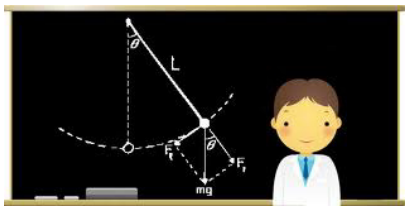
<In the Name of God>

Numerical Analysis Spring 2015

Instructor: Dr. Hamed Masnadi-Shirazi

HW #3

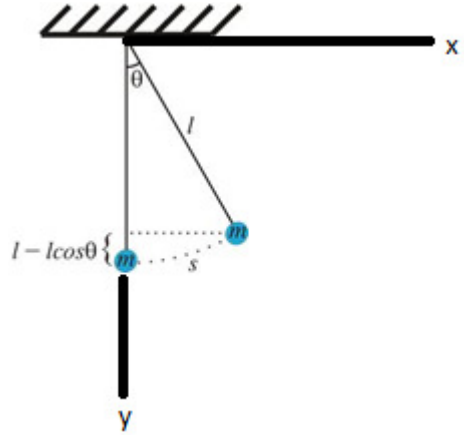


Due Date: (Late HWs will get a zero grade.)

(Note: getting help or helping others on this HW is NOT allowed!)

1) Pendulum:

Assume that we have a pendulum of length=L=10



We call "s" the arc-length as measured in the picture. s=0 corresponds to the pendulum at rest. We note the path of the pendulum over time as s(t). We can also show the "x" and "y" coordinates of the pendulum as

x(t)= L*sin(s(t)/L)

y(t)= -L*cos(s(t)/L)

It can be shown that the pendulum is governed by the differential equation

$$\frac{d^2s}{dt^2} = -gsin(\frac{s(t)}{L})$$

where g=-9.8(m/s^2). Use the 4th order Runge-Kutta method to find s(t), x(t) and y(t) for time increments of h=0.01 and assume that the initial position of the pendulum is

s(0)=7. Plot s(t), x(t) and y(t) from t=0 to t=10 seconds. What is the position of the pendulum at t=10(s) (s(10)=?, x(10)=? And y(10)=?).

2) Rocket:

It can be shown that the velocity of a rocket can be found from the following simplified rocket equation:

$$\frac{dv}{dt} = \frac{T - \left(\frac{1}{2} C_d \rho A v^2\right) - (mg\sin\theta)}{m}$$

Where :

T= rocket thrust (N)

v= rocket instantaneous velocity (m/s)

t= time (s)

Cd= 0.75 = rocket air drag coefficient

p= 1 = air pressure in Shiraz (kg/m^3)

A= cross sectional area of rocket (m^2)

m= mass of rocket (kg)

g= 9.8 (m/s^2)

θ = angle of rocket with horizon = 90 degrees if the rocket goes straight up.

What is the final velocity of the rocket after 10 seconds if it accelerates from stand still with a constant thrust T=100N and has a constant mass of m=1 kg and A = 0.000483 (m^2)? When will the rocket break the sound barrier? Use time steps of h=0.01 (s) and plot velocity versus time for the rocket.

Submission Guide: submit your Matlab program. Submit the plot and the output of your program. Failing to follow the above guidelines will result in a ZERO grade!