Ph.D. Qualifying Examination

Dynamics

Spring 2010

Notes:

- Duration: 2.5 hours.
- Closed book, closed notes (one sheet of formulæ is allowed).
- State your assumptions, methods, and procedures. Show your work on these exam sheets. Add additional sheets, if needed.
- Calculator allowed.
- Laptops and cell phones are not allowed.

Problem 1. (30) A thin ring having a mass of 15 kg strikes the 20-mm high step. Determine the maximum angular velocity ω_1 the ring can have so that the ring loses contact at point A (*i.e.* "bounces back") after striking it. The moment of inertia of the ring about its center axis is mr^2.

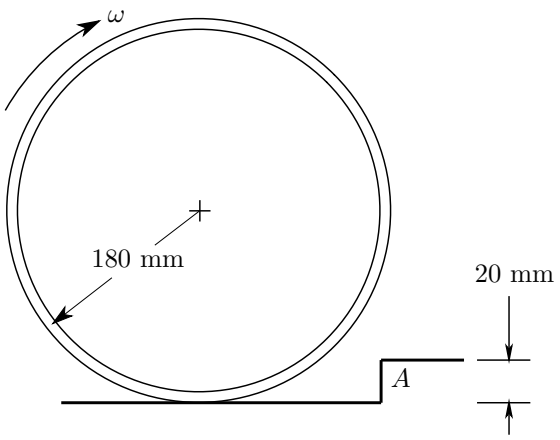

Figure 1: Plate.

Problem 2. (35) A small cylinder (body 2) of mass m and radius r is given an initial horizontal velocity v_0 as shown. The small cylinder rolls without slipping on larger fixed cylinder (body 1) of radius R. Find the value of angle θ when the small cylinder separates from the larger cylinder.

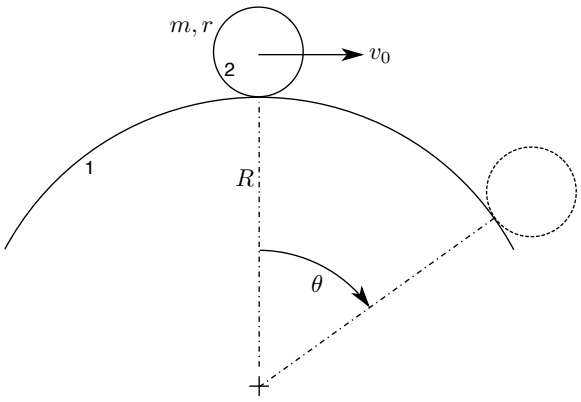

Figure 2: Plate.

Problem 3. (35) A mass $m = 10$ kg is initially positioned a distance $l = 1$ meter above a spring bumper as shown. When released, it strikes the bumper and compresses the spring, then rebounds back up the ramp. There is kinetic coefficient of friction $\mu_k = 0.1$ between mass and ramp, and the spring stiffness is $k = 17$ N/mm. Use $g = 9.81$ m/s^2.

1. Find the maximum compression δ of the spring.
2. How far back up the ramp does the mass rebound?

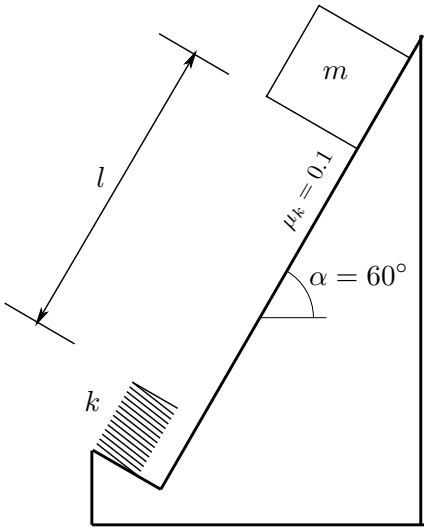

Figure 3: Plate.