Dynamics Ph.D. Qualifying Examination

Three problems—100 points total, 2 hours duration

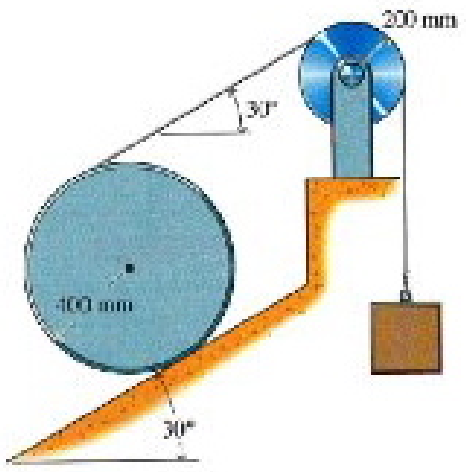
Closed book and notes—extra paper and a calculator may be used

Work neatly, and please show all your work!

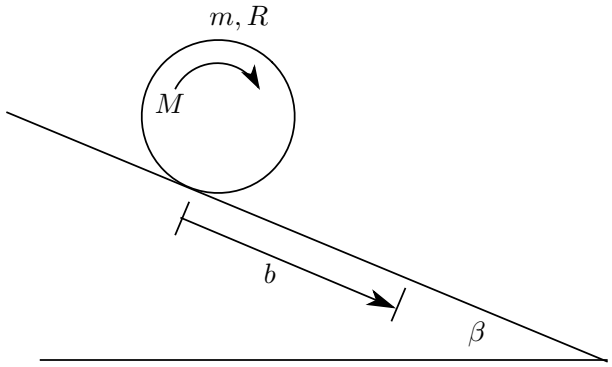
Problem 1. (35 points) A solid homogeneous cylinder with a mass of 100 kg and diameter of 400 mm rests on a 30° inclined surface as shown below. The coefficient of friction between the cylinder and inclined surface is 0.40. A cable wrapped around a shallow groove in the cylinder connects it to block, which has a mass of 75kg. The pulley that the cable passes over has a mass of 10 kg and diameter of 200 mm. If the system is released from rest in the position shown determine a) the acceleration of the mass center G of the block, b) the acceleration of the mass center G of the cylinder, and c) the tensions in the two parts of the cable. Using Newton's equations to determine the equations to be solved clearly showing the number of equations and number of unknowns are equal—then solve! Make sure you prove the cylinder doesn't slip. You can assume the cable does not slip on the pulley.

The mass moment of inertia of a cylinder of mass, M and radius R about its CG is

$$I = \frac{1}{2}MR^2$$



Problem 2. (35 points) A disk of mass m and moment of inertia $I = \frac{1}{2}mR^2$ is released from rest on an inclined surface and subjected to a constant clockwise couple M as it rolls down the inclined surface. If the disk rolls without slipping, what is the velocity of its center when it has moved a distance b?



Problem 3. (30 points) A body is dropped form an initial height of 5 m. It bounces and returns to a height of 4.5 m.

(a) What is the coefficient of restitution of the collision?

(b) How much energy was lost during the collision?

(c) If energy was lost, where did most of it go?