NEW YORK UNIVERSITY TANDON SCHOOL OF ENGINEERING
Department of Mechanical and Aerospace Engineering

Foundations of Robotics (ROB-GY 6003)

Homework Assignment | Chapter 6

Homework Problems: 6.15, 6.16*, 6.20

Instructor's Note: For 6.16, you are free to use the Newton-Euler or Lagrangian method. As you work on this assignment, note when Coriolis terms appear (or don't appear),

6.15 [28] Derive the dynamic equations for the RP manipulator of Example 6.5, using the Newton–Euler procedure instead of the Lagrangian technique.

EXAMPLE 6.5

The links of an RP manipulator, shown in Fig. 6.7, have inertia tensors

$$^{C_1}I_1 = \begin{bmatrix} I_{xx1} & 0 & 0 \\ 0 & I_{yy1} & 0 \\ 0 & 0 & I_{zz1} \end{bmatrix},$$

$$^{C_2}I_2 = \begin{bmatrix} I_{xx2} & 0 & 0 \\ 0 & I_{yy2} & 0 \\ 0 & 0 & I_{zz2} \end{bmatrix}, \qquad (6.78)$$

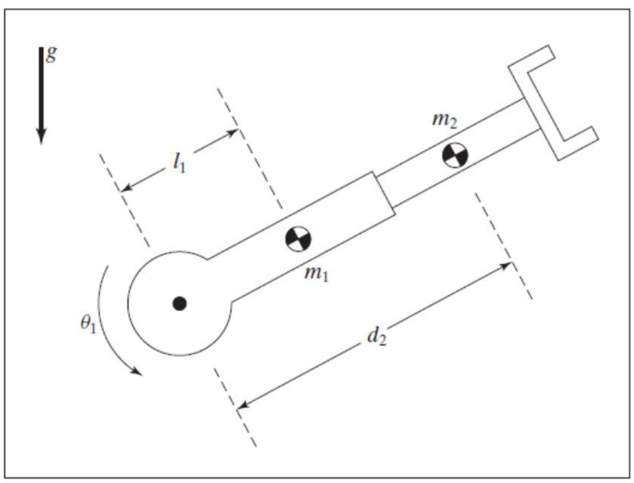

FIGURE 6.7: The RP manipulator of Example 6.5.

and total mass m_1 and m_2. As shown in Fig. 6.7, the center of mass of link 1 is located at a distance l_1 from the joint-1 axis, and the center of mass of link 2 is at the variable distance d_2 from the joint-1 axis. Use Lagrangian dynamics to determine the equation of motion for this manipulator.

6.16 [25] Derive the equations of motion for the PR manipulator shown in Fig. 6.10. Neglect friction, but include gravity. (Here, $\hat{X}_0$ is upward.) The inertia tensors of the links are diagonal, with moments I_{xx1}, I_{yy1}, I_{zz1} and I_{xx2}, I_{yy2}, I_{zz2}. The centers of mass for the links are given by

$$^1P_{C_1} = \begin{bmatrix} 0 \\ 0 \\ -l_1 \end{bmatrix},$$

$$^2P_{C_2} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}.$$

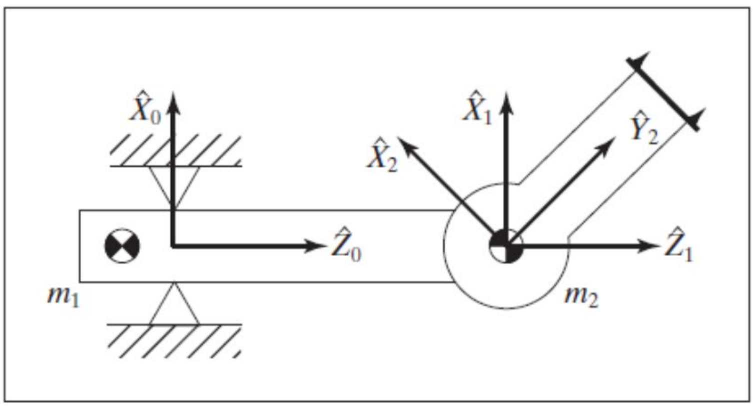

FIGURE 6.10: PR manipulator of Exercise 6.16.

6.20 [28] Derive the dynamic equations of the 2-DOF manipulator of Section 6.7, using a Lagrangian formulation.

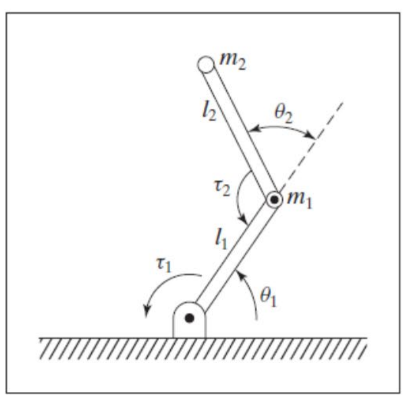

FIGURE 6.6: Two-link planar manipulator with point masses at distal ends of links.