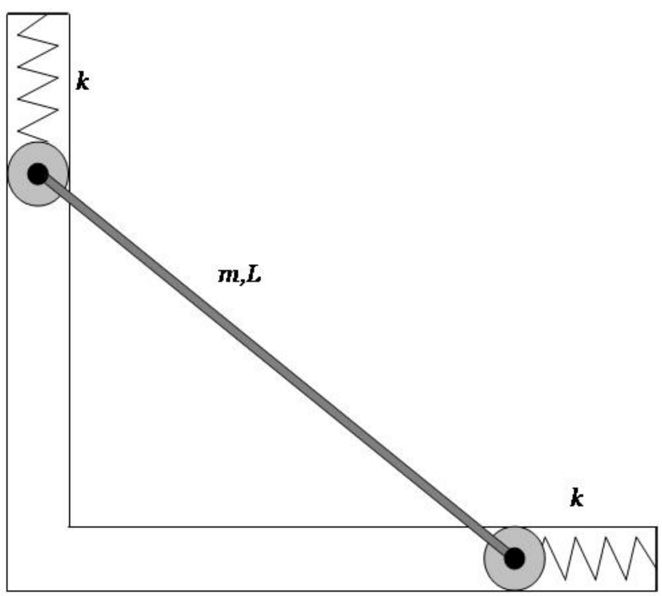
1.053/2.003 Dynamics and Control I
Fall 2006

Problem Set 7

Out: Monday, October 29th, 2007
Due: Monday, November 5th, 2007

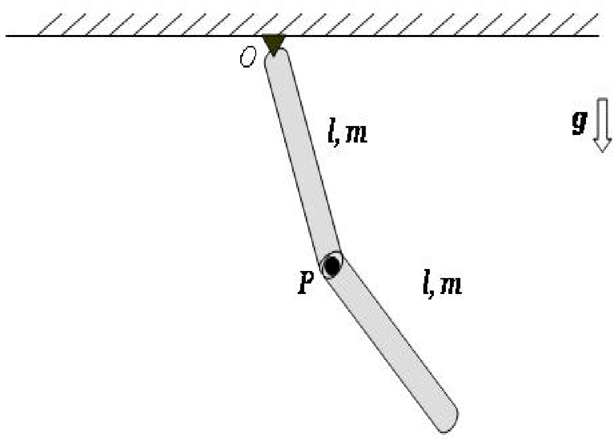
1. Oscillating slender rod

An L-shaped groove is shown in the figure below. Two ends of a slender rod of mass m and length L are attached to identical springs, each with a spring constant k. Both the springs are fixed to the L-shaped groove as shown in the figure below. Both the ends of the rod are constrained to move only along the L-shaped groove. Ignore gravity for this problem. Choose appropriate generalized coordinate(s) and derive the equation(s) of motion for this system using the Lagrangian approach.



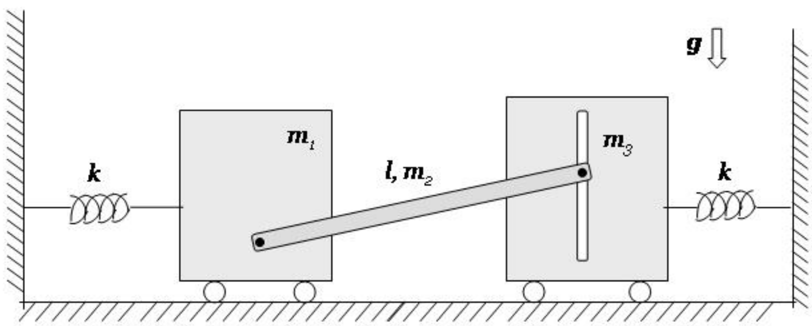
2. Double pendulum

A double pendulum is formed using two rigid, slender rods each of mass m and length l as shown in the figure below. Link 1 is free to pivot about point O and link 2 is free to pivot about point P. Note that gravity acts. Choose appropriate generalized coordinate(s) and derive the equation(s) of motion for this system using the Lagrangian approach.



3. Carts and springs

Two carts, of masses m_1 and m_3 respectively, are constrained to move together by a bar of mass m_2 and length l (this can be approximated as a slender rod). The bar is connected to the first cart via a fixed pin-joint, and to the second cart via a pin-joint that can translate vertically in a slot. Furthermore, each cart is connected to an adjacent wall by a spring, and both springs have stiffness k. Note that gravity acts. Choose appropriate generalized coordinate(s) and derive the equation(s) of motion for this system using the Lagrangian approach.



4. Wheeled pendulum

The figure below shows an inverted pendulum mounted on a rolling wheel. The wheel, which can be modeled as a disk of radius r_1 and mass m_1, rolls on the flat ground without slipping. The pendulum can be modeled as a point mass m_2 at one end of a mass-less rod of length r_2. The other end of the rod is attached to the disk and is free to pivot about point C. Note that gravity acts. Choose appropriate generalized coordinate(s) and derive the equation(s) of motion for this system using the Lagrangian approach.