

Homework 4: Dynamics

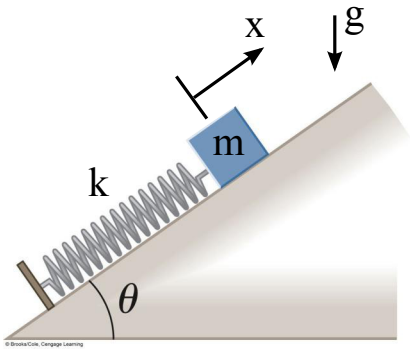
Due Friday, 14th November, 11:59 pm

October 31, 2014

Problems:

1. Simple Dynamics Problems

Write the equations of motion for the following systems using **both** Newton's equations of motion and the Euler-Lagrange equations and show that they give the same answers.

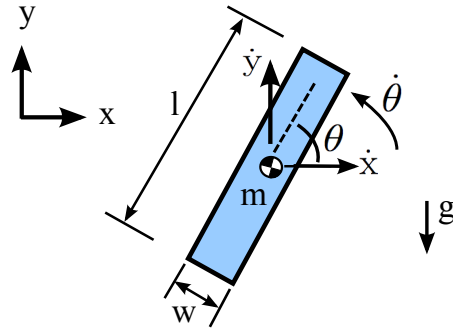


Newton's Eqns:

$$\sum F_x = m\ddot{x}$$

Euler-Lagrange Eqns:

$$\frac{\partial}{\partial t} \left(\frac{\partial L}{\partial \dot{x}} \right) - \frac{\partial L}{\partial x} = 0$$



Newton's Eqns:

(1)

$$\sum F_x = m\ddot{x}$$

(2)

$$\sum F_y = m\ddot{y}$$

(3)

$$\sum \tau = I\ddot{\theta}$$

(4)

Euler-Lagrange Eqns:

(5)

$$\frac{\partial}{\partial t} \left(\frac{\partial L}{\partial \dot{x}} \right) - \frac{\partial L}{\partial x} = 0$$

(6)

$$\frac{\partial}{\partial t} \left(\frac{\partial L}{\partial \dot{y}} \right) - \frac{\partial L}{\partial y} = 0$$

(7)

$$\frac{\partial}{\partial t} \left(\frac{\partial L}{\partial \dot{\theta}} \right) - \frac{\partial L}{\partial \theta} = 0$$

(8)

Note that in each of these systems, we are only considering forces that can be represented as potential energies (spring forces, gravitational forces, etc.) Thus if we include potential energy terms for these forces in the Lagrangian (L), the right hand sides of the Euler-Lagrange equations should be 0.

2. Double Pendulum

Write the equations of motion for the following double pendulum. (Use the Euler-Lagrange equations.)

This system has only two degrees of freedom, thus we only need two equations to define its motion, one for q_1 and one for q_2 .

