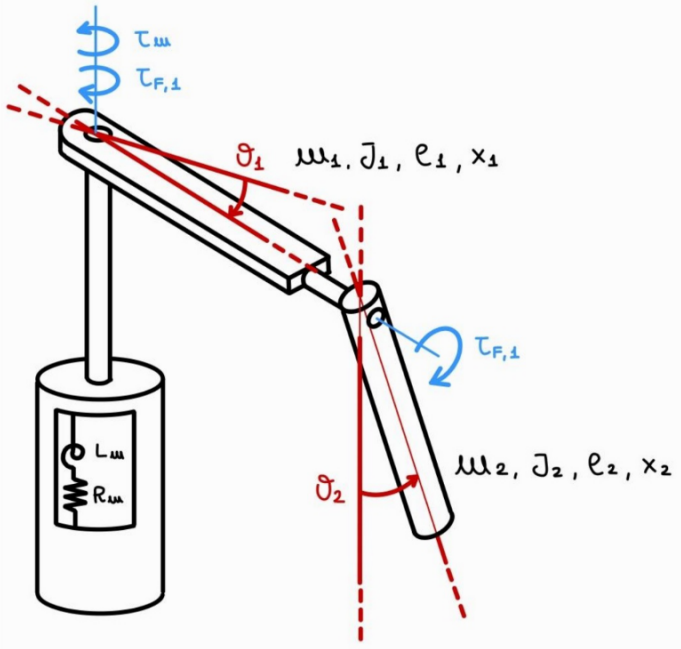

x_1 = centro di massa dell'asta $= \frac{l_1}{2}$

x_2 = centro di massa del pendolo $= \frac{l_2}{2}$

$$\begin{cases} \left[J_{eq} + m_2 (l_1^2 + x_2 s_2^2) \right] \ddot{\theta}_1 + m_2 l_1 x_2 c_2 \ddot{\theta}_2 + 2 m_2 x_2^2 s_2 c_2 \dot{\theta}_1 \dot{\theta}_2 - m_2 l_1 x_2 s_2 \dot{\theta}_2^2 + k_s \theta_1 = \\ \quad = \frac{k_m}{R_m} \cdot V_{IN} - \frac{k_m^2}{R_m} \dot{\theta}_1 - k_{F,1} \cdot \dot{\theta}_1 \\ m_2 l_1 x_2 c_2 \ddot{\theta}_1 + (m_2 x_2^2 + I_2) \ddot{\theta}_2 - m_2 x_2^2 s_2 c_2 \dot{\theta}_1^2 + m_2 g x_2 s_2 = - k_{F,2} \dot{\theta}_2 \end{cases}$$

$$J_{eq} = m_1 x_1^2 + I_1$$

$s_1 = \sin\theta_1 \quad s_2 = \sin\theta_2 \quad c_1 = \cos\theta_1 \quad c_2 = \cos\theta_2$