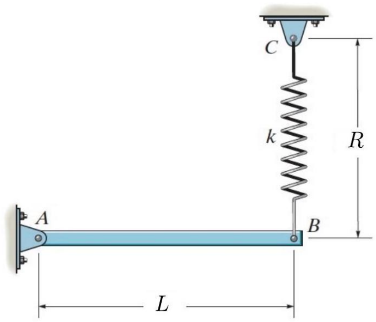
UNIVERSITY OF COLORADO - BOULDER
Department of Mechanical Engineering

MCEN 5228-Advanced Dynamics

Homework #4 (Assigned: 2/20, Due: 2/28)

1. For the beam-spring system shown below, calculate the work done by gravity and the work done by the spring force on the beam length L as it rotates from the initial position of $\theta = 0°$ to a position $\theta = 90°$ clockwise. Assume the beam has a mass m and the spring behaves linearly with spring constant k. Also assume the unstretched length of the spring is R.



2. The work-energy principle says that the work done by all external forces on a particle or rigid body is equal to the change in kinetic energy, that is $W_{1\to 2} = \Delta T$, where T is the kinetic energy. Show that if the work term is broken up into the work done by conservative forces and the work done by non-conservative forces, $W_{1\to 2} = W^{C}_{1\to 2} + W^{NC}_{1\to 2}$, then the work-energy principle becomes $W^{NC}_{1\to 2} = \Delta T + \Delta V$. Also, show that if the work done by non-conservative forces acting on the system $W^{NC}_{1\to 2} = 0$, then the system energy $E = T + V$ is conserved between the initial and final states.

3. Consider the system shown in Problem 1. If this system starts at rest at the initial state of $\theta = 0°$, find the spring constant k required such that the system is at rest in the final state $\theta = 90°$ (clockwise) in terms of m, g, L and R.

4. The system shown consists of a uniform rigid link of mass m and length L and two springs with stiffnesses k_1 and k_2, respectively. When the springs are unstretched, the link is horizontal. Use the principle of virtual work to calculate the relationship between the angle θ and the parameters k_1, k_2, m and l at equilibrium.