2.032 DYNAMICS Fall 2009

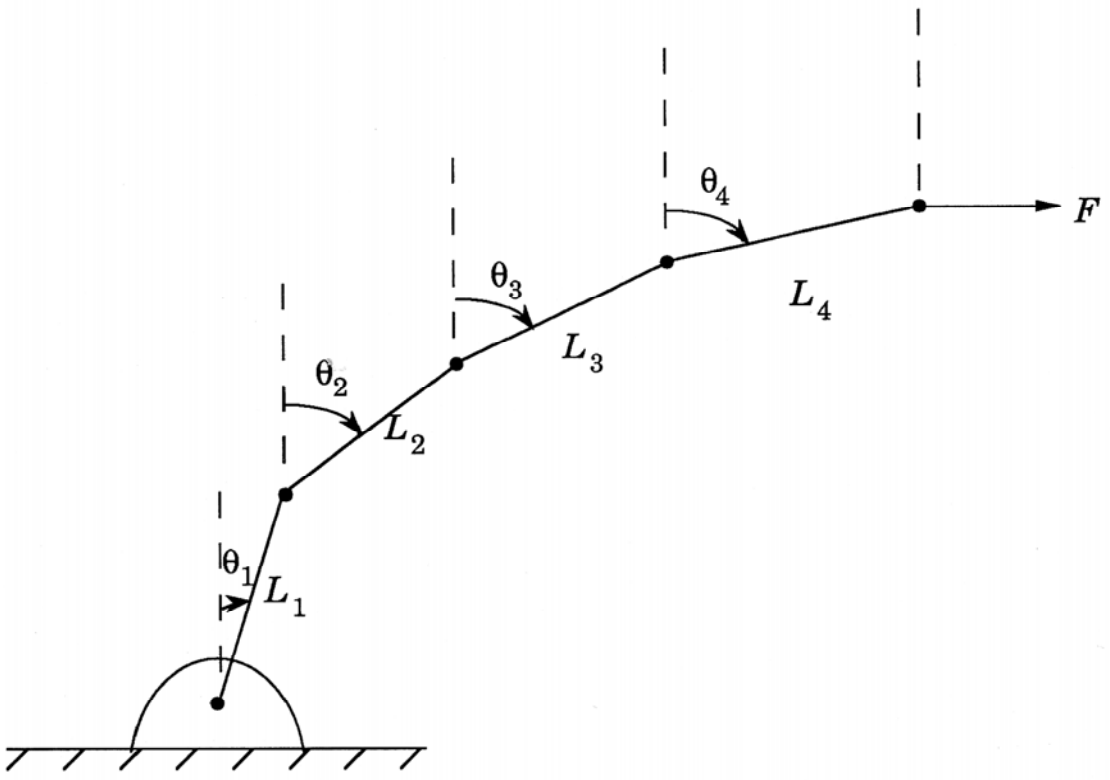
Problem Set No. 6

Out: Wednesday, October 14, 2009

The homework problems are for practice only. Solutions are posted in a separate file. Please work on the problems and be prepared to ask questions related to this homework in the recitation of October 20, 2009 (4:00–5:30pm in Room 1-379).

Problem 1

The force F acts horizontally at the end of the four-member linkage shown below. The linkage is described by the generalised coordinates $\xi_1 = \theta_1,\ \xi_2 = \theta_2,\ \xi_3 = \theta_3,\ \xi_4 = \theta_4$. Find the generalised forces $\Xi_1,\ \Xi_2$ conjugate to the generalised coordinates $\xi_1,\ \xi_2$ and due to the force F. You may *not* assume that $\theta_1,\ \theta_2,\ \theta_3,\ \theta_4$ are small angles.

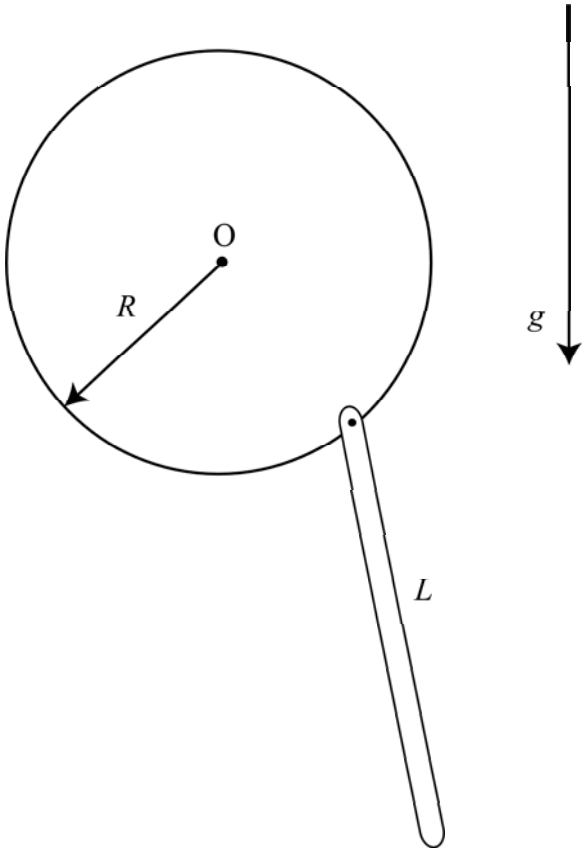


Problem 2

A pendulum consists of a rod of length L, mass m, and centroidal moment of inertia $\frac{1}{12}mL^2$ with a frictionless pivot at one end. The pendulum is suspended from a flywheel of radius R and mass M which can rotate about the fixed point O, as shown below.

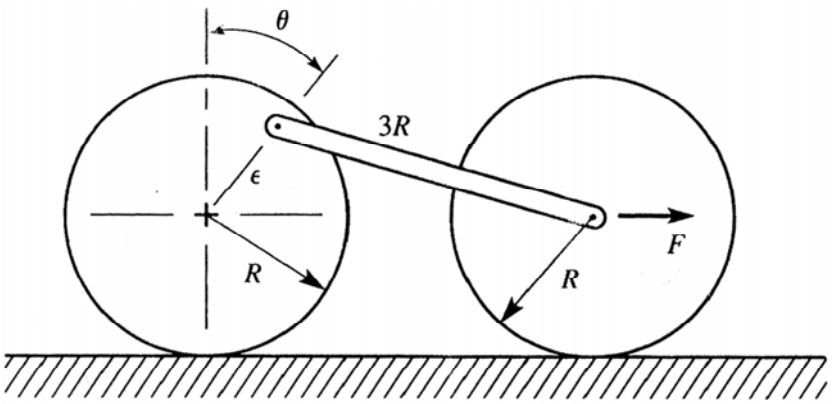
(a) Select a complete and independent set of generalised coordinates. (Please define these coordinates *clearly*.)

(b) Construct the Lagrangian without making any approximations (small angles, etc.).



Problem 3 (from Doctoral Qualifying Exam 2002)

Two identical rigid cylinders, each having radius R and mass m, are linked by a connecting rod of length $3R$ and mass M as shown below. A horizontal force $F(t)$ is applied to the center of the right cylinder and neither cylinder slips in its rolling motion. In the initial position, the angle θ locating the connecting pin is zero. Derive the governing equations of motion for this system.



Problem 4

Reconsider Problem 2 of PS No. 2. Take the mass of the ring to be M and the mass of the disk to be m. Using again the angles θ and ϕ as generalised coordinates, construct the Lagrangian and derive the governing equations of motion (taking into account the effects of gravity).