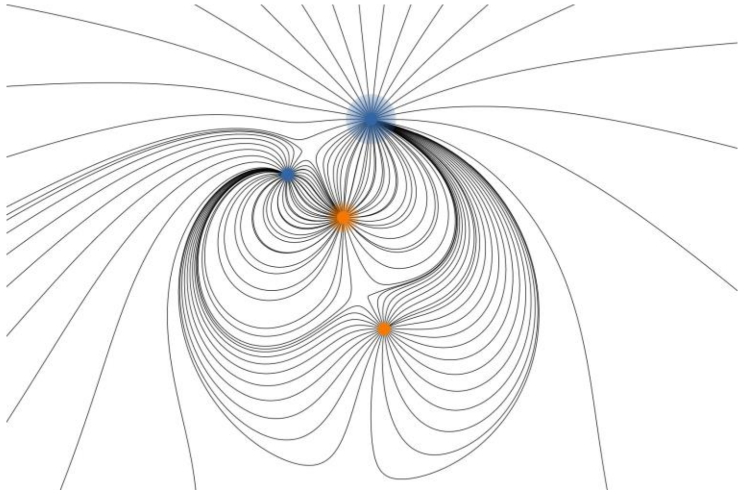

A MATLAB Project on The Motion of Charged Particle in Electric and Magnetic Field

Course Title: Numerical Techniques Laboratory

Course Title: EEE 212

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Section: B2

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Level-2 Term-1

Introduction:

The motion of charged particles in electric and magnetic fields is a fundamental phenomenon in physics, with important applications in various fields such as particle accelerators, plasma physics, and magnetic confinement fusion. Understanding the behavior of charged particles in these fields is crucial for developing advanced technologies and exploring the properties of matter at the atomic and subatomic level.

The objective of this project is to develop a simulation model in MATLAB that accurately predicts the motion of a charged particle in an electric and magnetic field. Specifically, we aim to investigate the effects of different electric and magnetic field configurations on the trajectory of a charged particle, including its speed, acceleration, and position.

The simulation model is based on the Lorentz force equation, which describes the interaction between a charged particle and an electric and magnetic field. The simulation uses numerical methods to solve the differential equations governing the motion of the charged particle, and generates a visualization of the particle's trajectory in three-dimensional space.

This project builds upon previous work in the field of charged particle motion, and aims to contribute to our understanding of the fundamental physics of this phenomenon. The simulation model developed in this project has potential applications in various fields, such as designing and optimizing particle accelerators, studying plasma dynamics, and exploring the behavior of charged particles in magnetic confinement fusion devices.

This report is structured as follows: first, we provide a brief overview of the physics of charged particle motion in electric and magnetic fields; second, we describe the methodology used to develop the simulation model in MATLAB; third, we present and analyze the simulation results, discussing the effects of different electric and magnetic field configurations on the charged particle's motion; fourth, we discuss the limitations and assumptions of the simulation model, and suggest potential improvements for future work; finally, we conclude with a summary of the key findings and their implications for the field of charged particle motion in electric and magnetic fields.

Objective and Motivation:

The motivation behind the project on the motion of charged particles in electric and magnetic fields were:

1. To develop a simulation model that accurately predicts the behavior of a charged particle in an electric and magnetic field.
2. To investigate the effects of different electric and magnetic field configurations on the motion of a charged particle.
3. To analyze the trajectory of a charged particle in a given electric and magnetic field, including its speed, acceleration, and position.
4. To study the energy transfer mechanisms between the electric and magnetic fields and the charged particle.
5. To compare the simulation results with theoretical predictions and experimental data, if available, to validate the accuracy of the model.
6. To explore the limitations and assumptions of the simulation model, and suggest improvements to enhance its accuracy and efficiency.
7. To investigate the applications of the simulation model in various fields, such as plasma physics, particle accelerators, and magnetic confinement fusion.

Overall, the objective and motivation of a MATLAB project on the motion of charged particles in electric and magnetic fields would be to provide insights into the fundamental physics of charged particle motion and to develop a powerful tool for simulating and predicting the behavior of charged particles under different electric and magnetic field conditions.

Theoretical Background:

The motion of a charged particle in an electric and magnetic field can be described by the Lorentz force equation, which states that the force on a charged particle is proportional to the electric field and the velocity of the charged particle, and is also proportional to the magnetic field and the cross product of the velocity and magnetic field. The Lorentz force equation is given by:

$$F = q \times (E + v \times B)$$

where F is the force on the charged particle, q is the charge of the particle, E is the electric field, v is the velocity of the particle, and B is the magnetic field.

The motion of the charged particle can be described by the equations of motion, which relate the acceleration of the particle to the net force acting on it. For a charged particle in an electric and magnetic field, the equations of motion are given by:

$$ma = q \times (E + v \times B)$$

where m is the mass of the particle, a is its acceleration, and the other symbols have their usual meanings. Using Newton's second law, we can write the equation of motion of the charged particle as:

$$m\frac{d^2r}{dt^2} = q \times (E + v \times B)$$

where m is the mass of the charged particle, r is the position vector of the particle, and t is the time.

To solve this equation, we can convert it into a system of first-order differential equations by introducing a new variable v that represents the velocity of the particle. The resulting system of differential equations is:

$$\frac{dv}{dt} = \frac{q}{m} \times (E + v \times B)$$

$$\frac{dx}{dt} = v$$

where x is the position vector and t is time.

The solutions to these equations depend on the initial conditions of the charged particle, such as its initial velocity and position, as well as the strength and orientation of the electric and magnetic fields.

In this project, we will develop a simulation model in MATLAB that numerically solves these differential equations using the fourth-order Runge-Kutta method. The simulation model will take as input the initial conditions and the parameters of the electric and magnetic fields, and output the velocity and position of the charged particle as a function of time. By varying the parameters of the electric and magnetic fields, we can investigate the effects of different field configurations on the motion of the charged particle and study the energy transfer mechanisms between the fields and the particle. We can also compare the simulation results with theoretical predictions and experimental data, if available, to validate the accuracy of the model.

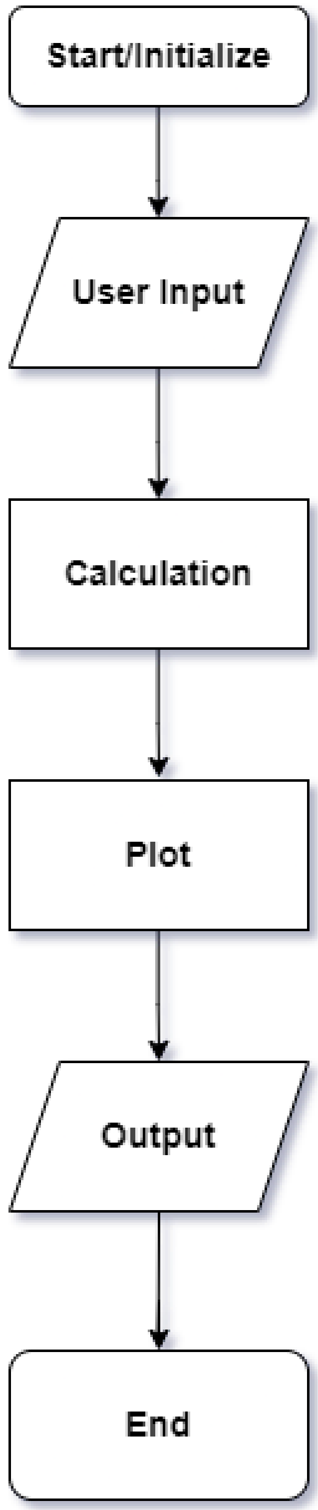
Algorithm:

Here is a basic algorithm for the project:

1. Define the input arguments of the function: electric field, magnetic field, initial position, initial velocity, mass of the particle, and charge of the particle.
2. Define the time step and the total simulation time.
3. Define the initial conditions for the simulation: time, position, and velocity.
4. Initialize empty arrays to store the position and velocity values at each time step.
5. Use a loop to simulate the motion of the charged particle:
   a. Calculate the Lorentz force acting on the particle.
   b. Update the position and velocity of the particle using the calculated force and the time step.
   c. Calculate the trajectory of the charged particle based on the input values using the 2nd order ODE.
   d. Store the new position and velocity values in their respective arrays.
   e. Update the time variable.
   f. Repeat until the simulation time is reached.
6. Return the arrays of position and velocity values.

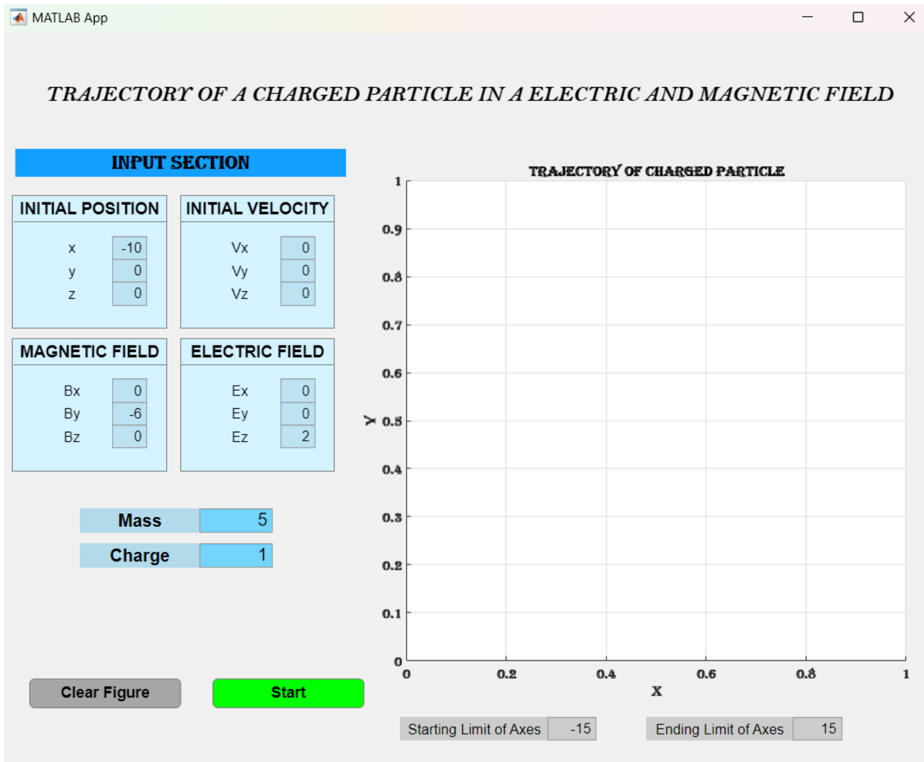
This algorithm can be further modified and optimized based on the specific requirements and objectives of the project.

Block Diagram:

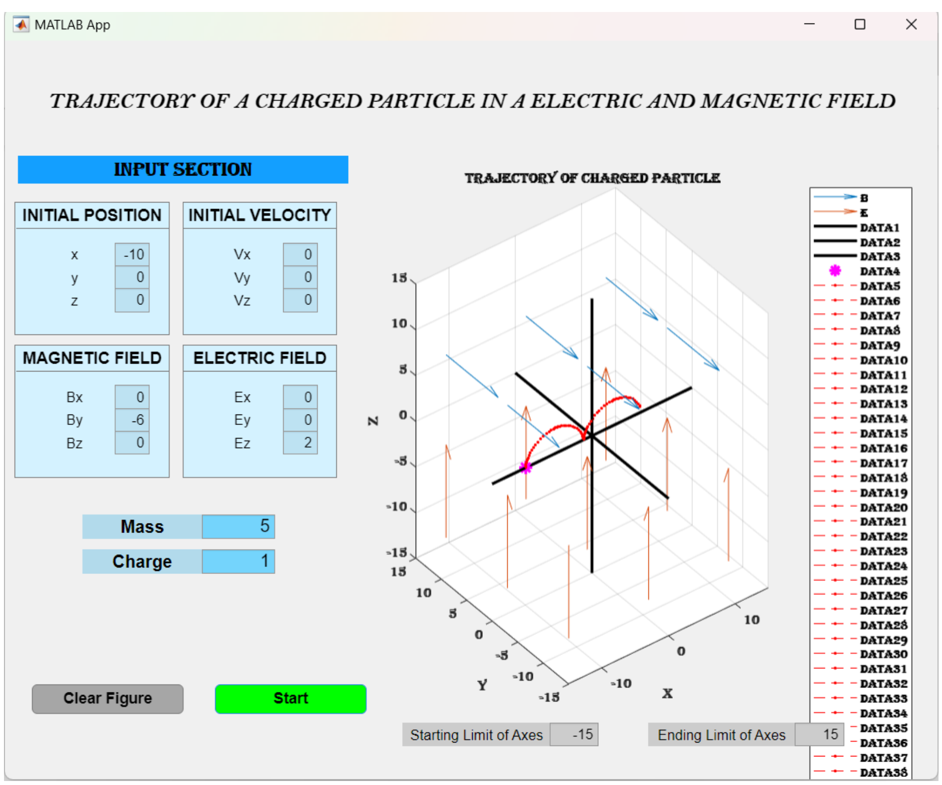


Sample Results:

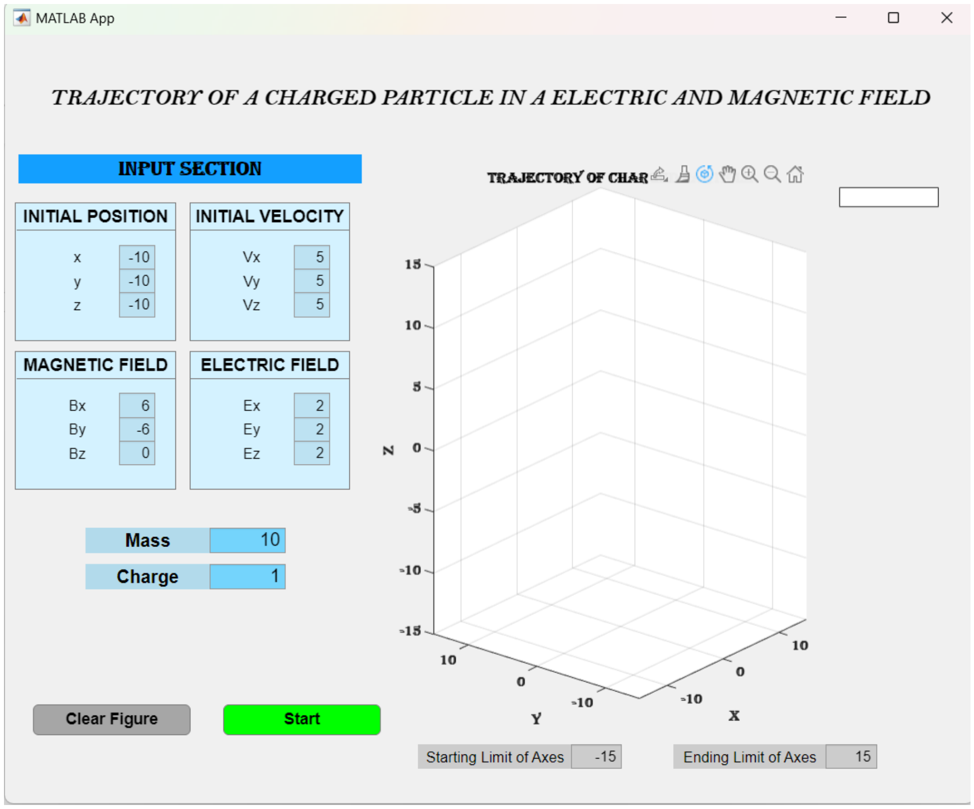
Input(default):



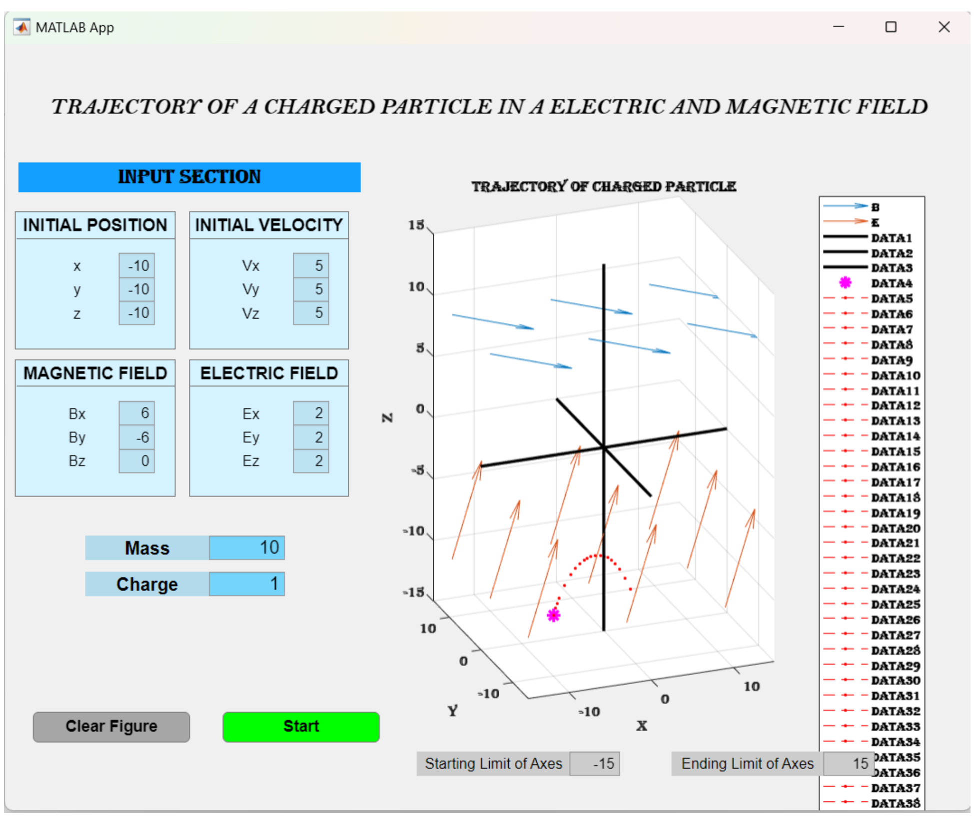
Output:



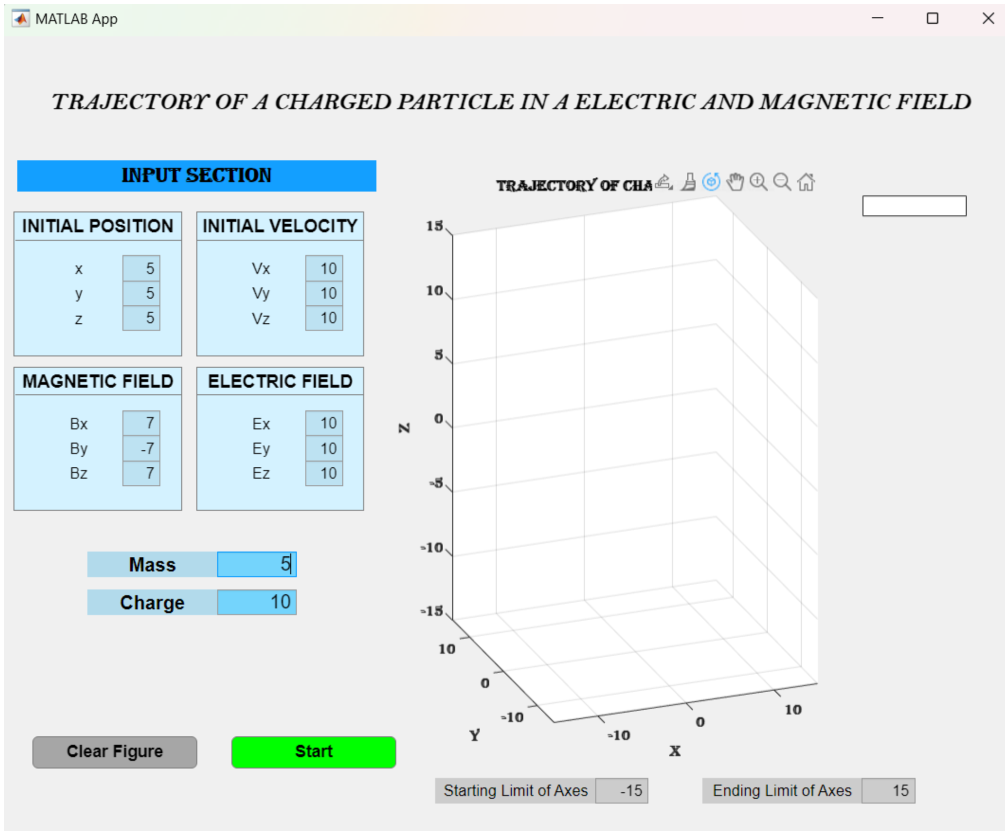
Input:



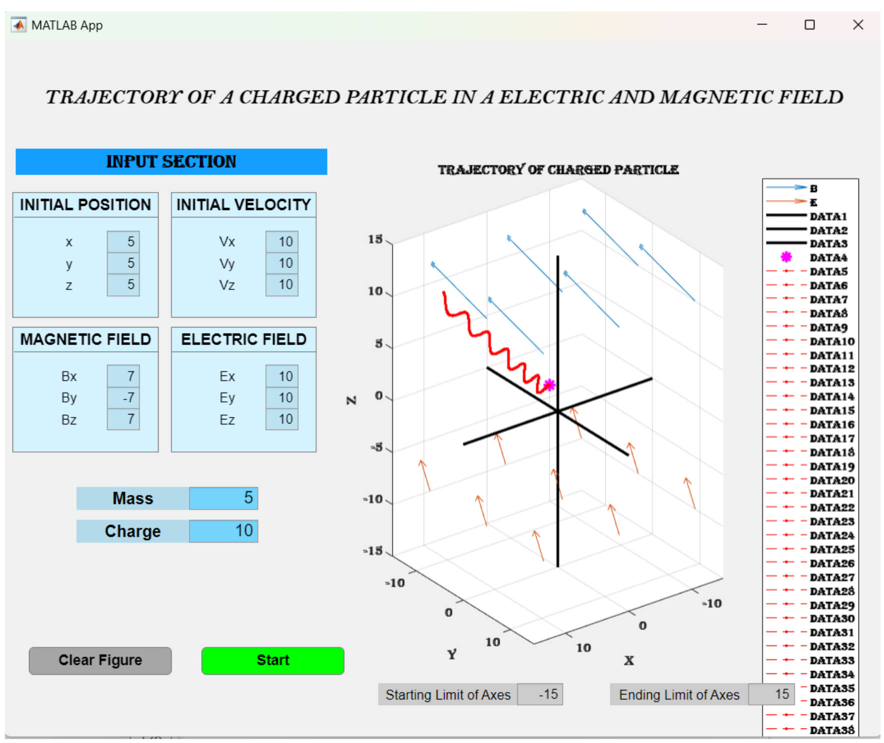
Output:



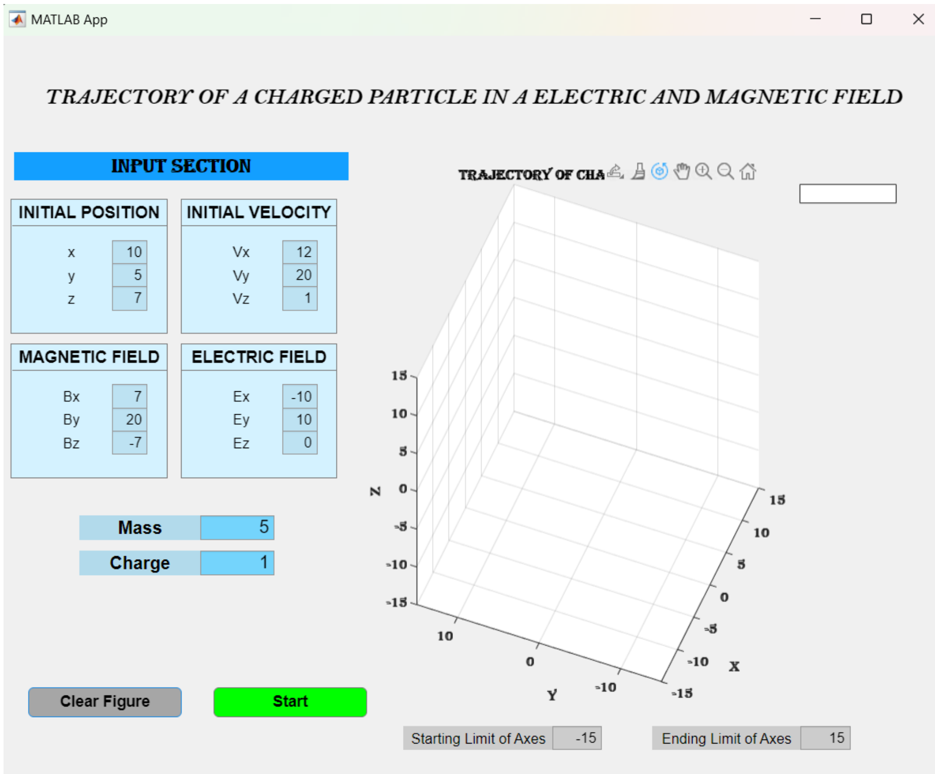
Input:



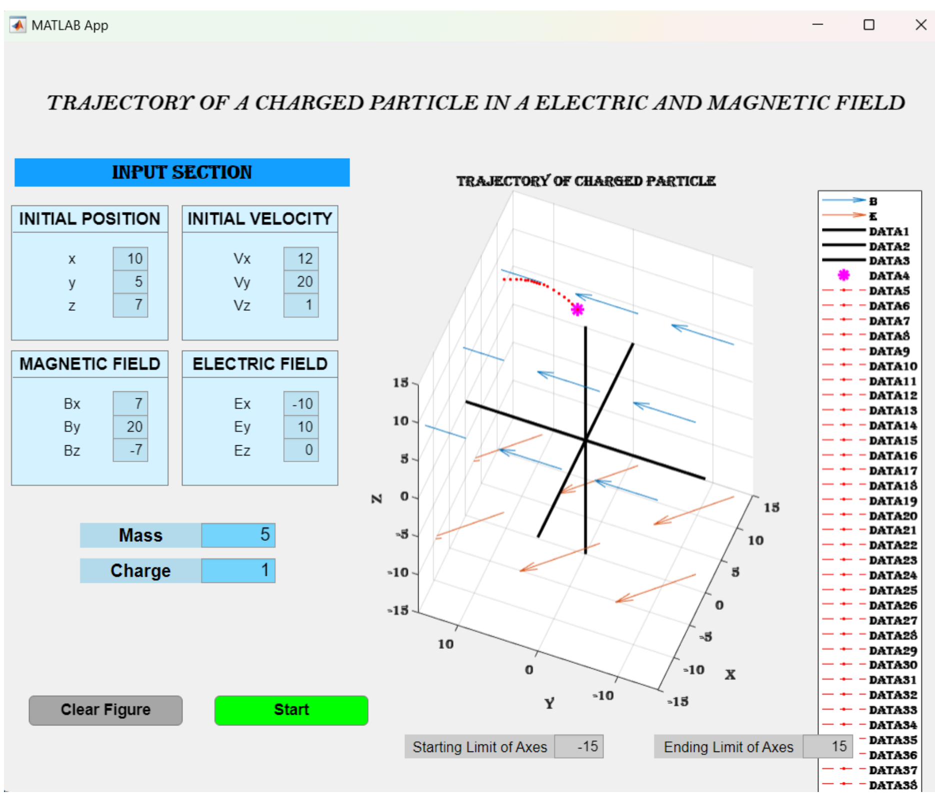
Output:



Input:



Output:



Copy of Full Code:

```
classdef Trajectory_Particle_EB < matlab.apps.AppBase

    % Properties that correspond to app components
    properties (Access = public)
        UIFigure                        matlab.ui.Figure
        EndingLimitofAxesEditField      matlab.ui.control.NumericEditField
        EndingLimitofAxesEditFieldLabel  matlab.ui.control.Label
        StartingLimitofAxesEditField    matlab.ui.control.NumericEditField
        StartingLimitofAxesEditFieldLabel  matlab.ui.control.Label
        ELECTRICFIELDPanel              matlab.ui.container.Panel
        EzEditField                     matlab.ui.control.NumericEditField
        EzEditField_6Label              matlab.ui.control.Label
        EyEditField                     matlab.ui.control.NumericEditField
        EyEditField_6Label              matlab.ui.control.Label
        ExEditField                     matlab.ui.control.NumericEditField
        ExEditField_6Label              matlab.ui.control.Label
        MAGNETICFIELDPanel              matlab.ui.container.Panel
        BzEditField                     matlab.ui.control.NumericEditField
        BzEditFieldLabel                matlab.ui.control.Label
        ByEditField                     matlab.ui.control.NumericEditField
        ByEditFieldLabel                matlab.ui.control.Label
        BxEditField                     matlab.ui.control.NumericEditField
        BxEditFieldLabel                matlab.ui.control.Label
        INITIALVELOCITYPanel            matlab.ui.container.Panel
        VzEditField                     matlab.ui.control.NumericEditField
        VzEditFieldLabel                matlab.ui.control.Label
        VyEditField                     matlab.ui.control.NumericEditField
        VyEditFieldLabel                matlab.ui.control.Label
        VxEditField                     matlab.ui.control.NumericEditField
        VxEditFieldLabel                matlab.ui.control.Label
        INITIALPOSITIONPanel            matlab.ui.container.Panel
        zEditField                      matlab.ui.control.NumericEditField
        zEditFieldLabel                 matlab.ui.control.Label
        yEditField                      matlab.ui.control.NumericEditField
        yEditFieldLabel                 matlab.ui.control.Label
        xEditField                      matlab.ui.control.NumericEditField
        xEditFieldLabel                 matlab.ui.control.Label
        ChargeEditField                 matlab.ui.control.NumericEditField
        ChargeEditFieldLabel            matlab.ui.control.Label
        MassEditField                   matlab.ui.control.NumericEditField
        MassEditFieldLabel              matlab.ui.control.Label
        ClearFigureButton               matlab.ui.control.Button
        StartButton                     matlab.ui.control.Button
        TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel
matlab.ui.control.Label
        INPUTSECTIONLabel               matlab.ui.control.Label
        UIAxes                          matlab.ui.control.UIAxes
    end

    % Callbacks that handle component events
    methods (Access = private)

        % Callback function
        function StopButtonPushed(app, event)

        end

        % Button pushed function: StartButton
```

```
        function StartButtonPushed2(app, event)
            v0=[app.VxEditField.Value, app.VyEditField.Value, app.VzEditField.Value]';
%Initial Velocity
            B=[app.BxEditField.Value, app.ByEditField.Value, app.BzEditField.Value]';  %B
            E=[app.ExEditField.Value, app.EyEditField.Value, app.EzEditField.Value]'; %E
            m= app.MassEditField.Value;
            q= app.ChargeEditField.Value;
            r0=[app.xEditField.Value, app.yEditField.Value, app.zEditField.Value]';%Initial
Position
            tspan=[0 70];

            % Initial Velocity
            Vx(1)=app.VxEditField.Value;
            Vy(1)=app.VyEditField.Value;
            Vz(1)=app.VzEditField.Value;

             %initial position
            x(1) = app.xEditField.Value;
            y(1) = app.yEditField.Value;
            z(1) = app.zEditField.Value;

            % Magnetic Field
            Bx=app.BxEditField.Value;
            By=app.ByEditField.Value;
            Bz=app.BzEditField.Value;


            % Electric Field
            Ex=app.ExEditField.Value;
            Ey=app.EyEditField.Value;
            Ez=app.EzEditField.Value;


            %to show B's direction
            St_L= app.StartingLimitofAxesEditField.Value;
            Ed_L= app.EndingLimitofAxesEditField.Value;     % Axes Limit
            lim=2000;

            [x_q,y_q] = meshgrid(St_L:12:Ed_L,St_L:12:Ed_L);
            z_q=10*ones(size(x_q));

            u_q=B(1)*ones(size(x_q));
            v_q=B(2)*ones(size(x_q));
            w_q=B(3)*ones(size(x_q));


            quiver3(app.UIAxes, x_q,y_q,z_q,u_q,v_q,w_q);
            hold(app.UIAxes,'on');
            % TO show electric field lines
            z_q=-10*ones(size(x_q));

            u_q=E(1)*ones(size(x_q));
            v_q=E(2)*ones(size(x_q));
            w_q=E(3)*ones(size(x_q));
            quiver3(app.UIAxes, x_q,y_q,z_q,u_q,v_q,w_q);

            legend(app.UIAxes, 'B','E');

            % To draw axis and all
            a_a = St_L:0.1:Ed_L;
```

```
            z_a = zeros(size(a_a));
            plot3(app.UIAxes, a_a,z_a,z_a,'k','LineWidth',2);
            plot3(app.UIAxes, z_a,a_a,z_a,'k','LineWidth',2);
            plot3(app.UIAxes, z_a,z_a,a_a,'k','LineWidth',2);

            % To set axis limits
            xlim(app.UIAxes, [St_L Ed_L]);
            ylim(app.UIAxes, [St_L Ed_L]);
            zlim(app.UIAxes, [St_L Ed_L]);

            rotate3d(app.UIAxes,'on');

            plot3(app.UIAxes, r0(1),r0(2),r0(3),'*m','MarkerSize',9,'LineWidth',2);



            dt=0.01;
            t=o:dt:70;
            for i=2:length(t);
                x(i) = x(i-1) + Vx(i-1)*dt;
                y(i) = y(i-1) + Vy(i-1)*dt;
                z(i) = z(i-1) + Vz(i-1)*dt;

            Vx(i) = Vx(i-1) + (q*Ex(i-1)/m)*dt + (q/m)*(Vy(i-1)*Bz(i-1)-Vz(i-1)*By(i-1))*dt;
            Vy(i) = Vy(i-1) + (q*Ey(i-1)/m)*dt + (q/m)*(Vz(i-1)*Bx(i-1)-Vx(i-1)*Bz(i-1))*dt;
            Vz(i) = Vz(i-1) + (q*Ez(i-1)/m)*dt + (q/m)*(Vx(i-1)*By(i-1)-Vy(i-1)*Bx(i-1))*dt;
            end
            end




            %To show animation
            for n=1:length(y)
                 plot3(app.UIAxes, y(n,1),y(n,2),y(n,3),'--.r');
                 pause(0.00001);

                 if n==200
                     break;
                 end
            end
            hold(app.UIAxes, 'off');

        end

        % Button pushed function: ClearFigureButton
        function ClearFigureButtonPushed(app, event)
            cla(app.UIAxes);
        end
    end

    % Component initialization
    methods (Access = private)

        % Create UIFigure and components
        function createComponents(app)

            % Create UIFigure and hide until all components are created
            app.UIFigure = uifigure('Visible', 'off');
            app.UIFigure.Position = [100 100 856 678];
```

```
            app.UIFigure.Name = 'MATLAB App';

            % Create UIAxes
            app.UIAxes = uiaxes(app.UIFigure);
            title(app.UIAxes, 'Trajectory Of Charged Particle')
            xlabel(app.UIAxes, 'X')
            ylabel(app.UIAxes, 'Y')
            zlabel(app.UIAxes, 'Z')
            app.UIAxes.FontName = 'Algerian';
            app.UIAxes.FontWeight = 'bold';
            app.UIAxes.XGrid = 'on';
            app.UIAxes.YGrid = 'on';
            app.UIAxes.ZGrid = 'on';
            app.UIAxes.FontSize = 12;
            app.UIAxes.Position = [330 70 509 494];

            % Create INPUTSECTIONLabel
            app.INPUTSECTIONLabel = uilabel(app.UIFigure);
            app.INPUTSECTIONLabel.BackgroundColor = [0.0745 0.6235 1];
            app.INPUTSECTIONLabel.HorizontalAlignment = 'center';
            app.INPUTSECTIONLabel.FontName = 'Algerian';
            app.INPUTSECTIONLabel.FontSize = 18;
            app.INPUTSECTIONLabel.FontWeight = 'bold';
            app.INPUTSECTIONLabel.Position = [13 549 303 26];
            app.INPUTSECTIONLabel.Text = 'INPUT SECTION';

            % Create TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel
            app.TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel =
uilabel(app.UIFigure);

app.TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel.HorizontalAlignment =
'center';
            app.TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel.FontName =
'Bell MT';
            app.TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel.FontSize = 20;
            app.TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel.FontWeight =
'bold';
            app.TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel.FontAngle =
'italic';
            app.TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel.Position = [10
601 838 47];
            app.TRAJECTORYOFACHARGEDPARTICLEINAELECTRICANDMAGNETICFIELDLabel.Text =
'TRAJECTORY OF A CHARGED PARTICLE IN A ELECTRIC AND MAGNETIC FIELD';

            % Create StartButton
            app.StartButton = uibutton(app.UIFigure, 'push');
            app.StartButton.ButtonPushedFcn = createCallbackFcn(app, @StartButtonPushed2,
true);
            app.StartButton.BackgroundColor = [0 1 0];
            app.StartButton.FontSize = 14;
            app.StartButton.FontWeight = 'bold';
            app.StartButton.Position = [194 62 139 27];
            app.StartButton.Text = 'Start';

            % Create ClearFigureButton
            app.ClearFigureButton = uibutton(app.UIFigure, 'push');
            app.ClearFigureButton.ButtonPushedFcn = createCallbackFcn(app,
@ClearFigureButtonPushed, true);
            app.ClearFigureButton.BackgroundColor = [0.651 0.651 0.651];
            app.ClearFigureButton.FontSize = 14;
```

```
app.ClearFigureButton.FontWeight = 'bold';
app.ClearFigureButton.Position = [26 62 139 27];
app.ClearFigureButton.Text = 'Clear Figure';

% Create MassEditFieldLabel
app.MassEditFieldLabel = uilabel(app.UIFigure);
app.MassEditFieldLabel.BackgroundColor = [0.698 0.8549 0.9216];
app.MassEditFieldLabel.HorizontalAlignment = 'center';
app.MassEditFieldLabel.FontSize = 16;
app.MassEditFieldLabel.FontWeight = 'bold';
app.MassEditFieldLabel.Position = [72 223 111 22];
app.MassEditFieldLabel.Text = 'Mass';

% Create MassEditField
app.MassEditField = uieditfield(app.UIFigure, 'numeric');
app.MassEditField.FontSize = 16;
app.MassEditField.BackgroundColor = [0.4549 0.8314 0.9882];
app.MassEditField.Position = [182 223 67 22];
app.MassEditField.Value = 5;

% Create ChargeEditFieldLabel
app.ChargeEditFieldLabel = uilabel(app.UIFigure);
app.ChargeEditFieldLabel.BackgroundColor = [0.698 0.8549 0.9216];
app.ChargeEditFieldLabel.HorizontalAlignment = 'center';
app.ChargeEditFieldLabel.FontSize = 16;
app.ChargeEditFieldLabel.FontWeight = 'bold';
app.ChargeEditFieldLabel.Position = [72 191 111 22];
app.ChargeEditFieldLabel.Text = 'Charge';

% Create ChargeEditField
app.ChargeEditField = uieditfield(app.UIFigure, 'numeric');
app.ChargeEditField.FontSize = 16;
app.ChargeEditField.BackgroundColor = [0.4549 0.8314 0.9882];
app.ChargeEditField.Position = [182 191 67 22];
app.ChargeEditField.Value = 1;

% Create INITIALPOSITIONPanel
app.INITIALPOSITIONPanel = uipanel(app.UIFigure);
app.INITIALPOSITIONPanel.TitlePosition = 'centertop';
app.INITIALPOSITIONPanel.Title = 'INITIAL POSITION';
app.INITIALPOSITIONPanel.BackgroundColor = [0.8314 0.949 1];
app.INITIALPOSITIONPanel.FontWeight = 'bold';
app.INITIALPOSITIONPanel.FontSize = 15;
app.INITIALPOSITIONPanel.Position = [10 410 142 122];

% Create xEditFieldLabel
app.xEditFieldLabel = uilabel(app.INITIALPOSITIONPanel);
app.xEditFieldLabel.HorizontalAlignment = 'center';
app.xEditFieldLabel.FontSize = 13;
app.xEditFieldLabel.Position = [17 63 76 22];
app.xEditFieldLabel.Text = 'x';

% Create xEditField
app.xEditField = uieditfield(app.INITIALPOSITIONPanel, 'numeric');
app.xEditField.FontSize = 13;
app.xEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.xEditField.Position = [92 63 32 22];
app.xEditField.Value = -10;

% Create yEditFieldLabel
```

```
app.yEditFieldLabel = uilabel(app.INITIALPOSITIONPanel);
app.yEditFieldLabel.HorizontalAlignment = 'center';
app.yEditFieldLabel.FontSize = 13;
app.yEditFieldLabel.Position = [17 42 76 22];
app.yEditFieldLabel.Text = 'y';

% Create yEditField
app.yEditField = uieditfield(app.INITIALPOSITIONPanel, 'numeric');
app.yEditField.FontSize = 13;
app.yEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.yEditField.Position = [92 42 32 22];

% Create zEditFieldLabel
app.zEditFieldLabel = uilabel(app.INITIALPOSITIONPanel);
app.zEditFieldLabel.HorizontalAlignment = 'center';
app.zEditFieldLabel.FontSize = 13;
app.zEditFieldLabel.Position = [17 21 76 22];
app.zEditFieldLabel.Text = 'z';

% Create zEditField
app.zEditField = uieditfield(app.INITIALPOSITIONPanel, 'numeric');
app.zEditField.FontSize = 13;
app.zEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.zEditField.Position = [92 21 32 22];

% Create INITIALVELOCITYPanel
app.INITIALVELOCITYPanel = uipanel(app.UIFigure);
app.INITIALVELOCITYPanel.TitlePosition = 'centertop';
app.INITIALVELOCITYPanel.Title = 'INITIAL VELOCITY';
app.INITIALVELOCITYPanel.BackgroundColor = [0.8314 0.949 1];
app.INITIALVELOCITYPanel.FontWeight = 'bold';
app.INITIALVELOCITYPanel.FontSize = 15;
app.INITIALVELOCITYPanel.Position = [164 410 142 122];

% Create VxEditFieldLabel
app.VxEditFieldLabel = uilabel(app.INITIALVELOCITYPanel);
app.VxEditFieldLabel.HorizontalAlignment = 'center';
app.VxEditFieldLabel.FontSize = 13;
app.VxEditFieldLabel.Position = [17 63 76 22];
app.VxEditFieldLabel.Text = 'Vx';

% Create VxEditField
app.VxEditField = uieditfield(app.INITIALVELOCITYPanel, 'numeric');
app.VxEditField.FontSize = 13;
app.VxEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.VxEditField.Position = [92 63 32 22];

% Create VyEditFieldLabel
app.VyEditFieldLabel = uilabel(app.INITIALVELOCITYPanel);
app.VyEditFieldLabel.HorizontalAlignment = 'center';
app.VyEditFieldLabel.FontSize = 13;
app.VyEditFieldLabel.Position = [17 42 76 22];
app.VyEditFieldLabel.Text = 'Vy';

% Create VyEditField
app.VyEditField = uieditfield(app.INITIALVELOCITYPanel, 'numeric');
app.VyEditField.FontSize = 13;
app.VyEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.VyEditField.Position = [92 42 32 22];
```

```
% Create VzEditFieldLabel
app.VzEditFieldLabel = uilabel(app.INITIALVELOCITYPanel);
app.VzEditFieldLabel.HorizontalAlignment = 'center';
app.VzEditFieldLabel.FontSize = 13;
app.VzEditFieldLabel.Position = [17 21 76 22];
app.VzEditFieldLabel.Text = 'Vz';

% Create VzEditField
app.VzEditField = uieditfield(app.INITIALVELOCITYPanel, 'numeric');
app.VzEditField.FontSize = 13;
app.VzEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.VzEditField.Position = [92 21 32 22];

% Create MAGNETICFIELDPanel
app.MAGNETICFIELDPanel = uipanel(app.UIFigure);
app.MAGNETICFIELDPanel.TitlePosition = 'centertop';
app.MAGNETICFIELDPanel.Title = 'MAGNETIC FIELD';
app.MAGNETICFIELDPanel.BackgroundColor = [0.8314 0.949 1];
app.MAGNETICFIELDPanel.FontWeight = 'bold';
app.MAGNETICFIELDPanel.FontSize = 15;
app.MAGNETICFIELDPanel.Position = [10 279 142 122];

% Create BxEditFieldLabel
app.BxEditFieldLabel = uilabel(app.MAGNETICFIELDPanel);
app.BxEditFieldLabel.HorizontalAlignment = 'center';
app.BxEditFieldLabel.FontSize = 13;
app.BxEditFieldLabel.Position = [17 63 76 22];
app.BxEditFieldLabel.Text = 'Bx';

% Create BxEditField
app.BxEditField = uieditfield(app.MAGNETICFIELDPanel, 'numeric');
app.BxEditField.FontSize = 13;
app.BxEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.BxEditField.Position = [92 63 32 22];

% Create ByEditFieldLabel
app.ByEditFieldLabel = uilabel(app.MAGNETICFIELDPanel);
app.ByEditFieldLabel.HorizontalAlignment = 'center';
app.ByEditFieldLabel.FontSize = 13;
app.ByEditFieldLabel.Position = [17 42 76 22];
app.ByEditFieldLabel.Text = 'By';

% Create ByEditField
app.ByEditField = uieditfield(app.MAGNETICFIELDPanel, 'numeric');
app.ByEditField.FontSize = 13;
app.ByEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.ByEditField.Position = [92 42 32 22];
app.ByEditField.Value = -6;

% Create BzEditFieldLabel
app.BzEditFieldLabel = uilabel(app.MAGNETICFIELDPanel);
app.BzEditFieldLabel.HorizontalAlignment = 'center';
app.BzEditFieldLabel.FontSize = 13;
app.BzEditFieldLabel.Position = [17 21 76 22];
app.BzEditFieldLabel.Text = 'Bz';

% Create BzEditField
app.BzEditField = uieditfield(app.MAGNETICFIELDPanel, 'numeric');
app.BzEditField.FontSize = 13;
app.BzEditField.BackgroundColor = [0.7412 0.8863 0.949];
```

```
app.BzEditField.Position = [92 21 32 22];

% Create ELECTRICFIELDPanel
app.ELECTRICFIELDPanel = uipanel(app.UIFigure);
app.ELECTRICFIELDPanel.TitlePosition = 'centertop';
app.ELECTRICFIELDPanel.Title = 'ELECTRIC FIELD';
app.ELECTRICFIELDPanel.BackgroundColor = [0.8314 0.949 1];
app.ELECTRICFIELDPanel.FontWeight = 'bold';
app.ELECTRICFIELDPanel.FontSize = 15;
app.ELECTRICFIELDPanel.Position = [164 279 142 122];

% Create ExEditField_6Label
app.ExEditField_6Label = uilabel(app.ELECTRICFIELDPanel);
app.ExEditField_6Label.HorizontalAlignment = 'center';
app.ExEditField_6Label.FontSize = 13;
app.ExEditField_6Label.Position = [17 63 76 22];
app.ExEditField_6Label.Text = 'Ex';

% Create ExEditField
app.ExEditField = uieditfield(app.ELECTRICFIELDPanel, 'numeric');
app.ExEditField.FontSize = 13;
app.ExEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.ExEditField.Position = [92 63 32 22];

% Create EyEditField_6Label
app.EyEditField_6Label = uilabel(app.ELECTRICFIELDPanel);
app.EyEditField_6Label.HorizontalAlignment = 'center';
app.EyEditField_6Label.FontSize = 13;
app.EyEditField_6Label.Position = [17 42 76 22];
app.EyEditField_6Label.Text = 'Ey';

% Create EyEditField
app.EyEditField = uieditfield(app.ELECTRICFIELDPanel, 'numeric');
app.EyEditField.FontSize = 13;
app.EyEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.EyEditField.Position = [92 42 32 22];

% Create EzEditField_6Label
app.EzEditField_6Label = uilabel(app.ELECTRICFIELDPanel);
app.EzEditField_6Label.HorizontalAlignment = 'center';
app.EzEditField_6Label.FontSize = 13;
app.EzEditField_6Label.Position = [17 21 76 22];
app.EzEditField_6Label.Text = 'Ez';

% Create EzEditField
app.EzEditField = uieditfield(app.ELECTRICFIELDPanel, 'numeric');
app.EzEditField.FontSize = 13;
app.EzEditField.BackgroundColor = [0.7412 0.8863 0.949];
app.EzEditField.Position = [92 21 32 22];
app.EzEditField.Value = 2;

% Create StartingLimitofAxesEditFieldLabel
app.StartingLimitofAxesEditFieldLabel = uilabel(app.UIFigure);
app.StartingLimitofAxesEditFieldLabel.BackgroundColor = [0.8 0.8 0.8];
app.StartingLimitofAxesEditFieldLabel.HorizontalAlignment = 'center';
app.StartingLimitofAxesEditFieldLabel.FontSize = 13;
app.StartingLimitofAxesEditFieldLabel.Position = [366 32 136 22];
app.StartingLimitofAxesEditFieldLabel.Text = 'Starting Limit of Axes';

% Create StartingLimitofAxesEditField
```

```
            app.StartingLimitofAxesEditField = uieditfield(app.UIFigure, 'numeric');
            app.StartingLimitofAxesEditField.FontSize = 13;
            app.StartingLimitofAxesEditField.BackgroundColor = [0.8 0.8 0.8];
            app.StartingLimitofAxesEditField.Position = [501 32 45 22];
            app.StartingLimitofAxesEditField.Value = -15;

            % Create EndingLimitofAxesEditFieldLabel
            app.EndingLimitofAxesEditFieldLabel = uilabel(app.UIFigure);
            app.EndingLimitofAxesEditFieldLabel.BackgroundColor = [0.8 0.8 0.8];
            app.EndingLimitofAxesEditFieldLabel.HorizontalAlignment = 'center';
            app.EndingLimitofAxesEditFieldLabel.FontSize = 13;
            app.EndingLimitofAxesEditFieldLabel.Position = [591 32 136 22];
            app.EndingLimitofAxesEditFieldLabel.Text = 'Ending Limit of Axes';

            % Create EndingLimitofAxesEditField
            app.EndingLimitofAxesEditField = uieditfield(app.UIFigure, 'numeric');
            app.EndingLimitofAxesEditField.FontSize = 13;
            app.EndingLimitofAxesEditField.BackgroundColor = [0.8 0.8 0.8];
            app.EndingLimitofAxesEditField.Position = [726 32 45 22];
            app.EndingLimitofAxesEditField.Value = 15;

            % Show the figure after all components are created
            app.UIFigure.Visible = 'on';
        end
    end

    % App creation and deletion
    methods (Access = public)

        % Construct app
        function app = Trajectory_Particle_EB

            % Create UIFigure and components
            createComponents(app)

            % Register the app with App Designer
            registerApp(app, app.UIFigure)

            if nargout == 0
                clear app
            end
        end

        % Code that executes before app deletion
        function delete(app)

            % Delete UIFigure when app is deleted
            delete(app.UIFigure)
        end
    end
end
```

Future Work:

This project can be extended in several ways to enhance its scope and applicability. Some of the potential future work that can be done on this project are:

1. Addition of external forces: The simulation model developed in this project only considers the force on the charged particle due to the electric and magnetic fields. Adding external forces, such as gravity or friction, can make the model more realistic and applicable to a wider range of scenarios.
2. Inclusion of multiple particles: The simulation model developed in this project only considers the motion of a single charged particle. Including multiple particles in the model can enable the study of collective effects, such as plasma waves and instabilities.
3. Integration with other software: The simulation model developed in this project can be integrated with other software, such as particle tracking software or visualization software, to enhance its capabilities and applicability.
4. Optimization and parallelization: The simulation model developed in this project can be optimized and parallelized to improve its efficiency and enable simulations of larger systems.
5. Experimental validation: The simulation results obtained in this project can be compared with experimental data to validate the accuracy of the model and gain insights into the behavior of charged particles in real-world scenarios.

Overall, the simulation model developed in this project has the potential to be a powerful tool for studying the motion of charged particles in electric and magnetic fields and for designing and optimizing advanced technologies in various fields, such as particle accelerators and plasma physics.

Conclusion:

In this project, we have developed a simulation model in MATLAB to study the motion of a charged particle in electric and magnetic fields. The simulation model uses the second order Eular method to numerically solve the differential equations governing the motion of the charged particle and outputs the velocity and position of the particle as a function of time. By varying the parameters of the electric and magnetic fields, we have investigated the effects of different field configurations on the motion of the charged particle and studied the energy transfer mechanisms between the fields and the particle.

The simulation results have demonstrated that the model can accurately predict the motion of a charged particle in various electric and magnetic field configurations. The results have also revealed interesting and complex behavior of the charged particle in different field configurations, such as circular motion, oscillatory motion, and chaotic motion.

The simulation model developed in this project has the potential to be a powerful tool for designing and optimizing advanced technologies in various fields, such as particle accelerators and plasma physics. The model can be extended in several ways to enhance its scope and applicability, such as extension to three dimensions, inclusion of external forces, and integration with other software.

Overall, this project has provided valuable insights into the motion of a charged particle in electric and magnetic fields and demonstrated the effectiveness and versatility of simulation models in studying complex physical systems.