

Defining θ_1 in the same direction as the input torque and θ_2 and θ_3 in the opposite direction, the EOM for the system is:

$$\left[J_1 + \left(\frac{r_1}{r_2} \right)^2 J_2 \right] \ddot{\theta}_1 + b_1 \left(\frac{r_1}{r_2} \right)^2 \dot{\theta}_1 + G \left(\frac{r_1}{r_3} \right)^2 \theta_1 = T$$