
ELEC 4700 Assignment 3 Part 1%

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% In this part of the assignment, we applied a 0.1 electric field in
the x
% direction. The motion of the electrons were mapped to view the
effects
% this field had on the movement. As before, density and temperature
maps
% were created.

close all
clear
%Constants

q_0 = 1.60217653e-19;           % electron charge
m_0 = 9.10938215e-31;           % electron mass
kB = 1.3806504e-23;             % Boltzmann constant
deltat = 0.2e-12;               % mean time between collisions
mn = 0.26*m_0;                  % effective mass of electrons

%variables

numofelec = 1000;               %current numbers of electrons to be
    simulated
T = 300;                        %temperature in kelvin

%NEW ADDITION for assignment 3%
Voltage = 0.1;                  %the one dimensional voltage applied
    across the
                                %x dimension of the semiconductor (PART A)
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

dt = 1;
%Assign each particle with the fixed velocity given by vth but give
each one a
%random direction.

vth = sqrt((kB*T)/mn);
%Spatial Boundaries

Length = 200;
Width = 100;

    %I am going to represent the location of each electron using
    vectors

x = randi([0 Length], 1, numofelec)*1e-9;           %initializing x
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y = randi([0 Width], 1, numofelec)*1e-9;           %initializing y

%top side of lower rectangle
for it=1:1:numofelec

    %moving spawned electrons outside of rectangles

    if x(1,it) >=(80e-9) && x(1,it) <= (120e-9) && y(1,it)<=
(40e-9)
        x(1,it) = x(1,it) + randi([45 80], 1,1)*1e-9;
    end

    if x(1,it) >=(80e-9) && x(1,it) <= (120e-9) && y(1,it)>=
(60e-9)
        x(1,it) = x(1,it) - randi([45 80], 1,1)*1e-9;
    end

end

%now we have position vectors for the x and y positions of each
%electron. Need to create vectors for vy and vx. Remember that
each
%electron has a rand angle to start with, but same velocity vth.

angles = randi([0 360], 1, numofelec);
v_x = zeros(1, numofelec);
v_y = zeros(1, numofelec);

v_x = vth*cos(angles);
v_y = vth*sin(angles);

%NEW ADDITION for assignment 3%

elec_x = Voltage/(Length*1e-9);           %value of electric field across x
(PART A)

fprintf('Part a) The value of the electric field on the electrons is
%i\n',elec_x);

Force = elec_x*q_0;           %creates a vector containing forces of all
electrons

%(PART B)
fprintf('Part b) The value of force on each electron is %i\n',Force);

a_elec = Force/mn;           %creates a vector containing all
acceleration of electrons

%will be used to modify the plot. stay
tuned

%for more (PART C)
fprintf('Part c) The value of acceletation on each electron is %i
\n',a_elec);
%%%%%%%%%%%%%%
%scatter
pscat = 1 - exp(-1e-14/(1e-11*0.2));

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    pscatvector = ones(1,numofelec)*pscat;

    colorarray= rand(1,20);
for time= 1:dt:250

    %movement of the electrons is now impacted by acceleration in the
    x
    %direction

    v_x = v_x + a_elec*(dt*3e-15);

    random = rand(1,numofelec);

    %all electrons with higher probabilities
    new = random < pscat;

    %all electrons with lower probabilities
    new2 = random >= pscat;

    rand_v_x = zeros(1,numofelec);
    rand_v_y = zeros(1,numofelec);

    for i = 1:1:numofelec
        r1 = randi([1 numofelec], 1,1);
        r2 = randi([1 numofelec], 1,1);
        rand_v_x(1,i) = v_x(1,r1);
        rand_v_y(1,i) = v_y(1,r2);
    end
        %all electrons with lower probabilities will stay the same
    v_x = v_x.*new2;
    v_y = v_y.*new2;

    rand_v_x=rand_v_x.*new;
    rand_v_y=rand_v_y.*new;

    v_x = v_x+rand_v_x;
    v_y = v_y+rand_v_y;

    dx = v_x*dt*1e-15*5;
    dy = v_y*dt*1e-15*5;
%
    x = x + dx;
    y = y + dy;
%
    %if y is greater than 200
    temp = y>=Width*1e-9;
    temp1 = y<Width*1e-9;

    temp = temp*(-1);

    temphigher = temp + temp1;

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%PART D setting up the plot for
    figure(2)
    scatter(time,I_d,'r.')
    title('current density of electrons')
    hold on

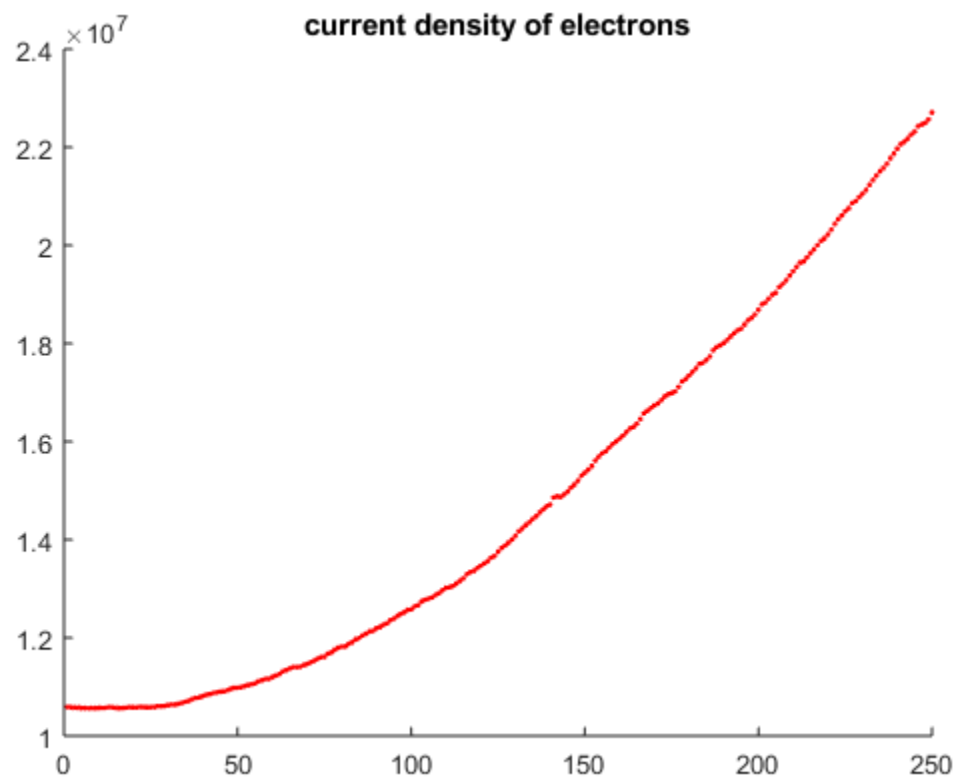
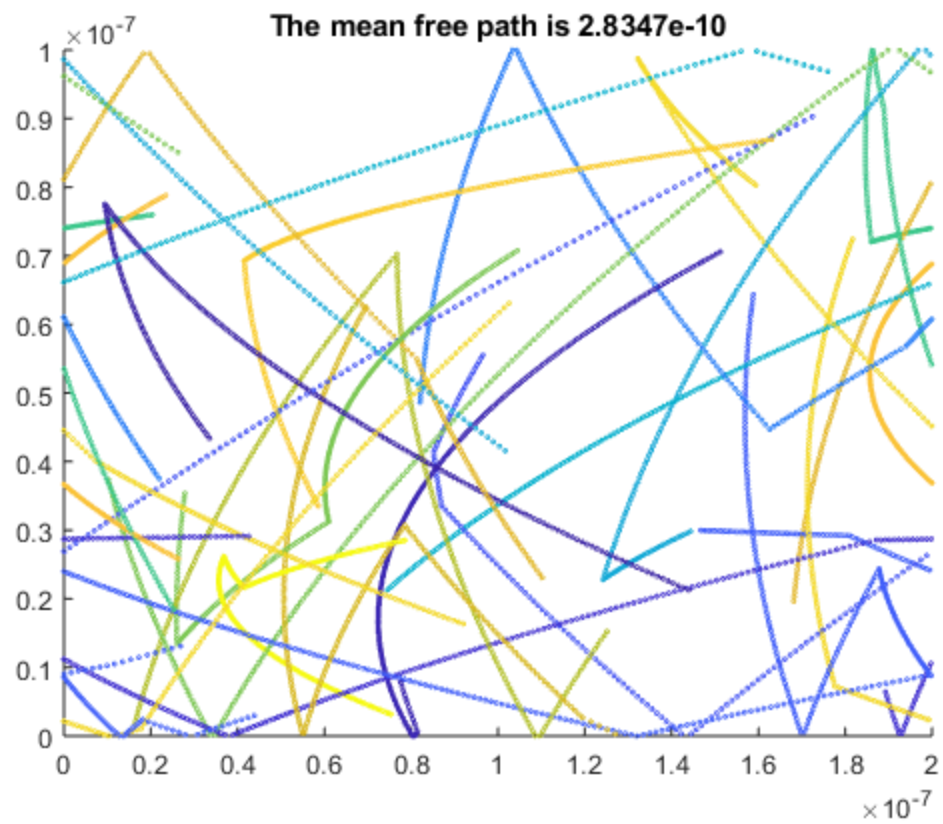
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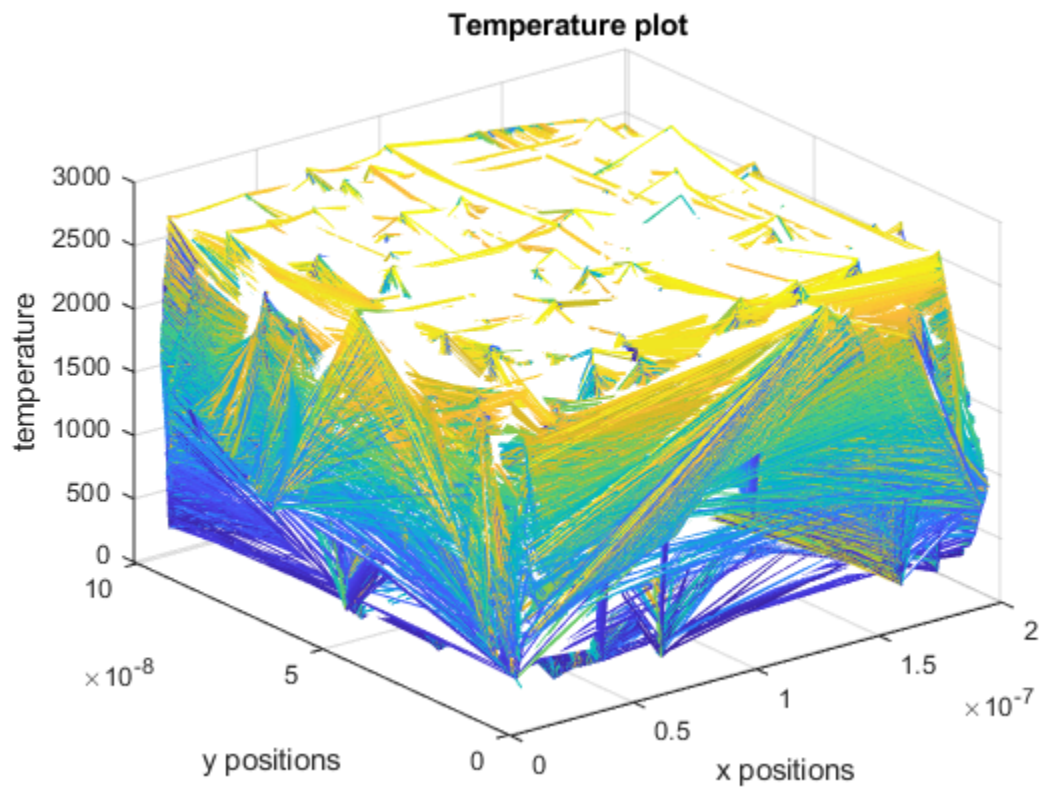
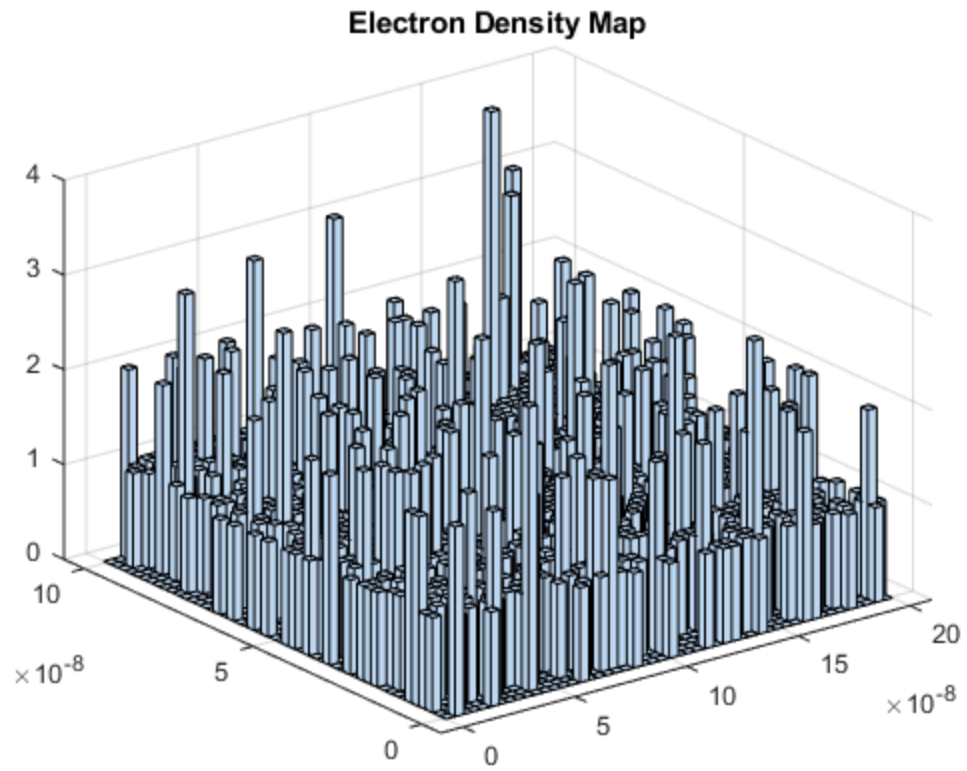
%PART E electron density map and temperature map
dens_mat = [x(:) y(:)];
figure(4)
hist3(dens_mat(:,1:2) ,[50 50]);
title("Electron Density Map")

%temperature plot
[X,Y] = meshgrid (x' , y');
f1 = scatteredInterpolant(x',y',T_matrix');
Z = f1(X,Y);
figure (5);
mesh(X,Y,Z);
title('Temperature plot')
xlabel('x positions')
ylabel('y positions')
zlabel('temperature')

Part a) The value of the electric field on the electrons is 500000
Part b) The value of force on each electron is 8.010883e-14
Part c) The value of acceletation on each electron is
338234653108549376

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