

University of British Columbia

Department of Mechanical Engineering



MECH 463. Midterm 1, October 1, 2019

Allowed Time: 70 min

Materials admitted: Pen, pencil, eraser, straightedge, simple scientific calculator without programming or communication capabilities, personal handwritten notes within one letter-size sheet of paper (one side).

There are 3 questions in this exam. You are asked to answer all three questions.

The purpose of this test is to evaluate your knowledge of the course material. Orderly presentation demonstrates your knowledge most clearly, while disorganized and unprofessional work creates serious doubt. Marks are assigned accordingly. A bonus of up to 2 marks will be given for exemplary presentation.

Complete the section below **during** the examination time **only**.

NAME: _____

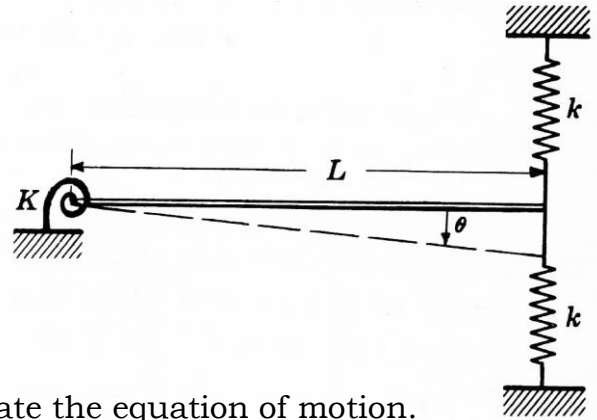
SIGNATURE: _____

STUDENT NUMBER: _____

	Mark Received	Maximum Mark
1		6
2		7
3		7
Presentation		2 bonus
Total		20+2

Name: _____

1. The diagram shows a uniform rod of length L and mass m secured at its left side by a rotational spring of torsional stiffness K , and on its right side by two springs of stiffness k . The centroidal moment of inertia of a uniform rod is $I_0 = mL^2/12$.

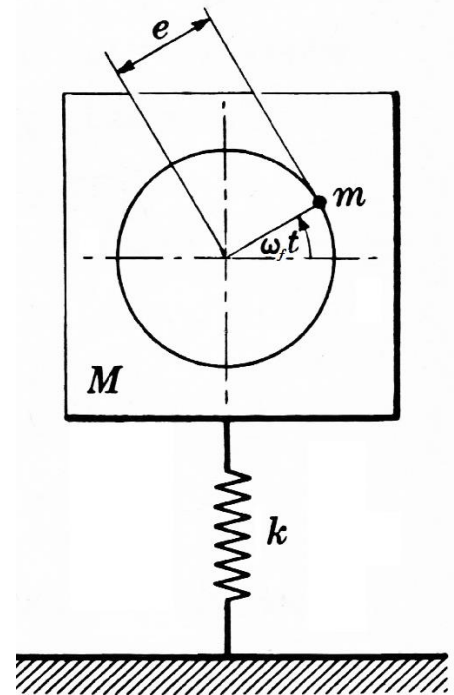


- Draw a labeled free-body diagram of the vibrating system.
- Use your free-body diagram to formulate the equation of motion.
- Solve your equation of motion to show the vibrational motion in time, then determine the natural frequency of vibration of the rod. Show the needed steps in detail.

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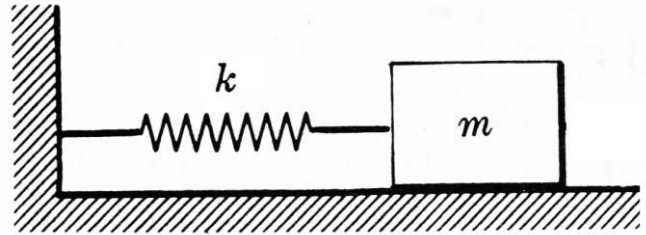
2. A production machine of mass M and supported on a spring mount of stiffness k , contains a rotor with an unbalanced mass m that rotates with an eccentricity e . The total mass of the machine plus rotor is $M+m$. The rotor turns with angular frequency ω_f .
- (a) Draw a free body diagram and formulate an equation of motion for the resulting vibrational displacement x of the machine.
 - (b) Using the method discussed in class, solve for the steady-state vibration of the machine as a function of frequency ratio. For simplicity, you need consider only vertical motions.
 - (c) Sketch the vibration amplitude vs. rotation speed response of the machine. The curve is somewhat different from the one considered in class, so be sure to explain your reasoning.



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3. A mass m is attached to a fixed wall through a spring of stiffness k . The mass slides on a rough surface with friction coefficient μ .



- (a) Draw a free-body diagram showing the forces acting on the mass when it is at a distance x toward the right while moving towards the left.
- (b) Based on your free-body diagram, determine the maximum initial displacement of the mass (with zero initial velocity) for which there is no subsequent motion. Explain your reasoning.
- (c) The mass is given an initial displacement (with zero initial velocity) to the right of $4\mu mg/k$. Using your equation of motion, determine the position x reached by the mass at the end of its subsequent motion towards the left.

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