EE 368 机器人运动与控制方法（Robotic Motion and Control）
Assignment #4

Due time: 5:00pm on Monday, May 29, 2023 via Blackboard

Q-1. The single-degree-of-freedom "manipulator" in Fig. Q-1 has total mass $m = 1$, with the center of mass at ${}^1\boldsymbol{P}_C = [2 \quad 0 \quad 0]^T$, and has inertia tensor ${}^C\boldsymbol{I}_1 = \text{diag}\{1 \quad 2 \quad 2\}$. From rest at $t = 0$, the joint angle θ_1 moves in accordance with the time function

$$\theta_1(t) = bt + ct^2$$

in radians. Given the angular acceleration of the link and the linear acceleration of the center of mass in terms of frame {1} as a function of t.

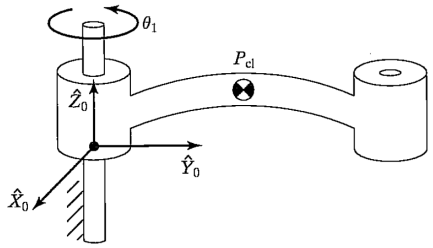

Figure Q-1

Q-2. Derive the equations of motion for the PR manipulator shown in Fig. Q-2. 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

$${}^1P_{C_1} = \begin{bmatrix} 0 \\ 0 \\ -l_1 \end{bmatrix} \quad \text{and} \quad {}^1P_{C_2} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}.$$

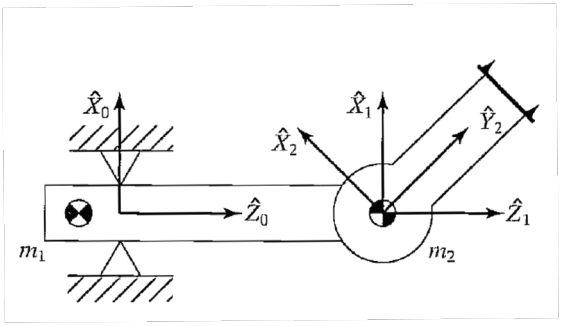

Figure Q-2

Q-3. Derive the Cartesian space form of the dynamics for the two-link planar manipulator of Q-2 in terms of the base frame. *Hint*: Use the Jacobian written in the base frame.