ECEN 4638: Lab W2

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1   Description

The goal of this lab is to design a controller and investigate the response of a two disc system when using ω_1 for feedback and measurement versus using ω_2. The key difference between these two methods is ω_1 is collocated control while ω_2 is non-collocated. We anticipate using ω_1 will produce a more robust controller and during the course of this lab we will confirm or refute this prediction.

2   Setup

For the following experiments we will arrange the TDS with the lower disc containing four weights at 6.5 cm and the middle disc with two weights at 6.5 cm. Using this setup the system parameters calculated from the methods described in Lab W are the following:

$$b = 0.305 \qquad\qquad k = 2.55$$
$$c_1 = 0.004 \qquad\qquad c_2 = 0.0016$$
$$J_1 = 0.011475 \qquad\qquad J_2 = 0.0064375$$

3   System model

3.1   LTI model

The two disc torsional disc system can be modeled as an LTI system with the following equations:

$$J_1\ddot{\theta}_1 + c_1\dot{\theta}_1 + k(\theta_1 - \theta_2) = bu \tag{1}$$
$$J_2\ddot{\theta}_2 + c_2\dot{\theta}_2 + k(\theta_2 - \theta_1) = 0 \tag{2}$$

The difference in position of the discs, β is also of interest, where $\beta = \theta_1 - \theta_2$. If we make this substitution, as well as substituting in angular velocity ω for $\dot{\theta}$, our system becomes:

$$J_1\dot{\omega}_1 + c_1\omega_1 + k\beta = bu \tag{3}$$
$$J_2\dot{\omega}_2 + c_2\omega_2 - k\beta = 0 \tag{4}$$

3.2   State Space Representation

Lab W2 will use the state space representation of the LTI model. State space methods are used because they are easier to manipulate when dealing with a system with multiple outputs such as the two disc TDS.

$$\begin{bmatrix} \dot{\omega}_1 \\ \dot{\omega}_2 \\ \dot{\beta} \end{bmatrix} = \begin{bmatrix} -\frac{c_1}{J_1} & 0 & -\frac{k}{J_1} \\ 0 & -\frac{c_2}{J_2} & -\frac{k}{J_2} \\ 1 & -1 & 0 \end{bmatrix} \begin{bmatrix} \omega_1 \\ \omega_2 \\ \beta \end{bmatrix} + \begin{bmatrix} \frac{b}{J_1} \\ 0 \\ 0 \end{bmatrix} \tag{5}$$

4 Matlab Controller Design ω_1

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- bandwidth

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- bandwidth

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