MECH 7610 ADVANCED DYNAMICS

FINAL EXAM

April 28, 2020

General Instructions

Solve each problem fully showing your work. Clearly indicate the answer(s) to each problem. State all assumptions used in your analyses.

The exam must be submitted to me via email no later than 8:00 AM, Wednesday, April 29, 2020.

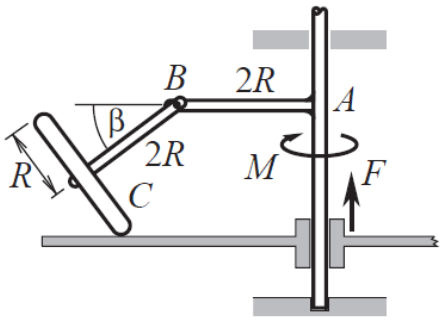
This exam is open book and open notes.

Name: _____

1. The horizontal platform translates upward, and the T-bar rotates about the vertical axis. Both the force F and torque *M* are known functions of time. The mass of the disk is m_D.

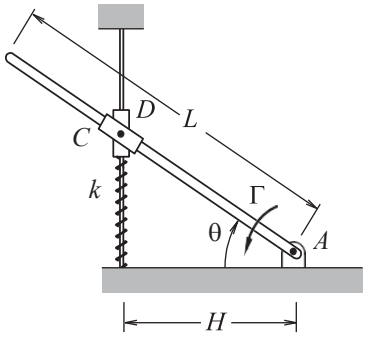
   The rolling motion of disk *C,* which spins freely about shaft *BC*, is such that there is no slippage in the direction perpendicular to the sketch, but there is slippage in the radial direction. This means that the velocity component of the contact point C in the direction orthogonal to the page is zero.

   Derive the Lagrange equation(s) of motion (using the method of Lagrange multipliers) governing this system in the situation where only the disk's mass is significant. (60 points)



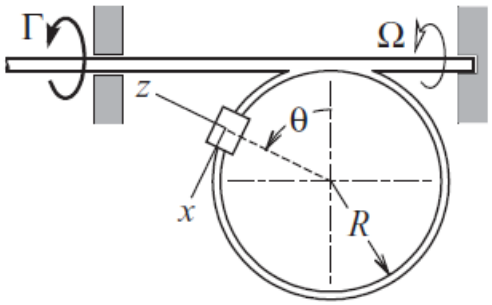
2. Rod *AB* slides through collar *C,* which is pinned to collar *D* that slides over the vertical guide. The bar's mass is *m. The* mass of the collars is negligible. The motion is actuated by torque $\Gamma(t)$. The system lies in the vertical plane, and the spring is unstretched in the position where $\theta = 20^{\circ}$.

Determine the equations of motion for this system. (60 points).



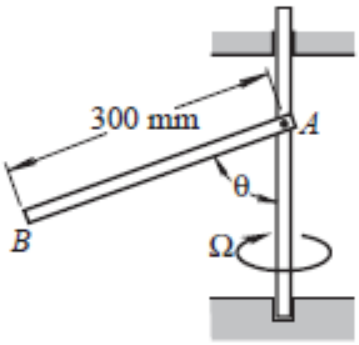
3. A known torque Γ acts about the horizontal shaft, resulting in rotation Ω. The collar slides without friction over the hoop. The mass of the collar is m. Treat the collar as a point mass. The moment of inertia of the hoop–shaft assembly about its rotation axis is I_T.

Develop the equations of motion for this system. (60 points).



4. Bar *AB,* of mass 2 kg, is pinned to the vertical shaft, which rotates freely. When the bar is inclined at $\theta = 10^\circ$, the rotation rate about the vertical axis is $\Omega = 10$ rad/s and the time rate of change of θ is 4 rad/s, at that instant. The mass of the vertical shaft may be neglected.

   Determine the maximum value of θ in the subsequent motion. (60 points).



5. Slender bar AB, with mass M and length L, is attached at both ends to rollers that follow a horizontal circular groove of radius, R. Frictional resistance is negligible.

At what angle θ relative to the bar should force *F* be applied to maximize the angular acceleration of the bar? (60 points).