EE106/206 HW6: Dynamics

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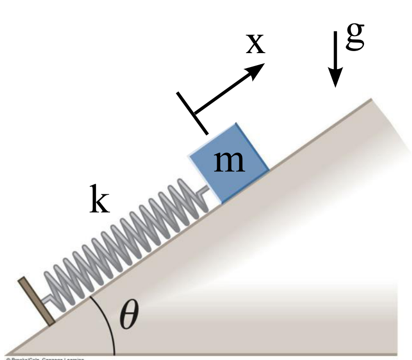
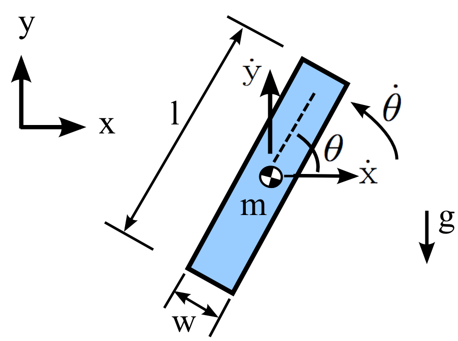
Homework due: Thursday 10/25/2018 @ 11:59 PM on GradeScope

Problem-sets are due as a PDF on GradeScope Feel free to use a computer to help you with this problem set. If you do write any code, to help you solve the problem, attach the code at the end of your problem set. If you use any pre-made code (such as MATLAB's pseudo-inverse function pinv()), state that you use it as a step in your solution.

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)

$$\sum F_x = m\ddot{x} \quad (2)$$

$$\sum F_y = m\ddot{y} \quad (3)$$

$$\sum \tau = I\ddot{\theta} \quad (4)$$

Euler-Lagrange Eqns: (5)

$$\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}}\right) - \frac{\partial L}{\partial x} = 0 \quad (6)$$

$$\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{y}}\right) - \frac{\partial L}{\partial y} = 0 \quad (7)$$

$$\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{\theta}}\right) - \frac{\partial L}{\partial \theta} = 0 \quad (8)$$

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.