Homework 9 in LaTeX

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1 Question 1: The Lagrangian and Equations of Motion

1.1 (a) Write an Expression for the Lagrangian of the Particle

$$L = -1.0Rgm_1 \sin(q_1) + 0.5\dot{q}_1^2 \left(I_1 + R^2 m_1\right) \tag{1}$$

1.2 (b) Find the Equation of Motion of the Particle

$$\tau_k = 1.0I_1\ddot{q}_1 + 1.0R^2 m_1 \ddot{q}_1 + 1.0Rgm_1 \cos(q_1) \tag{2}$$

2 Question 2: Equations of Motion of a Two Link Manipulator

2.1 (a) Find the Lagrangian

$$L = 1.0gm_2 q_2 \cos(q_1) + 0.5m_2\dot{q}_2^2 + 0.5\dot{q}_1^2 \left(I_1 + I_2 + m_2 q_2^2\right)$$

2.2 (b) Find Equation of Motion

$$\begin{aligned}\tau_k = & 1.0gm_2q_2\sin(q_1) - 1.0gm_2\cos(q_1) \\ & - 1.0m_2q_2\dot{q}_1^2 + 2.0m_2q_2\dot{q}_1\dot{q}_2 \\ & + 1.0m_2\ddot{q}_2 + 1.0\ddot{q}_1\left(I_1 + I_2 + m_2q_2^2\right)\end{aligned}$$

3 Question 3: Equations of Motion of a Pendulum

3.1 (a) Find the Lagrangian of the Pendulum

$$L = l_1m_2\left(-1.0g\sin(q_1) + 0.5l_1\dot{q}_1^2\right) \tag{3}$$

3.2 (b) Find Equation of Motion

$$\tau_k = 1.0l_1m_2\left(g\cos(q_1) + l_1\ddot{q}_1\right) \tag{4}$$