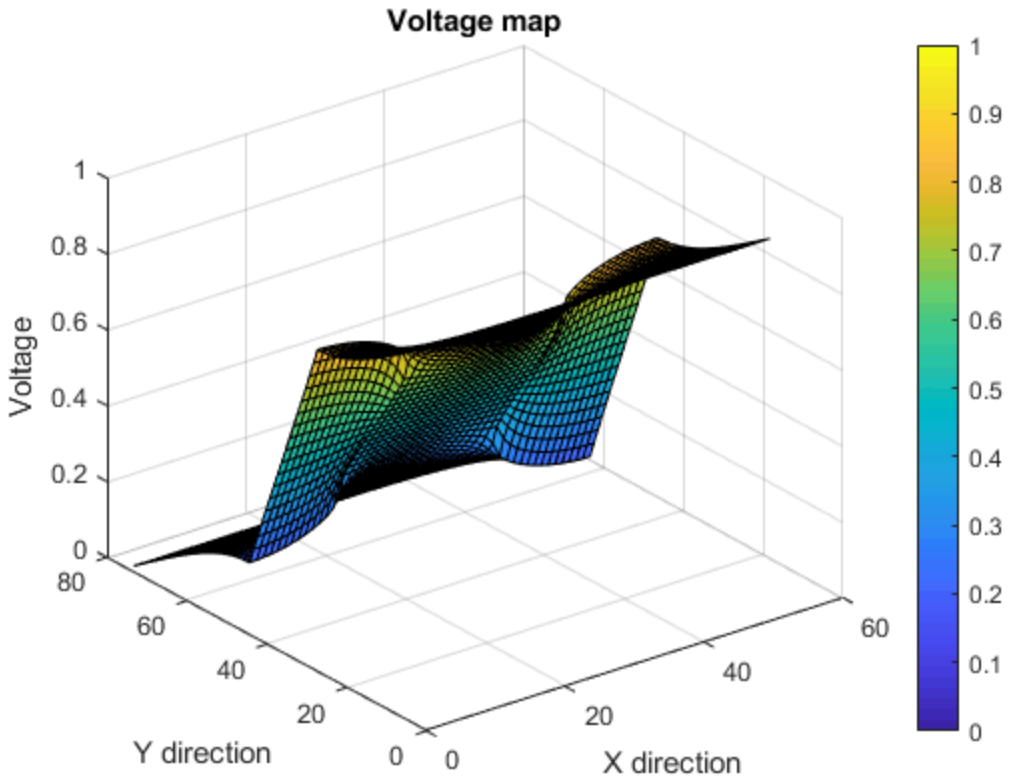
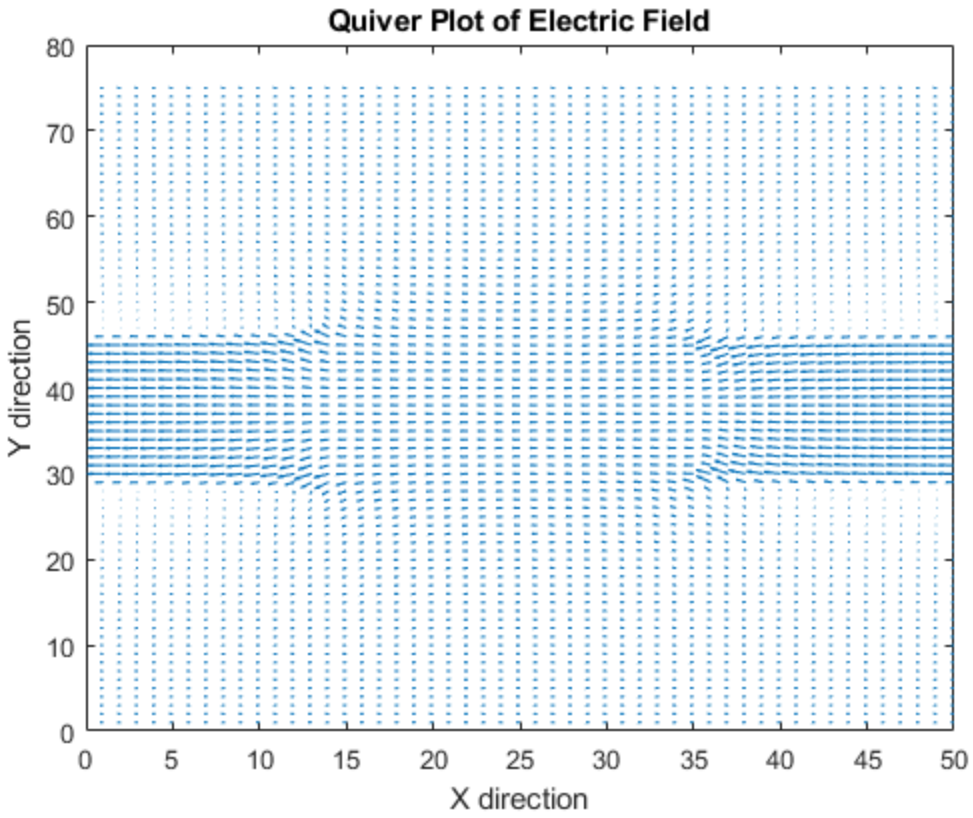
figure(6)
quiver(MX,MY,Ex,Ey)
title('Quiver Plot of Electric Field'),xlabel('X direction'),ylabel('Y
 direction')
```





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