

ELE639 - Lab 1 - Executive Summary

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Introduction

This lab focuses on three LTI control systems; *Proportional*; *P*, *Proportional + Integral*; *PI*, *Proportional + Derivative*; *PD*. The system characteristics will be calculated and observed as part of this lab. We are concerned with the *Proportional Gain*, K_P of the three different control modes, as well as the effects that the changing controller has on the *Frequency of Oscillation*, ω_{osc} .

Observations

We observed the following *Critical Gains*, $K_{P,crit}$, and *Critical Frequencies of Oscillation*, $\omega_{osc,crit}$, throughout the labs, as well the theoretical values we calculated for both parameters.

	Theoretical		Experimental	
	$K_{P,crit}$	$\omega_{osc,crit}$	$K_{P,crit}$	$\omega_{osc,crit}$
P	14.399	1.433	14.413	1.457
PI	14.680	2.051	12.1205	1.313
PD	31.612	2.689	31.450	4.120

Table 1: Gains and Oscillations observed in Lab

Throughout the lab it was also requested that the Gain margin, G_m , was calculated for both theoretical and experimental systems. For the P Controller it was required that we calculated the operating gain, $K_{P,OP}$, via a provided G_m and the measured and calculated $K_{P,crit}$. For the the PI and PD Controllers it was required that a gain margin was calculated using the $K_{P,OP}$ from the P controller, and their respective $K_{P,crit}$

	Theoretical			Experimental		
	P	PD	PI	P	PD	PI
K_{crit}	14.399	14.680	31.612	14.413	12.1205	31.450
K_{OP}	3.59975	3.59975	3.59975	3.603	3.603	3.603
G_m	4	4.0781	8.7817	4	3.363	8.729

Table 2: Gain Margins observed in Lab

Conclusion

The observation we made our conclusions from are the experimental ones as MATLAB is likely to make less errors than us. There is small variance in our calculated values and the experimental but some of the system gains we calculated are greater than the observed critical gain and cause instability. From the results we can conclude the following properties and characteristics:

- As a we transition from P to PI control our K_{crit} decreases, meaning that our $\omega_{osc,crit}$ will also decrease, what this implicates for our system is that our gain margin is now smaller.
- As a we transition from P to PD control our K_{crit} increases, meaning that our $\omega_{osc,crit}$ will also increases, what this implicates for our system is that our gain margin is now larger.
- It was also observed that for some systems Proportional control is not enough for the system to respond completely to the input, meaning the system undershoots and does not reach the centering point.
- For many systems with reasonable operating gains (Both K_P , and τ_I or τ_D) oscillations can be minimized and a smooth complete response is attainable.