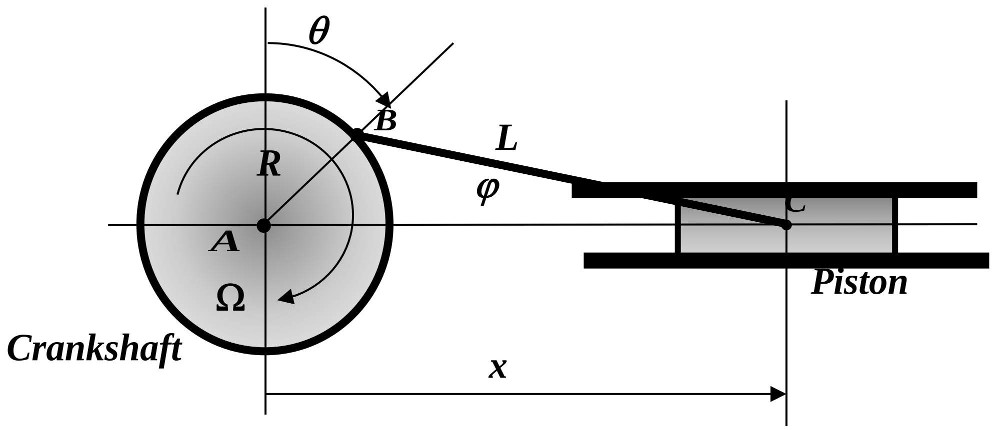
Mechanical Engineering Department
University of New Mexico
Ph.D. Qualifying Examination
Dynamics Section
Spring 2020

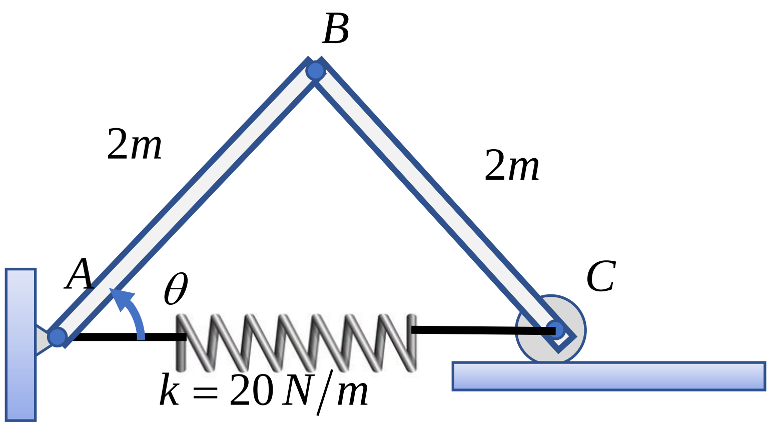
INSTRUCTIONS:

- Time allowed: 2 hours
- Closed book and closed notes; one sheet (8.50×11.00 in, 2-sided) of formulas is allowed
- There are 4 problems worth a total of 100 points
- You MUST show and explain work to get credit
- Calculator allowed
- Laptops, cell phones, and similar electronic devices are not allowed

1. (25) The figure shown models a crankshaft and piston. The crankshaft has a radius, R, and is rotating at a constant angular velocity, Ω, such that $\theta = \Omega t$. The piston rod's length is L. Determine the linear velocity of the piston, $\dot{x}$, in terms of the crankshaft angular velocity, Ω and time, t.

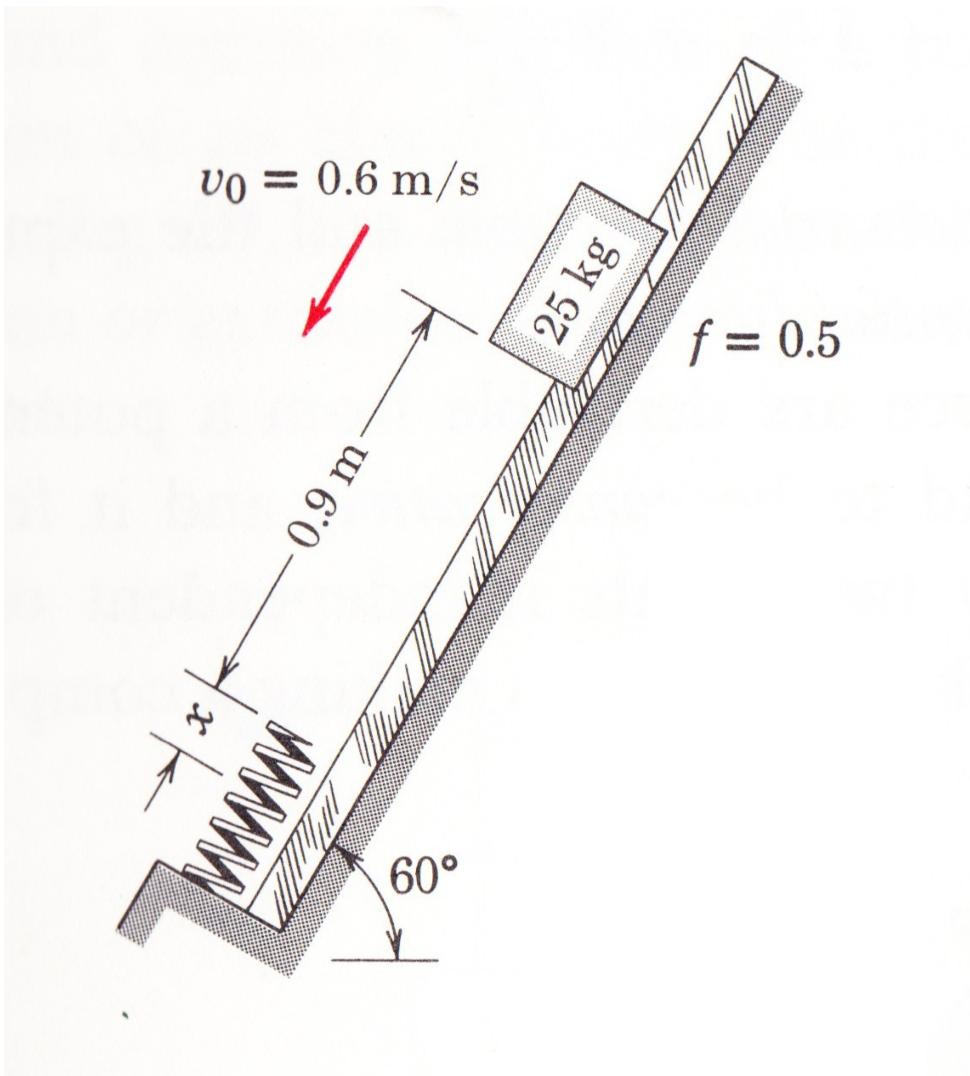


2. (25) The 12 *kg* slender rods are pin connected and released from rest at the position $\theta = 60^{\circ}$. If the spring has an unstretched length of 1.5m , determine the angular velocity of rod *BC*, when the system is at the position $\theta = 0^{\circ}$. Neglect the mass of the roller at *C*.



Problem 3.

The 25-kg slider is released from the position shown with a velocity of $v_0 = 0.6$ m/s on the inclined rail and slides under the influence of gravity and friction. The coefficient of friction between the slider and the rail is $f = 0.5$. Calculate the velocity of the slider as it passes the position for which the spring is compressed a distance $x = 100$ mm. The spring offers a compressive resistance C and is known as a "hardening" spring, since its stiffness increases with deflection as given by $C = 16x + 0.06x^2$.



Problem 4.

A particle of mass m starts from rest and moves in a horizontal straight line under the action of a constant force P. Resistance to motion is proportional to the square of the velocity and is $R = kv^2$. Determine the total impulse I on the particle from the time it starts until it reaches its maximum velocity.