Washington University in St. Louis
ESE447
Robotics Laboratory

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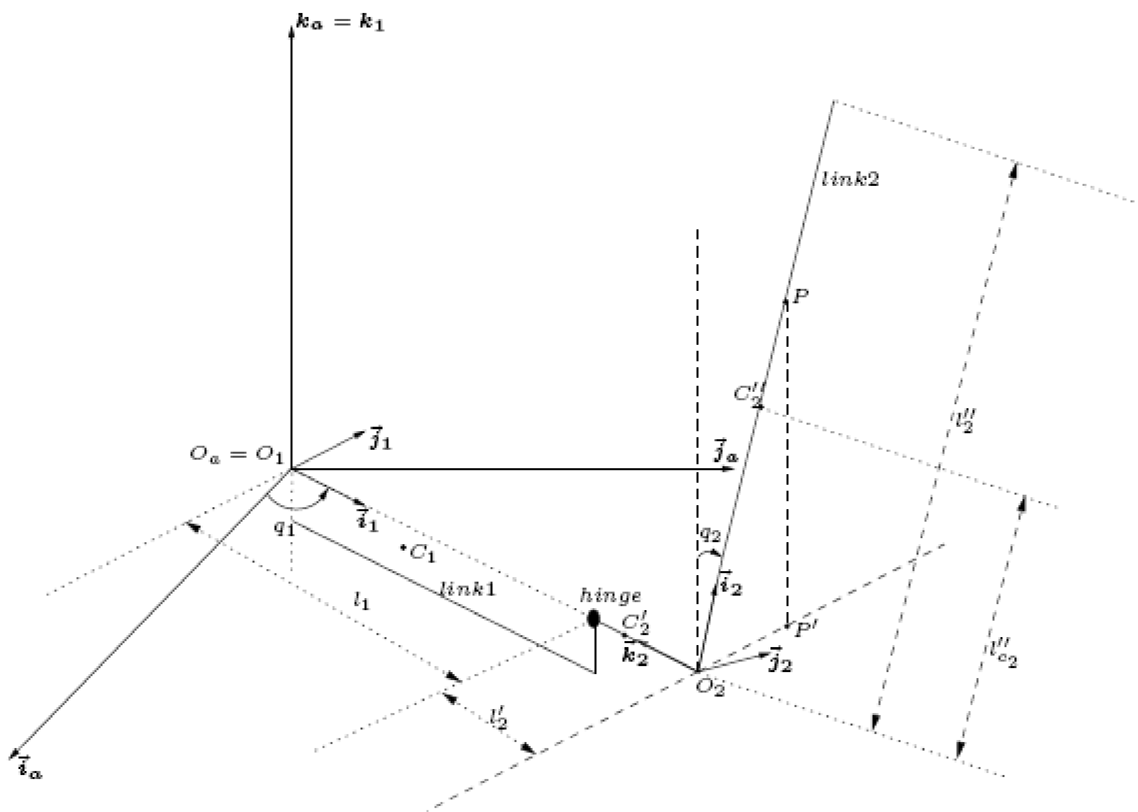
LAB ASSIGNMENT – Adding dynamic motion to the "Robot"
TESTBED: Quanser Power Plant with single inverted pendulum (Robot)



TASK OBJECTIVE: Add dynamic motion to our "Robot" model.

TASK-1: Using the information provided in the "Dynamics" document, derive the dynamic equations for our "Robot" (single inverted pendulum as shown in the above figure). This should result in one equation for each joint (two equations). This may be done by hand or using a MATLab script with symbolic variables.

TASK-2: Arrange the equations in the matrix form shown below where *'v'* represents voltage and *'q'* represents the generalized coordinate system (joint variables).

$$\begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} m_{11}(q) & m_{12}(q) \\ m_{21}(q) & m_{22}(q) \end{bmatrix} * \begin{bmatrix} \ddot{q_1} \\ \ddot{q_2} \end{bmatrix} + \begin{bmatrix} c_{11}(q,\dot{q}) & c_{12}(q,\dot{q}) \\ c_{21}(q,\dot{q}) & c_{22}(q,\dot{q}) \end{bmatrix} * \begin{bmatrix} \dot{q_1} \\ \dot{q_2} \end{bmatrix} + \begin{bmatrix} f_1(\dot{q}_1) \\ f_2(\dot{q}_2) \end{bmatrix} + \begin{bmatrix} g_1(q_1) \\ g_2(q_2) \end{bmatrix}$$

TASK-3: Using the following list of "Robot" characteristics, find values for the "Physical Parameters" of the system. Discuss what you believe these parameters represent. Discuss the relative values (comparing them to each other) of these parameters. Do these valves seem to make sense based on your "Engineering Sense"?

J_1=0.0012	m_2=0.127	(l_1+l_2')=0.2
l_2=0.3	l_{c2}=0.15	β_1=0.015
β_2=0.002	R_a=2.6	k_t=k_v=0.00768
k_r=70		

TASK-4: In order to show simulated motion for the robot, it is necessary to solve the above matrix equation (Task-2) for the acceleration in each joint. We can then implement this in Simulink to bring the "Robot" to life with its own "physics engine"(class discussion). Demonstrate your virtual robot behaves as physics would dictate. Compare this to the actual motion of the real system.