2.032 DYNAMICS Fall 2004

Problem Set No. 9

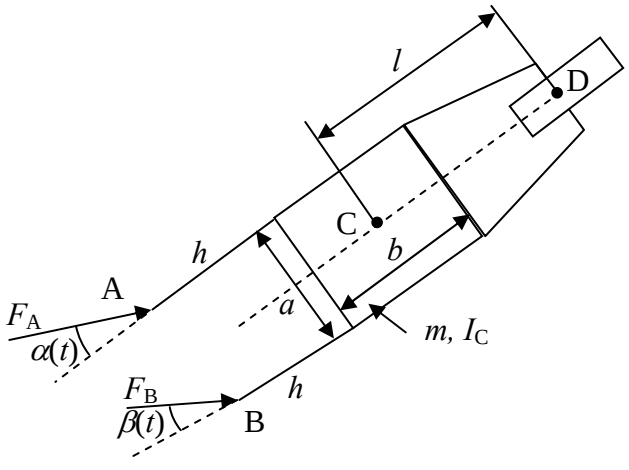
Out: Wednesday, November 17, 2004

Due: Wednesday, November 24, 2003 at the beginning of class

Problem 1

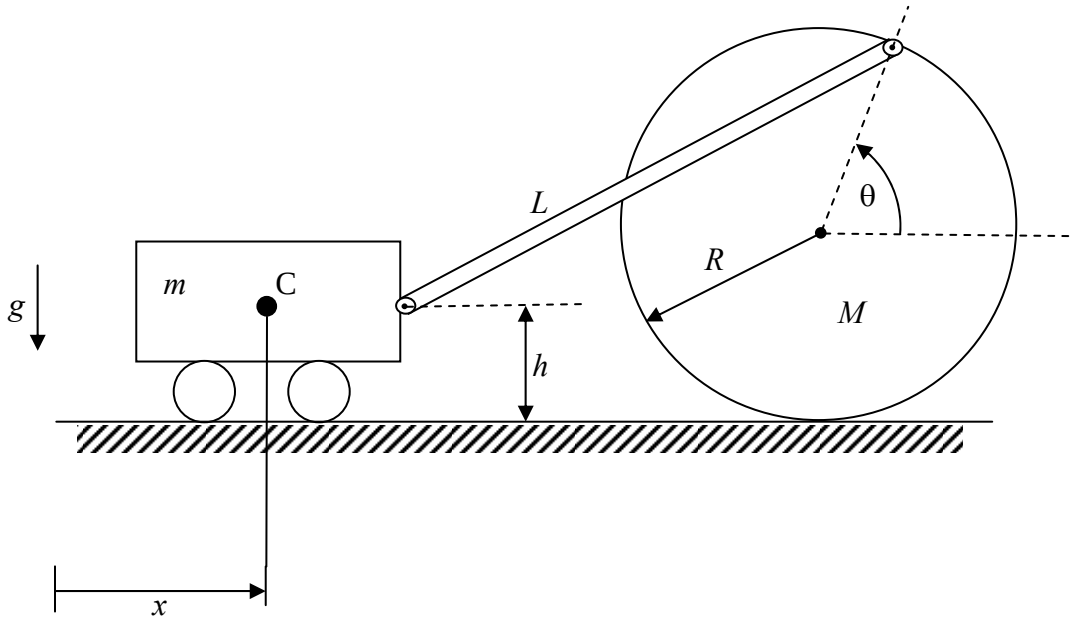
Consider a wheelbarrow with a wheel of negligible mass, as shown in the figure below. The distance between the center of mass C of the wheelbarrow and the center of its wheel D is l. The handles of the wheelbarrow are of length h, and are pushed at their tips by the forces F_A and F_B. The time-dependent angles between the forces and the handles are given by $\alpha(t)$ and $\beta(t)$, respectively. The wheel rolls without slipping.

The centroidal moment of inertia and the mass of the wheelbarrow are given by I_c and m, respectively. With the position of C and the orientation of the wheelbarrow as generalized coordinates, derive the equations of motion using Lagrange multipliers.



Problem 2

A cart and a rolling disk are connected by a rigid massless link of length *L*, as shown in the figure below. The disk rolls without slipping. Use Lagrange multipliers to determine the force in the link.



Problem 3

Consider the "spinning disk on a rotating linkage with torsional spring" problem discussed in class.

(a) By introducing generalized moments associated with the coordinates φ and ψ, reduce the set of equations of motions to a single equation of motion for ν.

(b) For $p_\varphi = 0$, sketch the trajectories of the above equation on the $(\upsilon, \dot{\upsilon})$ phase plane for different values of p_ψ (select all other parameters to be equal to one).