# 2.003J/1.053J Dynamics and Control I
Fall 2007

Problem Set 2
Out: Monday, 17 September, 2007
Due: Wednesday, 26 September, 2007

1. Pulley problem

A pulley of radius R is *rigidly* fixed to the wall as shown in the figure. A point mass is attached to one end of a *non-elastic* string of length l_o and the other end of the string is fixed to the top of the pulley as shown in the figure. Initially the mass is held such that the string is tight and horizontal and is suddenly released. In the class we found the acceleration of the mass with respect to a stationary observer on the ground by writing all position vectors in terms of a frame attached to the ground and taking derivatives. Now solve the same problem using magic formula. Indicate the name of each term in the final acceleration expression.
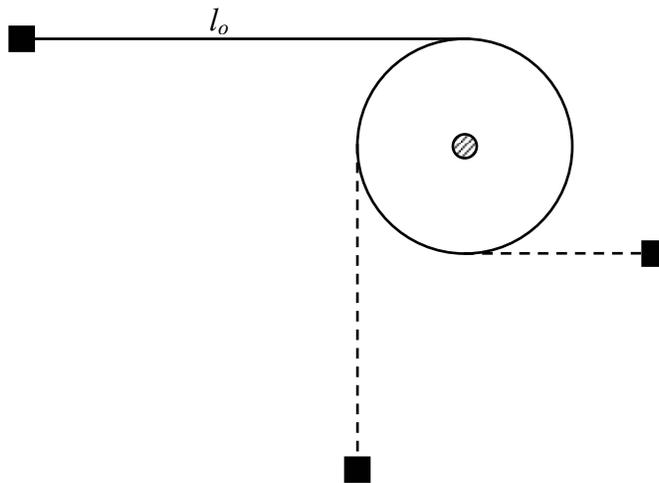

2. Pulley problem

Redo the above problem using the super-magic formula.

3. Robot manipulator

A robot arm consisting of links A and B, and the end-effector E is shown in the figure below. Link A rotates in the anti-clockwise direction with a constant angular speed ω_A, while link B rotates in the anti-clockwise direction with a constant angular speed ω_B with respect to link A. End-effector E slides along link B. Set up appropriate frames and define appropriate parameter(s).

a. Find the acceleration of E with respect to an observer fixed to link A.
b. Find the acceleration of E with respect to an observer fixed to the ground.
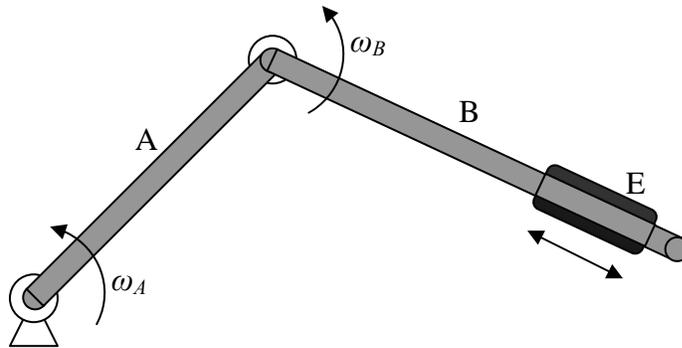
4. Robot manipulator

Redo the above problem using the super-magic formula.

5. Problem 3-34 from the textbook

This problem has been slightly modified from problem 3-34 in the textbook. As shown in the figure below, a bigger disk of radius R is rotating with constant angular speed Ω about a vertical axis through its center coming out of the page. A smaller disk of radius r is rotating with constant angular speed ω with respect to the bigger disk about a vertical axis through its center coming out of the page. Note that the center of the smaller disc, Q, is on the periphery of the bigger disc. A point P is fixed on the smaller disc. Consider an instant when QP is perpendicular to OQ. Find relation between Ω and ω such that the acceleration of point P at that instant with respect to a frame fixed to the ground is parallel to OQ.
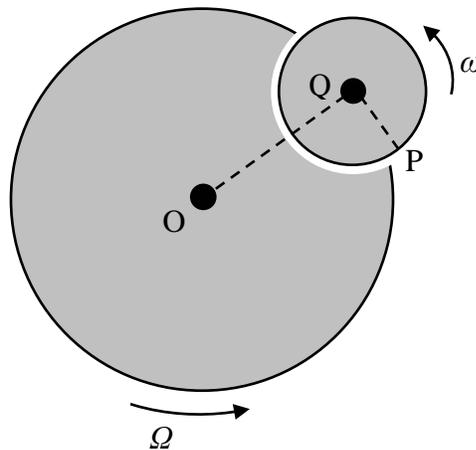
6. Problem 3-34 from the textbook

Redo the above problem using the super-magic formula.