PHYS 301
HOMEWORK #8

To be submitted by email to me at dslavsk@luc.edu no later than 5 : 00 pm 23 March 2015. This assignment consists of writing *Mathematica* programs as described below. Please submit your *Mathematica* notebook (.nb file) to me via email. I will open and execute your program.

In class we have studied the use of recursion techniques and discrete methods to solve one dimensional trajectory problems. In this assignment, you will solve two dimensional trajectory problems, both ignoring and including friction.

Let' s begin by considering a projectile launched with an initial velocity of 40 m/s at an angle of 40^o with respect to the horizontal. We know its initial components of velocity are :

$$v_o(x) = v_o \cos\theta \qquad v_o(y) = v_o \sin\theta$$

and the equations of motion are

$$x(t) = x_o + v_o \cos\theta\, t \qquad y(t) = y_o + v_o \sin\theta\, t - \frac{1}{2} g t^2$$

It is trivial to solve these to show that the time of flight is

$$t_{flight} = \frac{2 v_o \sin\theta}{g}$$

the range is :

$$R = \frac{v_o^2 \sin 2\theta}{g}$$

and the maximum height is

$$y_{max} = \frac{v_o^2 \sin^2\theta}{2 g}$$

Part I of the assignment : In part 1 of the assignment, ignore air friction and use Euler' s method and discrete techniques to find :

- x (n) and y (n) for the projectile (where n represents the nth evaluation point)
- v_x (n) and v_y (n)
- the time of flight, range and maximum height achieved (and compare to the theoretical values)
- produce plot of y (n) vs. x (n)

In Part II, we add linear air friction, so that Newton' s second law can be written as :

$\sum F_x = m a_x = -k v_x$ where k is a constant

$$\sum F_y = m a_y = -k v_y - m g$$

Use these results, again with Euler' s method and discrete techniques that we have covered in class, and find :

• the x and y coordinates of the projectile at any evaluation point
• the x and y components of velocity at any given evaluation point
• time of flight, range and maximum height achieved
• a plot of y (n) vs. x (n)

Finally, show both trajectories on a single set of axes to compare the theoretical trajectory with no friction to the more realistic trajectory including friction. For Part II of this problem, set k = 0.5 for motion in both the x and y directions.

This entire problem will count for 100 points.