PHYS-330 - Classical Mechanics - Fall 2017

Homework 5

Due: 16th October 2017 by the start of class. Anything later will be considered late. Late assignments will be subjected to 10% deduction each day late. The late day starts by the end of class when the assignment is due.

Instructions: Complete all of the questions below. You are encouraged to use Jupyter Notebooks to complete any numerical work and written. While the use of python is encouraged, you can use any programming language you want. You can either email me your assignment or provide me with a hard copy in class.

1. Consider a pendulum whose length, l, varies with time.
   a. Show that the equation of motion in the absence of damping is

   $$l\ddot{\theta} + 2\dot{l}\dot{\theta} + g\sin\theta = 0$$

   using three different methods.
      i. using $\boldsymbol{\tau} = \dot{\mathbf{L}}$.

      ii. Using $\mathbf{F} = m\mathbf{a}$

      iii. Using Lagrangians.

   b. If $l = l_0 + \alpha t$, find numerical solutions to the above differential equation. Assume $\theta_0 = 60^o$, $\dot{\theta}(0) = 0$, $g = 9.8$ m/s/s and $l_0 = 10.0$ m. Do this for two cases $\alpha = \pm 0.1$ m/s. Plot the graph of $\theta(t)$ for each α. Plot the trajectory in the x,y plane.
2. Consider an undamped oscillator (a particle subjected to a linear restoring force) which is driven at its resonance frequency ω_0 by a force $F = F_0 \sin\omega_0 t$ with initial conditions $x_0 = 0$ and $v_0 = 0$.
   a. Determine x(t).
   b. If the breaking strength of the 'spring' for the oscillator is $4F_0$, determine the time, t_b, to reach the breaking point in terms of ω_0 to 5 significant figures.
3. 6.22 from Taylor
4. 7.20 from Taylor

5. 7.34 from Taylor