Math 321 Assignment 2 Computer Problem

In this problem, we use *Matlab* to compare the solutions of the pendulum equation

$$\frac{d^2\theta}{dt^2} = -\frac{g}{L}\sin\theta$$

with the linearized approximation

$$\frac{d^2\theta}{dt^2} = -\frac{g}{L}\theta.$$

Let $g/L = 2$ and consider two pairs of initial conditions (i) $\theta(0) = .75$, $(d\theta/dt)(0) = 0$ and (ii) $\theta(0) = 2.75$, $(d\theta/dt)(0) = 0$.

The *Matlab* code to solve the nonlinear and linearized pendulum equations and plot the solutions (on the same graph) with the first set of initial conditions is simply

```
% The next two lines define the right side of the differential equation
gn = inline('[y(2);-2*sin(y(1))]','t','y')
gl = inline('[y(2);-2*y(1)]','t','y')
% The next two lines define the initial conditions
y10=.75
y20=0
% The next two lines call the numerical solver ode45
[tsn,ysn] = ode45(gn,[0,10],[y10;y20]);
[tsl,ysl] = ode45(gl,[0,10],[y10;y20]);
% The next two lines plot the solution of the nonlinear problem
% and keep the plotting window open
plot(tsn,ysn(:,1))
hold on
% The next two lines plot the solution of the linear problem
% in the same window
plot(tsl,ysl(:,1))
hold off
```

(a) Use *Matlab* to obtain plots for the solutions of the nonlinear and linearized pendulum equation for both sets of initial conditions. You can print out the plot that appears in the plotting window by selecting *File* and then *Print*.

(b) Explain why you expect the two solutions to be close for the first set of initial conditions, but not necessarily for the second set.