1. (25 Points)

Consider the system shown in Figure 1, a rigid bar is connected at its both ends by two frictionless rollers A and B. At A, a spring with a spring constant k is connected. While at B, a force P is exerted. The horizontal displacement at A and the vertical displacement at B are u and v, respectively. Neglecting gravitational force. Our goal is to find the final static equilibrium position (i.e., final θ).

(a) Please provide physical explanations for the following two principles. (6 Pts)

(i) Principle of virtual work

(ii) Principle of work and energy

(b) Without performing any detailed calculation, please tell us as detailed as possible your approach to solve this problem. (6 Pts)

(c) Please use any methods to solve this problem. (8 Pts)

(d) Now, instead of finding the static equilibrium position, we like to obtain the equation motion. Please tell us as detail as possible how you solve this problem. You do not need to perform any detailed mathematical operations. (5 Pts)

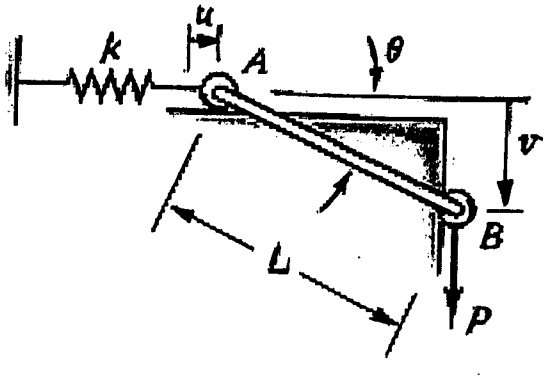

Figure 1

2.　(25 points)

Refer to Figure 2. The speed of the brake drum shown is controlled by a belt attached to the control bar AD.　A force P of magnitude 25 lb is applied to the control bar at A.　Determine the magnitude of the couple being applied to the drum, knowing that the coefficient of kinetic friction between the belt and the drum is 0.25, that a =4 in., and that the drum is rotating at a constant speed (a) counterclockwise, (b) clockwise.

(a).　Without performing any calculations, please tell us how to solve this problem. (10 Pts)

(b).　Go ahead to solve this problem.　(15 Pts)

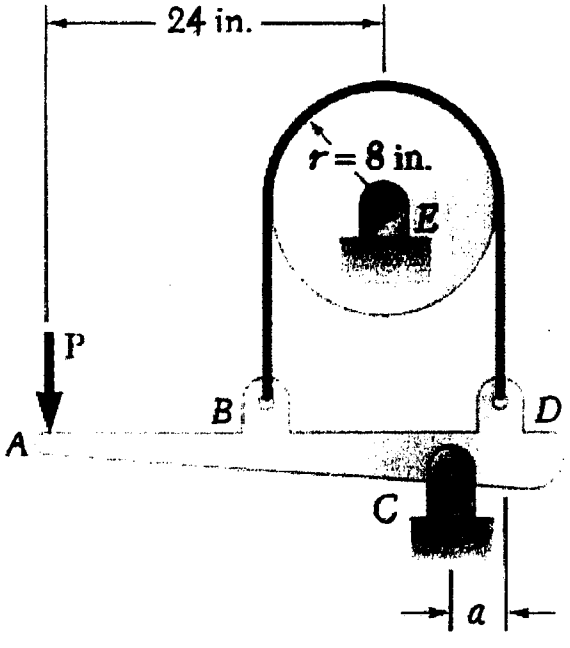

Figure 2

3. (25 points)

The uniform pole has a mass of 15Kg and falls from rest when $\theta = 90°$ until it strikes the edge at A, $\theta = 60°$. If the pole then begins to pivot about this point after contact, determine the pole's angular velocity just after the impact. Assume that the pole does not slip at B as it falls until it strikes A.

(a): Without performing any calculations, please tell us how to solve this problem. (10 Pts)

(b): Go ahead to solve this problem. (15 Pts)

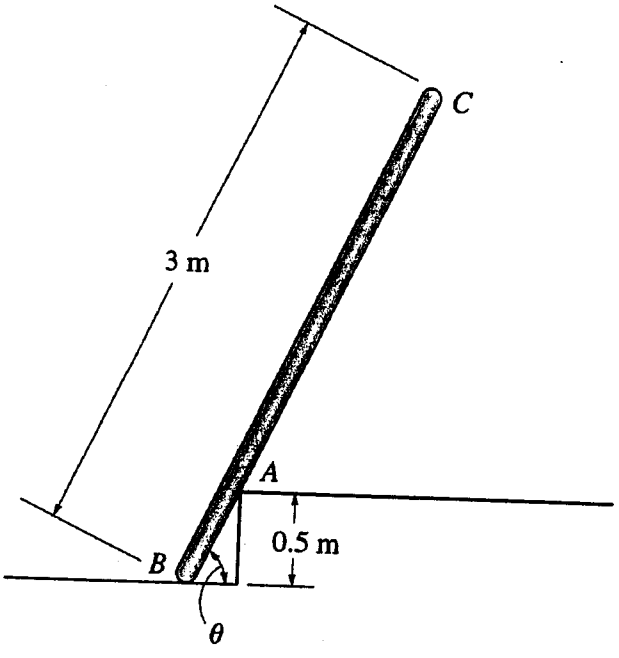

Figure 3

4. (25 points)

A mass-spring-damper system is subject to **a step force 10N**. Its step response is shown in Figure 4.

(a) Is this system an over damped, critical damped, or under damped system? Why? (5 Pts)

(b) What is the damped natural frequency of this system? (5 Pts)

(c) Please tell us how to estimate the stiffness, mass, and damping coefficient of this system. (10 Pts)

(d) Please find the stiffness, mass, and damping coefficient of this system. (5 Pts)

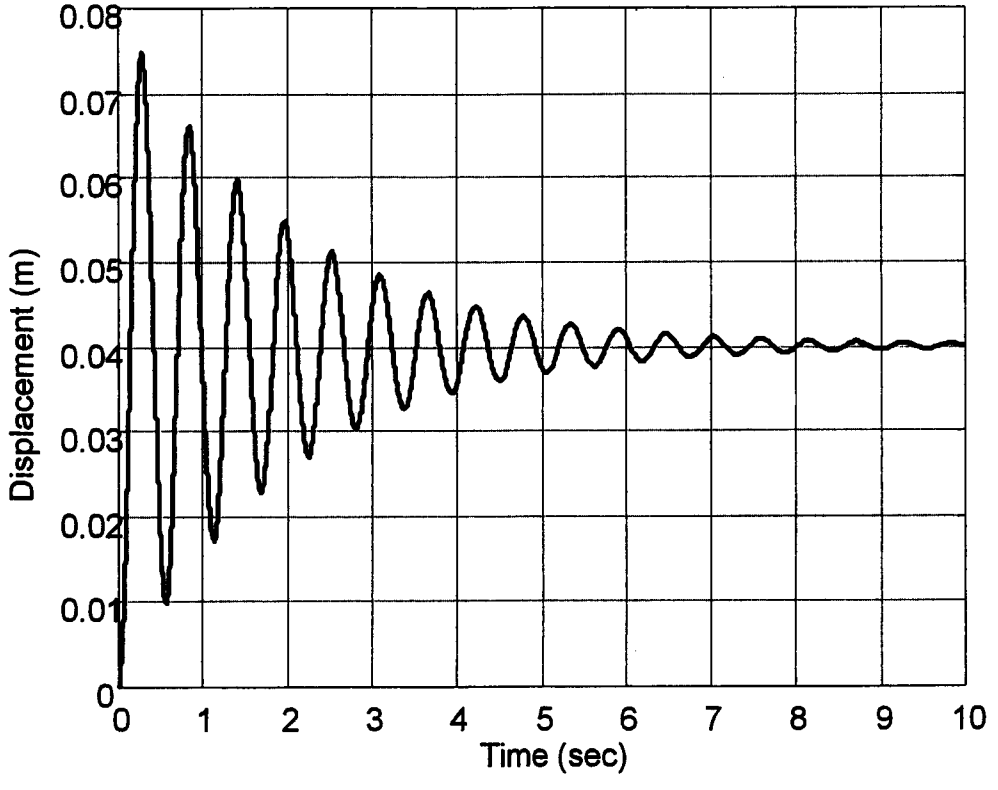

Figure 4