GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff

School of Mechanical Engineering

Ph.D. Qualifiers Exam - Fall Semester 1999

Dynamics and Vibrations

EXAM AREA

Assigned Number (DO NOT SIGN YOUR NAME)

- **Please sign your name on the back of this page—**

Dynamics and Vibrations Ph.D. Qualifying Exam
Fall 1999

Instructions:

1. You must solve all three problems.

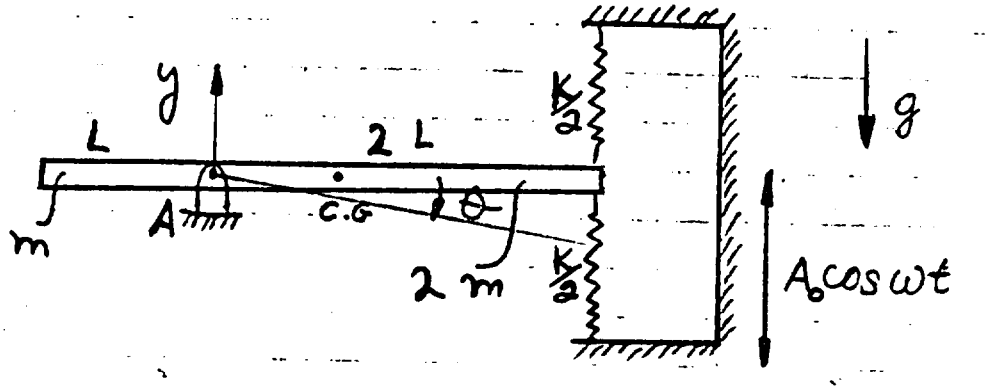
2. Write your work clearly in dark ink. Define clearly your variables. If you need to make an assumption you must briefly justify it. Do not assume that the examination committee can "guess" what you "mean."

3. Budget your time. Concentrate on concepts and setting up the solution first. Then work out the math.

Problem 1

A uniform rod has a total length of $3 \cdot L$ and a total mass of $3 \cdot m$. The rod is hinged at point "A" away from the center of mass (C.G.) as shown in the figure. The gravitational filed is shown to act downwards (in the plane of the paper). The rod is forced to oscillate by the two springs attached to a moving frame as shown. A_o is the displacement amplitude and ω is the oscillation frequency of the moving frame. You can assume that A_o to be much smaller than L.

1. Derive the differential equation of motion.
2. Determine the natural frequency of the system.
3. Determine the steady-state response of the rod.
4. Determine the total reaction at point "A" as a function of time.

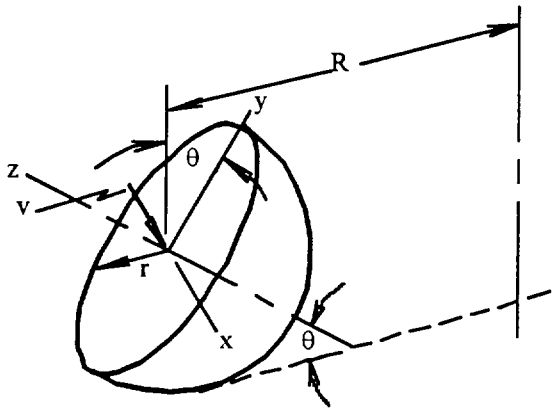


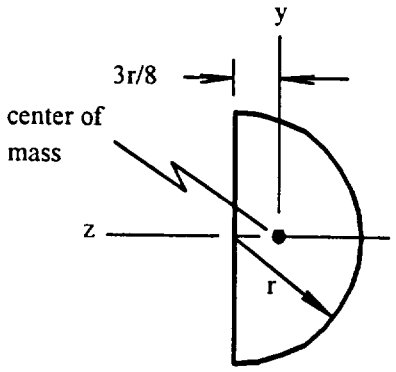
Problem 2

A hemisphere is observed to roll without slipping on a horizontal surface. The motion is such that the center of the hemisphere follows a horizontal circle of radius R at speed v, and the angle of inclination θ of the centerline of the hemisphere is constant.

(a) Use kinematics principles to derive expressions for the angular velocity and angular acceleration of the hemisphere. Describe these components in terms of the xyz coordinate axes in the sketch, for which the origin coincides with the center and x is the horizontal diameter of the flat face.

(b) Derive a solvable set of algebraic equations whose solution would yield an expression relating v and the friction force f to the values of θ, R, and r. *Do not actually solve these equations.*





$I_{zz} = (2/5)mr^2$

$I_{xx} = (83/320)mr^2$

Problem 3

A slender uniform rod of weight W is smoothly hinged to a fixed support at A and rests on a block at B. (See Figure) The block is suddenly removed. Find: (a) the initial angular acceleration and components of reaction at A; (b) the components of reaction at A when the rod becomes horizontal.