#1

Sistema rotacional en espacio de estados

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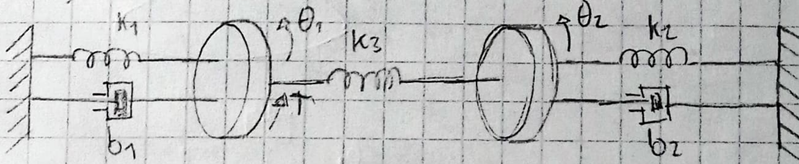
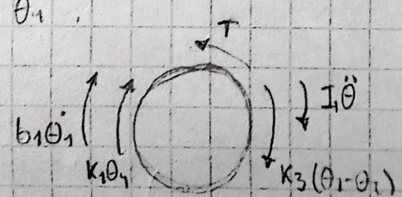


Diagramas de cuerpo libre:

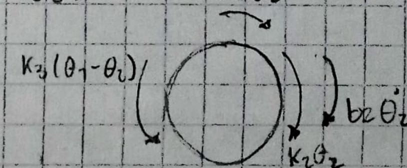
Para θ_1.



$$-T + b_1\dot{\theta}_1 + k_1\theta_1 + k_3(\theta_1-\theta_2) + I_1\ddot{\theta} = 0$$

$$\ddot{\theta}_1 = \frac{T}{J_1} - \frac{b_1}{I_1}\dot{\theta}_1 - \frac{k_1}{J_1}\theta_1 - \frac{k_3}{J_1}\theta_1 + \frac{k_3}{J_1}\theta_2$$

Para θ_2:



$$-k_3\theta_1 + k_3\theta_2 + J_2\ddot{\theta}_2 + k_2\theta_2 + b_2\dot{\theta}_2 = 0$$

$$\ddot{\theta}_2 = \frac{k_3}{J_2}\theta_1 - \frac{k_3}{J_2}\theta_2 - \frac{k_2}{J_2}\theta_2 - \frac{b_2}{J_2}\dot{\theta}_2$$

$q_1 = \theta_1$ $\qquad$ $q_3 = \theta_2$

$q_2 = \dot{q}_1 = \dot{\theta}_1$ $\qquad$ $q_4 = \dot{q}_3 = \dot{\theta}_2$

$\dot{q}_2 = \ddot{\theta}_1$ $\qquad$ $\dot{q}_4 = \ddot{\theta}_2$

$$\dot{q}_2 = \frac{T}{J_1} - \frac{b_1}{J_1}q_2 - \frac{k_1}{I_1}q_1 - \frac{k_3}{J_1}q_1 + \frac{k_3}{J_1}q_3$$

$$\dot{q}_2 = q_1\left(\frac{-k_1-k_3}{J_1}\right) + q_2\left(\frac{-b_1}{I_1}\right) + q_3\left(\frac{k_3}{I_1}\right) + \frac{T}{J_1}$$

$$\dot{q}_4 = q_1\left(\frac{k_3}{J_2}\right) + q_3\left(\frac{-k_3-k_2}{J_2}\right) + q_4\left(\frac{-b_2}{J_2}\right)$$

$$\begin{bmatrix}\dot{q}_1\\ \dot{q}_2\\ \dot{q}_3\\ \dot{q}_4\end{bmatrix} = \begin{bmatrix}0 & 1 & 0 & 0\\ (-k_1-k_3)/J_1 & +b_1/J_1 & k_3/I_1 & 0\\ 0 & 0 & 0 & 1\\ k_3/I_2 & 0 & (-k_3-k_2)/J_2 & +b_2/I_2\end{bmatrix}\begin{bmatrix}q_1\\ q_2\\ q_3\\ q_4\end{bmatrix} + T\begin{bmatrix}0\\ 1/J_1\\ 0\\ 0\end{bmatrix}$$

$$\begin{bmatrix}\theta_1\\ \theta_2\end{bmatrix} = \begin{bmatrix}1 & 0 & 0 & 0\\ 0 & 0 & 1 & 0\end{bmatrix}\begin{bmatrix}q_1\\ q_2\\ q_3\\ q_4\end{bmatrix}$$