

$$q_1 = x$$

$$\dot{q}_1 = \dot{q}_2$$

$$q_2 = \dot{x}$$

$$q_3 = \theta$$

$$\dot{q}_3 = \dot{q}_4$$

$$q_4 = \dot{\theta}$$

1st Equation

$$(m_1 + m_2) \ddot{x} + m_2 L (\ddot{\theta} \cos \theta - \dot{\theta}^2 \sin \theta) = F$$

$$(m_1 + m_2) \dot{q}_2 + m_2 L (\dot{q}_4 \cos(q_3) - (q_4)^2 \sin(q_3)) = F$$

$$(m_1 + m_2) \dot{q}_2 + m_2 L \dot{q}_4 \cos(q_3) - m_2 L q_4^2 \sin(q_3) = F$$

$$(m_1 + m_2) \dot{q}_2 + [m_2 L \cos(q_3)] \dot{q}_4 = F - m_2 L q_4^2 \sin(q_3) \leftarrow$$

2nd Equation

$$m_2 (L^2 \ddot{\theta} + L \ddot{x} \cos \theta) = m_2 g L \sin \theta$$

$$m_2 (L^2 \dot{q}_4 + L \dot{q}_2 \cos q_3) = m_2 g L \sin q_3$$

$$L^2 \dot{q}_4 + L \dot{q}_2 \cos q_3 = g L \sin q_3$$

$$L \dot{q}_4 + [\cos q_3] \dot{q}_2 = g \sin q_3 \leftarrow$$

$Ax = b$

$$(m_1 + m_2) \dot{q}_2 + [m_2 L \cos(q_3)] \dot{q}_4 = F - m_2 L q_4^2 \sin(q_3)$$

$$[\cos q_3] \dot{q}_2 + L \dot{q}_4 = g \sin q_3$$

$$\begin{bmatrix} (m_1 + m_2) \\ \cos(q_3) \end{bmatrix} \begin{bmatrix} m_2 L \cos(q_3) \\ L \end{bmatrix} \begin{bmatrix} \dot{q}_2 \\ \dot{q}_4 \end{bmatrix} = \begin{bmatrix} F - m_2 L \dot{q}_4^2 \sin(q_3) \\ g \sin q_3 \end{bmatrix}$$