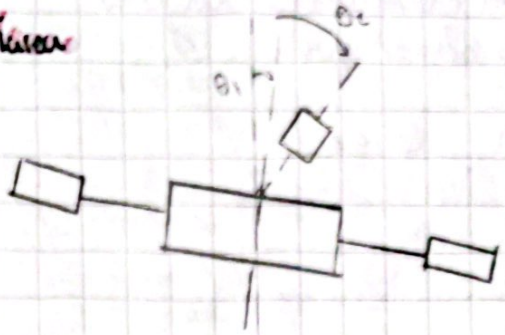
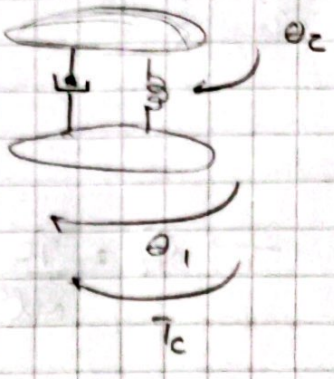
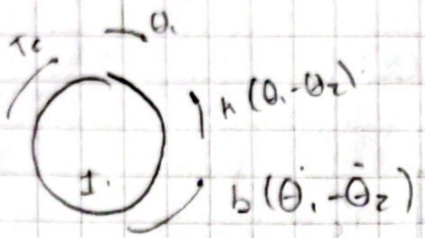
Kalman

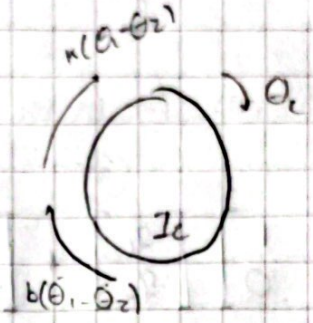


θ_c : Sensor

θ_1 : Body







$T_c - k(\theta_1 - \theta_2) - b(\dot\theta_1 - \dot\theta_2) = I_1\ddot\theta_1$ $\qquad b(\dot\theta_1 - \dot\theta_2) + k(\theta_1 - \theta_2) = I_2\ddot\theta_2$

$\therefore \ddot\theta_1 = \frac{T_c}{I_1} - \frac{k}{I_1}(\theta_1 - \theta_2) - \frac{b}{I_1}(\dot\theta_1 - \dot\theta_2)$ $\qquad q_1 = \theta_1$ $\qquad q_3 = \theta_2$

$q_2 = \dot\theta_1 = \dot q_1$ $\qquad q_4 = \dot\theta_2 = \dot q_3$

$\dot q_2 = \ddot\theta_1$ $\qquad \dot q_4 = \ddot\theta_2$

$= \dot q_2 = \frac{T_c}{I_1} - \frac{k}{I_1}q_1 + \frac{k}{I_1}q_3 - \frac{b}{I_1}q_2 + \frac{b}{I_1}q_4$ ①

$\rightarrow \ddot\theta_2 = \frac{b}{I_2}(\dot\theta_1 - \dot\theta_2) + k(\theta_1 - \theta_2)$

$= \dot q_4 = \frac{b}{I_2}q_2 - \frac{b}{I_2}q_4 + kq_1 - kq_3$ ②

$$\begin{bmatrix} \dot q_1 \\ \dot q_2 \\ \dot q_3 \\ \dot q_4 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ -k/I_1 & -b/I_1 & k/I_1 & b/I_1 \\ 0 & 0 & 0 & 1 \\ k & b/I_2 & -k & -b/I_2 \end{bmatrix} \begin{bmatrix} q_1 \\ q_2 \\ q_3 \\ q_4 \end{bmatrix} + \begin{bmatrix} 0 \\ 1/I_1 \\ 0 \\ 0 \end{bmatrix} T_c$$

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