MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Department of Mechanical Engineering

Course 2.05 **Kinematics and Dynamics of Mechanisms and Manipulators**
Fall 2000

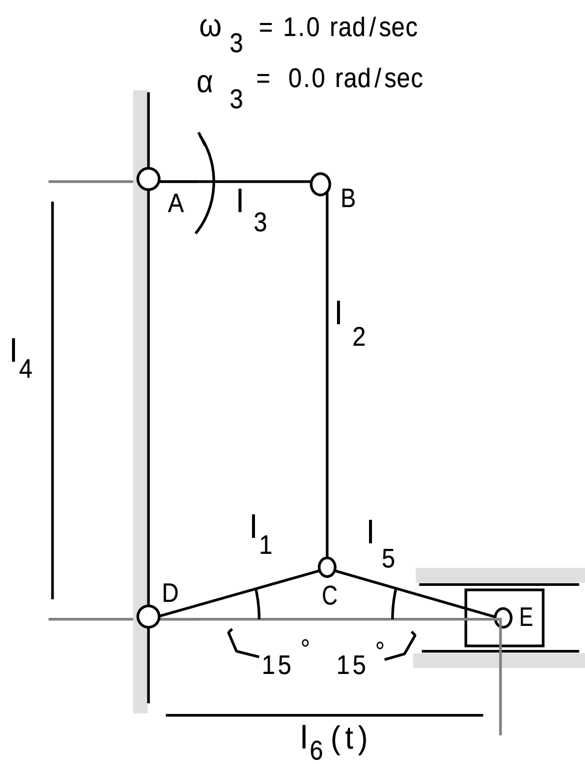
Problem Set No. 3 | Assigned: 09/26/00
Due: 10/03/00

Problem 3.1

The mechanism shown in Figure 5. can be used as a locking device. If the input link, link 3, is given a constant angular velocity, then for the position shown find graphically:

(a) the angular velocities of links 1, 2, and 5, and the linear velocity of E.

(b) the acceleration of E with respect to ground.



l_1 = 1.035 inches
l_2 = 2.0 inches
l_3 = 1 inch
l_4 = 2.259 inches
l_5 = 1.035 inches

velocity scale: 1 in/sec = 2 inches
acceleration scale: 1 in/sec^2 = 2 inches

Figure 5. Locking Mechanism

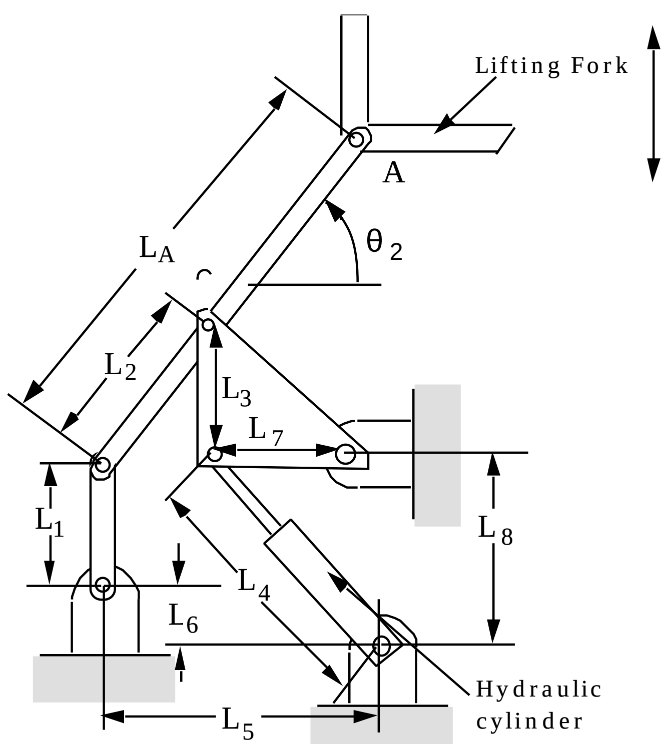
Problem 3.2

(a) For the fork lift mechanism shown, write the vector loop equations required to determine angles of the mechanism links in complex variable notation. Assume L_4 is the system input. Be sure to clearly define the angles you used in your analysis on a separate vector loop diagram. Your analysis should be valid for all mechanism positions.

(b) Transform these complex equations into a set of scalar equations, and identify all the unknown variables. Is your set of equations sufficient to solve for these unknowns?

(c) Using the equations developed in part (a) above, obtain a set of scalar equations which when solved will yield the angular rates of the mechanism as a function of mechanism angles, lengths and L_4. Do not attempt to solve these equations.

(d) Write an expression for the velocity of point A as function of the mechanism angles, the angular rates, and link lengths.



Problem 3.3

The mechanism shown above is called an epicyclical linkage. It consists of two slider (elements 1 and 3) traveling in perpendicular tracks and connected by a link (element 2). The link-slider connections are simple pin joints.

a. For this epicyclical linkage, write the position closure equation in complex variable notation. Be sure to define your vectors clearly on the diagram. Transform this complex equation into real (scalar) equations relating x, y and θ_2.
b. Write the complex velocity and acceleration closure equations for this device. Transform these equations into sets of equations of real variables.
c. If the system is driven such that $\dot{\theta}_2$ is a constant called ω_{in} $(\ddot{\theta}_2 = 0)$, using the above expressions. Find value of $\ddot{x}$ and $\ddot{y}$ as a function of θ_2 and ω_{in}.
d. For the conditions given in part (c) and assuming F2 is zero, calculate the force exerted on element 3 by link 2. You may neglect both gravity and friction in your analysis.