Math 450H
Homework V: Due 12/1/05

Prof. Bukiet

Topic: Pendulum

You may work in pairs on this assignment

1a. Set up a pendulum experiment using the LoggerPro system and a photogate set up so that the light is blocked when the pendulum passes through the equilibrium position. Use two different masses that differ by at least a factor of 2 and 2 different lengths that differ by at least a factor of 2. Compare the linearized pendulum equation's (without damping) predicted frequency with the experimental value for initial θs of $\pi/18$, $\pi/9$ and $\pi/6$. Is there any trend in the errors as the angle grows. (Start the experiment with zero initial velocity). Please carefully describe how you performed your experiments. Give lots of detail.

1b. Solve numerically (using a Runge-Kutta code) the nonlinear pendulum problem:

$$\ddot{\theta} + \frac{g}{L}\sin\theta = 0 \ , \tag{1}$$

subject to the initial conditions in part 1a. Use your computer code to evaluate the period of the oscillations. Do these results compare more or less favorably with the experimental results compared to the linearized pendulum equation's frequency predictions? Justify and give reasoning.

1c. Plot the (analytically evaluated) trajectory in the phase plane of this system for $\theta_0 = \pi/3$ for the linearized pendulum equation and plot the (numerically computed) trajectory for the non-linear pendulum system. How do the trajectories compare?