Assignment-5 (5/03/2019) deadline: 25th March, 2019

Assignments must be submitted in the form of a report along with MATLAB codes (through moodle). For all the problems below, **provide graphs (from the simulation) in your report**(use "hold on" and "subplot" wherever necessary to generate the graphs)**.Plots/graphs must be properly labeled with proper units and right choice of axis.**

For each problem: describe the model (governing mathematical equations), approximations made and conclusions based on the simulation (final data/plot). Choose realistic initial conditions, take help from google.

You can do more investigations with your program/code in addition to what have been asked in the question for a particular problem (put these investigations under "additional investigation" section in your report below each problem.)

Use Matlab ODE solver for the following problems:

1. Charge Particle trajectories under Lorentz force:

Write a general MATLAB code to reproduce charge particle motionsunder Lorentz force in the following cases (as shown in slides, choice of correct initial conditions are important to reproduce the trajectories).

Report on the initial conditions and the rationale behind observed motion. Support your answer with several supporting graphs. (Try different 3D plotting schemes in MATLAB for better visualization, other than "plot3" as discussed in the class). Analyze the motion for t=0 to a reasonable value of t=t_final.

(i) Static and Uniform E field (for +ve and –ve charges)
(ii)Static and uniform B field. (for +ve and –ve charges)
(iii) Static and uniform E and B. (ExB drift) (what happens when v=v0x; B=B0z; and E=E0y; and v0=E0/B0).
(iv) Static and uniform B, and under gravitational force (for different mass)

Investigate for at-least three different initial conditions for all the cases (i-iv). Compare the results for different cases including different charges and mass.

(v) Static and non-uniform (in the direction perpendicular to B) B field (grad B drift) (Optional)

2. Compute with your matlab code, the cyclotron frequency and thecyclotron radius for – an electron in the Earth's ionosphere at 300 kmaltitude, where the magnetic flux density B~.00005 Tesla, consideringthat the electron moves at the thermal velocity (kT/m), with T=1000 K,where "k" is Boltzmann's constant. Plot a graph to show themotion/results and compare your results with analytical calculations.

What will be the effect of gravitational drift velocity "v_g" in this case?

3. Modify the program to describe the motion of a charged particle in an oscillating electric field. Consider a uniform alternating electric field in x-direction
   E=Ex0 sin (omega t)
   Angular freq→ Omega= 2 (pi) (frequency)
   Amplitude → Ex0

   Plot the trajectory of the particle in time. What happens when the particle has non-zero initial velocity in x or y direction.