Quiz No.2

Wednesday, December 8, 2004

This is a CLOSED-BOOK, Open notes Quiz.

Problem 1 (20 points)

Two small masses, m_1 and m_2, are constrained to move in a vertical plane by two inextensible strings, as shown in figure 1. The lengths of the two strings are R and $L = \rho + r$, respectively. There is a force of magnitude F acting on the mass m_2, with its line of attack always parallel to the string attached to m_2. The constant of gravity is g. The pulley shown in the figure is small and frictionless.

   (a) Classify all constraints and forces (give reasoning). Determine the number of degrees of freedom.
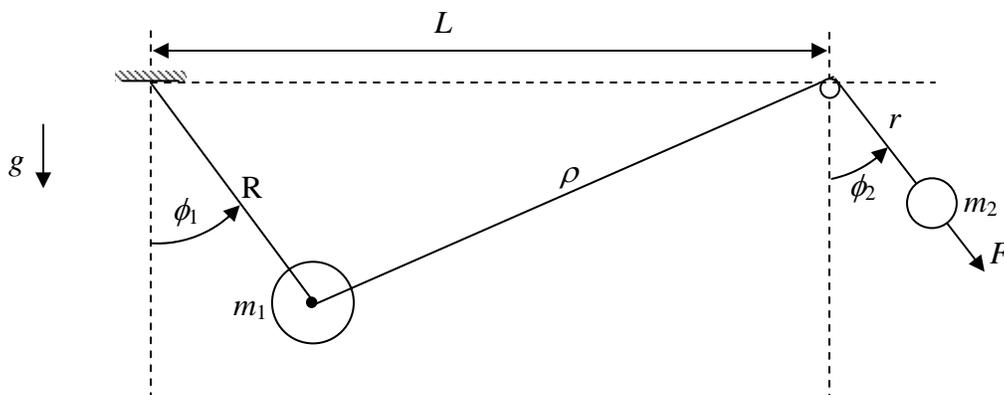   (b) Derive the Lagrangian equations of motion in terms of ϕ_1 and ϕ_2.

Figure 1

Problem 2 (20 points)

A disk of radius r and mass M is placed on a fixed tube of radius R, as shown in Figure 2. The center of the disk is at a distance l from the ceiling and is attached to the ceiling through a spring of stiffness k_1 and unstretched length l_0. At the same time, a block of mass m is hanging from the center of the disk on a spring of stiffness k_2 and unstretched length l_0. We assume that the disk cannot slip on the tube and the lower spring remains vertical on any motion of the system. The constant of gravity is g.
Without deriving equations of motion, find sufficient and necessary conditions for the stability of the equilibrium shown in Fig. 2.
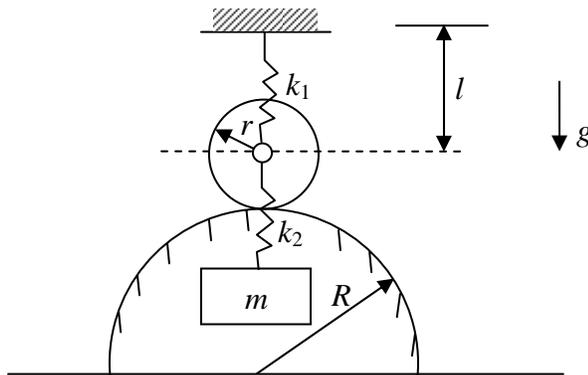

Figure 2