Assignment V

ME 3030– Modeling and Simulation (2023-2024)
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November 2023 Submission time: 15-11-23, 11:59 PM.

Question 1

Derive the equations of motion for a two-mass system with revolute joints at P and Q (Fig. 1) considering gravity using Newton's laws of motion and solve them in MATLAB.
Consider the following position vectors (superscript 0 represents global fixed frame, and superscripts 1 and 2 represent local moving frames)
$\boldsymbol{r}^0_{O_1} = \begin{bmatrix} x_1 \\ y_1 \end{bmatrix}, \boldsymbol{r}^0_{O_2} = \begin{bmatrix} x_2 \\ y_2 \end{bmatrix}, \boldsymbol{r}^0_P = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \boldsymbol{r}^1_P = \begin{bmatrix} a \\ b \end{bmatrix}, \boldsymbol{r}^1_Q = \begin{bmatrix} -a \\ -b \end{bmatrix}, \boldsymbol{r}^2_Q = \begin{bmatrix} a \\ b \end{bmatrix},$
parameters
$m_1 = 1$, $m_2 = 2$, $J_1 = 1$, $J_2 = 2$, $g = 10$, $a = 0.2$, $b = 0.2$,
and initial conditions:
$\theta_1(0) = \pi/2$, $\theta_2(0) = \pi/4$.

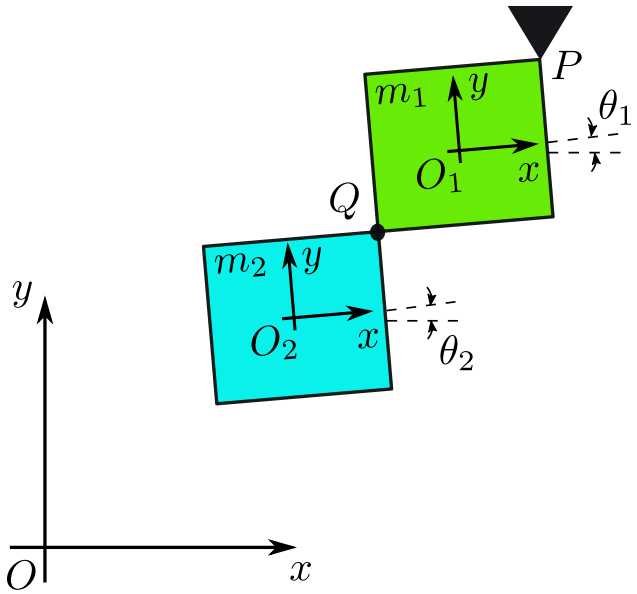

Figure 1: Schematic of a two-mass system with revolute joints at P and Q.

Hint: Consider the following constraints

$$\boldsymbol{r}^0_{O_1} + R(\theta_1)\boldsymbol{r}^1_Q = \boldsymbol{r}^0_{O_2} + R(\theta_2)\boldsymbol{r}^2_Q,$$
$$\boldsymbol{r}^0_{O_1} + R(\theta_1)\boldsymbol{r}^1_P = \boldsymbol{r}^0_P.$$