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

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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. The adjustments were determined based on the response of the system to a step input as outlined in section 4.2 and to a ramp disturbance in section 4.3.

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 - Step Response

The values shown in table 1 were calculated from the closed loop transfer function of the system model. The ideal step response from matlab was then compared to experimental data from the TDS. This experimental data was collected by adjusting the K_p and K_I values in Labview and saving the response data to a text file.reference to transfer function or system model. Data was collected for TDS machine 1 and TDS machine 4.

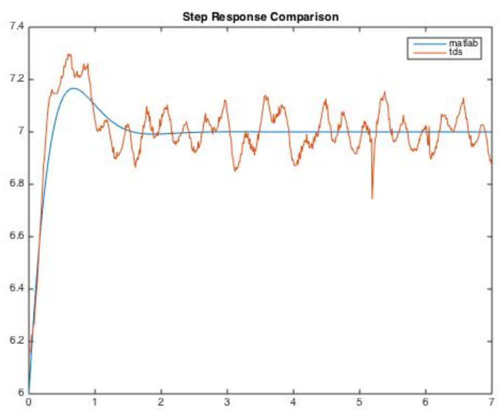

Figure 1: Step Response test1

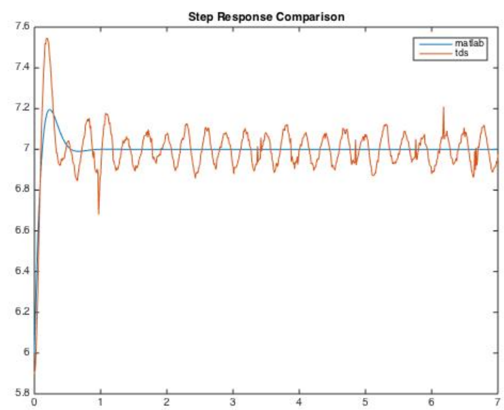

Figure 2: Step Response test2

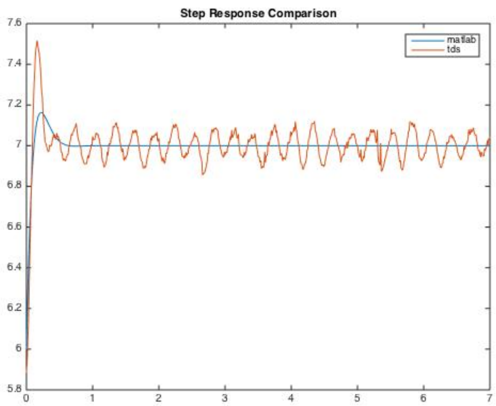

Figure 3: Step Response test3

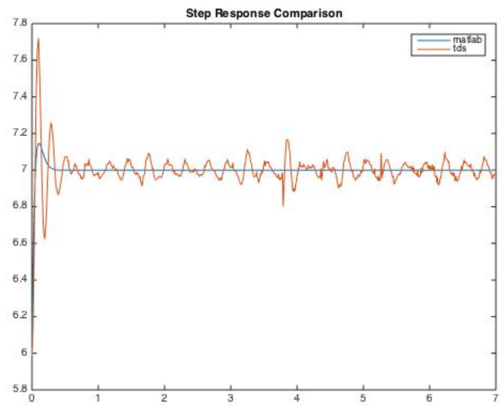

Figure 4: Step Response test4

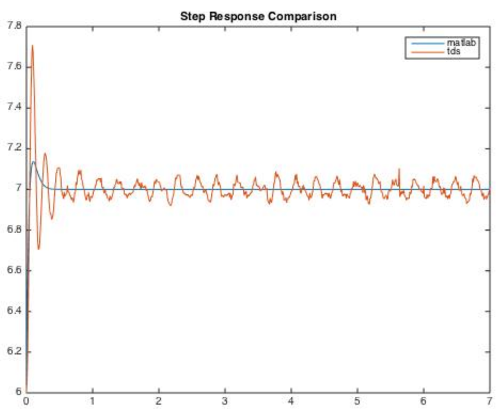

Figure 5: Step Response test5

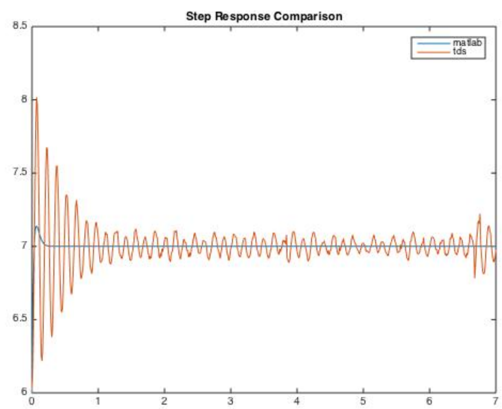

Figure 6: Step Response test6

Figures 1 through 6 show the plots of the matlab data and the collected experimental data for machine 1. Figures add machine 4 plots. From this information it is possible to calculate the actual rise time and overshoot of the system for different K_I and K_p values. Table **??** shows the calculated t_r and M_p using matlab's stepinfo function.

matlab t_r	mach1 t_r	mach4 t_r	matlab M_p	mach4 M_p	mach4 M_p
0.275	0.1515	0	16.646	6.1417	0
0.09	0	0	19.58	0	0
0.085	0	0	16.23	0	0
0.039	0	0	14.67	0	0
0.038	0	0	13.63	0	0
0.025	0	0	3.916	0	0

Table 2: t_r and M_p Comparison

4.3 Time Domain - Disturbance

4.4 Frequency Domain

5 PI Controller Design