Assignment-3 deadline: 16th February, 2015

Assignments must be submitted in the form of report along with MATLAB codes.

For all the problems below, **provide graphs in your report** (use “hold on” and “subplot” wherever necessary to generate the graphs) to support your observations and conclusions. Sample codes made during the lectures are placed in lecture folder for reference.

Instruction regarding submission of report will be provided by the Lab instructors.

1. Sliding Block Problem:

   Investigate (computationally) the motion of a block sliding without friction down a fixed inclined plane with different initial parameters.
   Derive the analytical solution for displacement, velocity, and acceleration.
   Compare the computational results with analytical solutions for the case when the angle of the inclined plane is 30 degree - to check the accuracy of the computational model. (Example 2.1; Marion and Thornton).

2. Introduce the effect of static friction and kinetic friction into the previous problem. Take coefficient of static friction=.4 and coefficient of kinetic friction=.3 and computationally analyze the motion for different initial angles. Report your computational observations and how the results compare with theoretical solutions (Example 2.2-2.3; Marion and Thornton).

3. Projectile Motion: Cannon Shell/ Missile Problem

(a) Investigate (computationally) the cannon-shell trajectories ignoring both air drag and the effect of air density. Compare your result with exact solutions.
Acceleration due to gravity depends on altitude; include this effect in your computational model by making some rational assumption.

(b) Investigate the trajectory of the canon shell including both air drag (proportional to square of velocity) and reduced air density at high altitudes. Perform your calculation for different firing angles; and determine the value of the angle that gives the maximum range.

$$F_{drag} = - B v^2$$

Density of atmosphere varies as follows:

$$\rho = \rho_0 \exp(-y/y_0)$$

y is the altitude; y_0 =1000 m.

Drag force with air resistance:

$$F^*_{\text{drag}} = \frac{\rho}{\rho_0} F_{\text{drag}}(y = 0)$$

Take initial speed=750 m/s;
B/m= 4E-5 m^{-1}.

(c) Generalize the program so that it can deal with situations where the target is at a different altitude (higher or lower) than the canon. Investigate for both the cases. How the minimum firing velocity to hit a target varies as the altitude of the target varies.
(d) Optional: Effect of wind on shell trajectory. Can you include this in your computational model and investigate the effects.

4. Simple Harmonic Motion:
   Computationally investigate the motion of a pendulum and a spring-mass system as discussed in the class for damped, driven system. Draw phase plots to explain your observations.
   Estimate the time constant of decay for a damped system and compare the results with analytical solution.