ECEN 4638: Lab X.1PI

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1 Description

This lab will further explore the Torsional Disc System. The system setup will be similar to what was used in labX.1P; only the bottom disc of the TDS will used and the four weights will be set at a radius of 6.5cm.

2 System Model

2.1 Calculated Parameters

2.2 Transfer Functions

3 Matlab Analysis

3.1 Time Domain

3.2 Frequency Domain

4 Experimental Analysis

After conducting the matlab analysis in section 3 experimental data was collected from two different torsion disc systems. Data was collected from two systems in order to examine the robustness of the PI controller and make any necessary adjustments.

4.1 Setup

The first step in collecting experimental data was to select a rise time (t_r) and overshoot (M_p) for the system. As an initial starting point values of $t_r = 0.5$ sec and $M_p = 5\%$ were selected. Using these values the damping ζ and natural frequency ω_n were calculated using equations 1 and 2

$$\zeta = \frac{|\ln(0.05)|}{\sqrt{\pi^2 + [ln(0.05)]^2}} = 0.69 \tag{1}$$

$$\omega_n = \frac{1.8}{0.5} = 3.6 \tag{2}$$

These values were used as an initial starting point and adjustments were made based on the response calculated in matlab and the corresponding response on the TDS. In cases where the overshoot became too high the damping was increased. It also became necessary to increase the bandwidth of the system in order to reduce the noise on the live system. Table 1 shows the various calculated values based on necessary changes. For each iteration the value in bold was adjusted to improve the response.

Test	M_p	t_r	ζ	ω_n	K_p	K_I	BW
test1	**5.00**	**0.50**	0.69	3.60	0.1548	0.4611	6.55
test2	19.58	0.090	0.69	**10**	0.469	3.558	19.55
test3	16.23	0.085	**0.80**	10	0.5472	3.558	20.948
test4	14.67	0.039	**0.90**	**20**	1.258	14.23	45.59
test5	13.63	0.038	**0.95**	20	1.329	14.23	47.00
test6	13.92	0.025	0.95	**30**	2.006	32.018	71.08

Table 1: System Response

4.2 Time Domain

4.3 Frequency Domain

5 PI Controller Design