MECH 211

Fall 2003

Test 2

Due November 12, 2003 at the start of class.

Show all work. Any force existing in an equation must also be denoted on an appropriate free body diagram. Clearly indicate final answers.

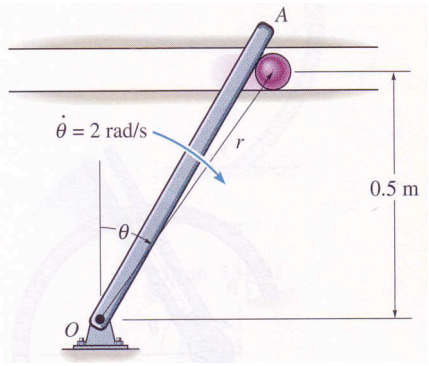
This test is taken under the Rice Honor Code system. You may consult only the textbook (Pytel and Kiusalaas), notes that you have personally taken, and any material downloaded from the course website. You may use a calculator, including programmable calculators. The test must be taken during a 3 hour period, with an optional 30 minute break.

Time started:_____

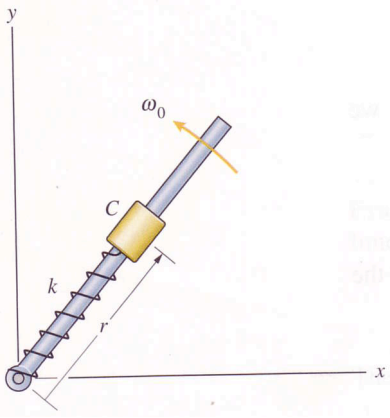
Time finished:_____

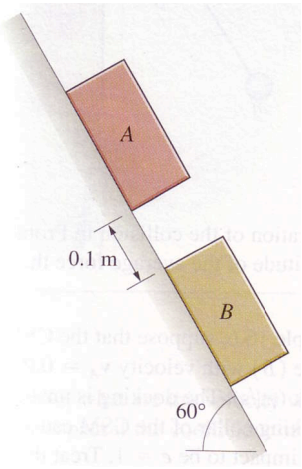
Pledge:_____

1. The ball has a mass of 0.5 kg and is confined to move along the frictionless horizontal slot due to the rotation of the arm OA. Determine the forces of the rod on the ball and the normal force of the slot on the ball when $\theta = 30°$. When $\theta = 30°$ the rod is rotating with an angular velocity of $\dot{\theta} = 2$ rad/s and an angular acceleration of $\ddot{\theta} = 3$ rad/s^2. Assume that the ball contacts only one side of the slot at any instant. You should assume that the radius of the ball is very small such that the angle that the rod makes with the vertical is θ. Hint: it is easiest to solve this problem using Cartesian coordinates. Also $\frac{d}{d\theta}(\tan\theta) = \frac{1}{\cos^2\theta}$ and $\frac{d}{d\theta}\left(\frac{1}{\cos^2\theta}\right) = \frac{2\sin\theta}{\cos^3\theta}$. $g = 9.81$ m/s^2 downward.



2. The massless bar rotates freely in the horizontal plane (i.e. gravity acts into the page) about a pin at the origin. The 2-kg sleeve C slides on the smooth (frictionless) bar. The spring constant $k = 40$ N/m, and the unstretched length of the spring is 0.8 m. At $t = 0$, the angular velocity of the bar is $\omega_0 = 6$ rad/s, $r = 0.2$ m, and the radial velocity of the sleeve is $v_r = 0$ m/s. What is the angular velocity of the bar and the velocity $\vec{\mathbf{v}}$ of the sleeve when the spring is unstretched?





3. The kinematic coefficients of friction between the two 5-kg crates A and B and the inclined surface are $\mu_A = 0.1$ and $\mu_B = 0.4$. The coefficient of restitution between the crates is $e = 0.8$. If the crates are released from rest in the positions shown, determine the time it takes for the crates to collide and their velocities immediately after they collide. Note that both crates start to move once they are released. $g = 9.81$ m/s^2 downward.

4. The 8-lb ball is released from rest 10-ft from the surface of a flat plate P which weighs 16-lb and is resting on the spring with stiffness $k = 3$ lb/in. Determine the maximum height of the ball after the impact of the ball with the plate assuming that the coefficient of restitution is $e = 1$, and derive an equation governing the maximum deflection of the spring after the impact. The maximum deflection of the spring should be the only unknown in this equation. You do not need to attempt to solve this equation. Note that the deflection of the spring is *not* zero in the position shown. $g = 32.2$ ft/s^2 downward.