ELECENG 3CL4 Lab 2 Report

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L02	L02

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Member Contributions

Both group members contributed an even amount to both the exercises and the report. Both members went through the exercises together and contributed to all sections of the report.

Objective

The objective of this lab was to identify the plant model of a marginally-stable servomotor for the subsequent experiments.

3 Perform Closed Loop Identification

3.1 Experiment 1: Time Domain Identification

With a default proportional gain of 1, we observed some small non-linear effects when the servo motor slows down, where the servo angle plot went from a curve to a line at the end of the movements. This is visible in the graph shown below. When we increased the proportional gain to 2, we observed that the small non-linear effects shown above were greatly reduced. Consequently, the overshoot of the servo motor increased as a result of the P-gain increase.

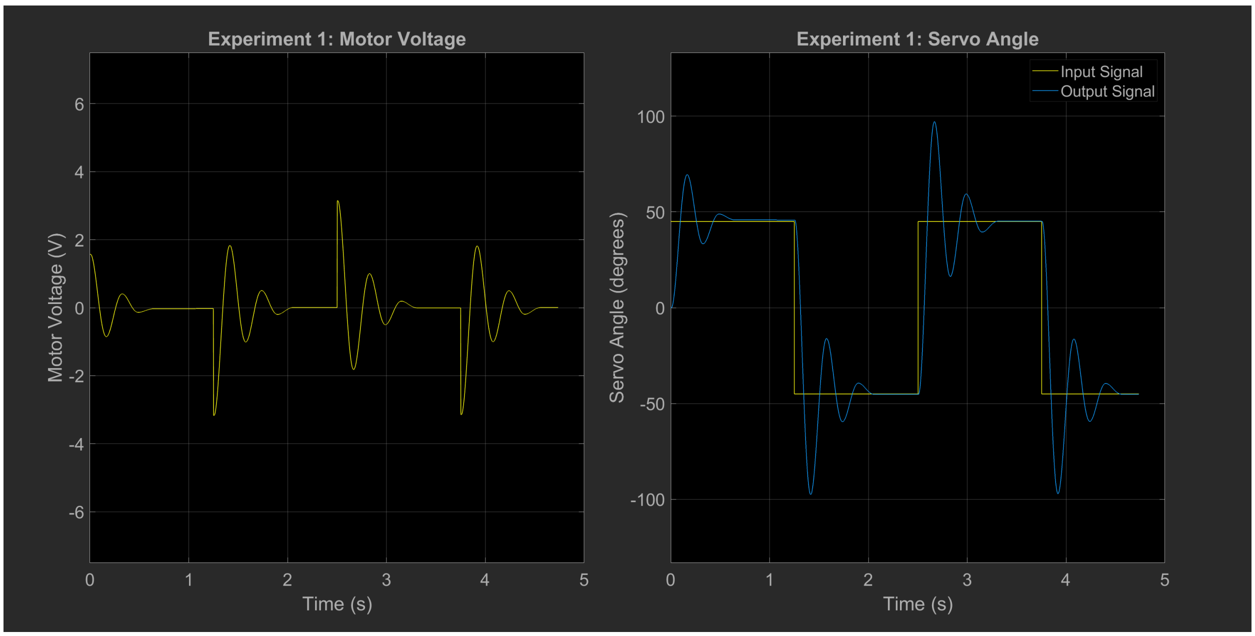

Figure 1: Motor Voltage and Servo Angle for Time Domain Identification

The amplitude of the input square wave was 45 degrees. The switching time was determined to be negligible and assumed to be 0.

To measure the height and time of the first overshoot peak, we use the "Peak Finder" tool in the scopes. The tool determines the peaks in the plots and states the value of the peak and the time it occurs. The height of the first overshoot peak was 69.43 degrees, and the time of the first overshoot peak was 0.162 seconds. We can use the recorded measurements to determine the percent overshoot $P.O.$ and the peak time T_p.

$$P.O. = 100\left(\frac{69.43}{45}\right) - 100 \quad T_p = 0.162$$
$$\approx 54.3\%$$

We can determine ζ and ω_n by using the equations derived in the prelab which relate them to $P.O.$ and T_p.

$$\zeta = \frac{-\log\left(\frac{P.O.}{100}\right)}{\sqrt{\pi^2 + \left(\log\left(\frac{P.O.}{100}\right)\right)^2}} \quad \omega_n = \frac{\pi}{T_p\sqrt{1-\zeta^2}}$$
$$= 0.191 \qquad\qquad = 19.756$$

We can determine the motor parameters A and τ_m by using the equations derived in the prelab which relate them to ζ and ω_n.

$$A = \frac{\omega_n/2\zeta}{K} \quad \tau_m = \frac{1}{2\omega_n\zeta}$$
$$= 25.877 \qquad = 0.133 \tag{1}$$

The values of A and τ_m were determined to be 25.877 and 0.133 in Equation 1.

3.2 Experiment 2: Frequency Domain Identification

To verify that the choice of K = 2 lead to a reasonable peak shown in Figure 3 of the lab document, we calculated that our ζ was 0.191, and from Figure 3 we observed that it gave us a peak of approximately 8 dB, which is large enough that we could easily identify the peak.

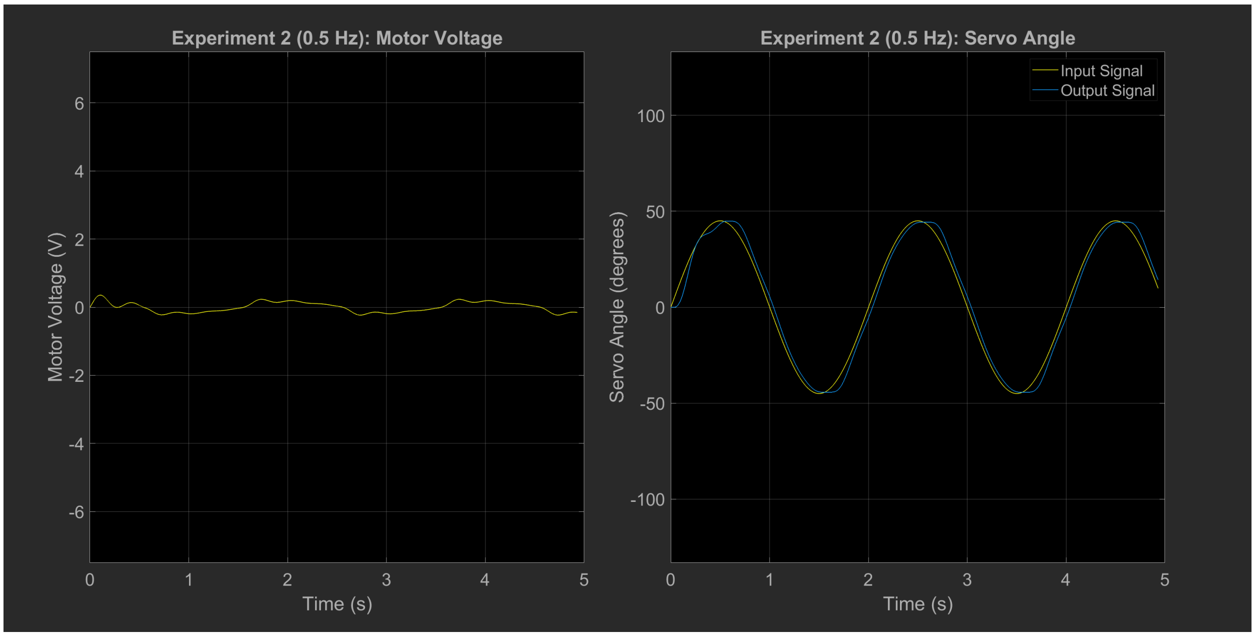

Figure 2: Motor Voltage and Servo Angle for 0.5 Hz Input Signal

some observations

some observations

some observations

some observations

some observations

some observations

In general, we can observe that the magnitude and phase of the output signal match our expectations based on Figure 3 from the lab document. There is no magnitude gain to start, with the gain beginning to increase until it reaches a peak value, then starts to decrease. There is no phase delay to start, with the delay beginning to increase then plateauing around 180 degrees.

To determine the frequency where the magnitude reaches its peak, we observed the change in the magnitude of the output signal using the ”Peak Finder” tool as we changed the frequency. During our previous observations, the largest magnitude value occurred at 3 Hz. We determined the peak value by applying a binary search method beginning at 3 Hz, and

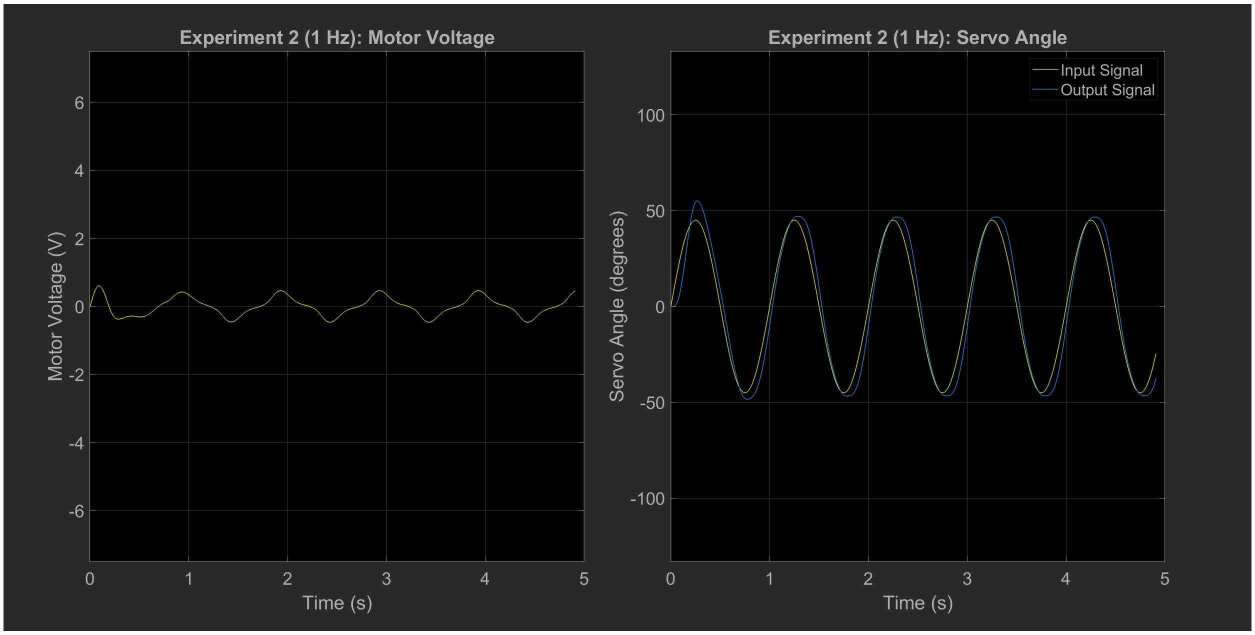

Figure 3: Motor Voltage and Servo Angle for 1 Hz Input Signal

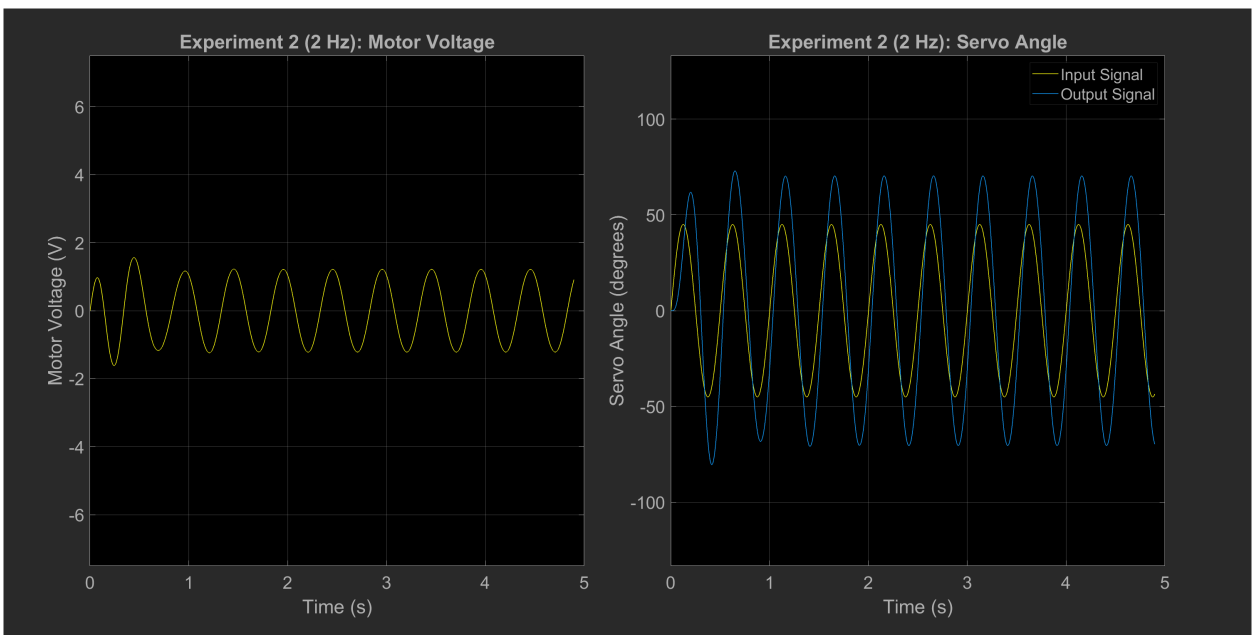

Figure 4: Motor Voltage and Servo Angle for 2 Hz Input Signal

eventually determined that the frequency where the magnitude reaches it peak value was around 3.06 Hz, where the magnitude was 139.9 degrees.

We can use the recorded measurements to determine the value of the peak M_p and the peak

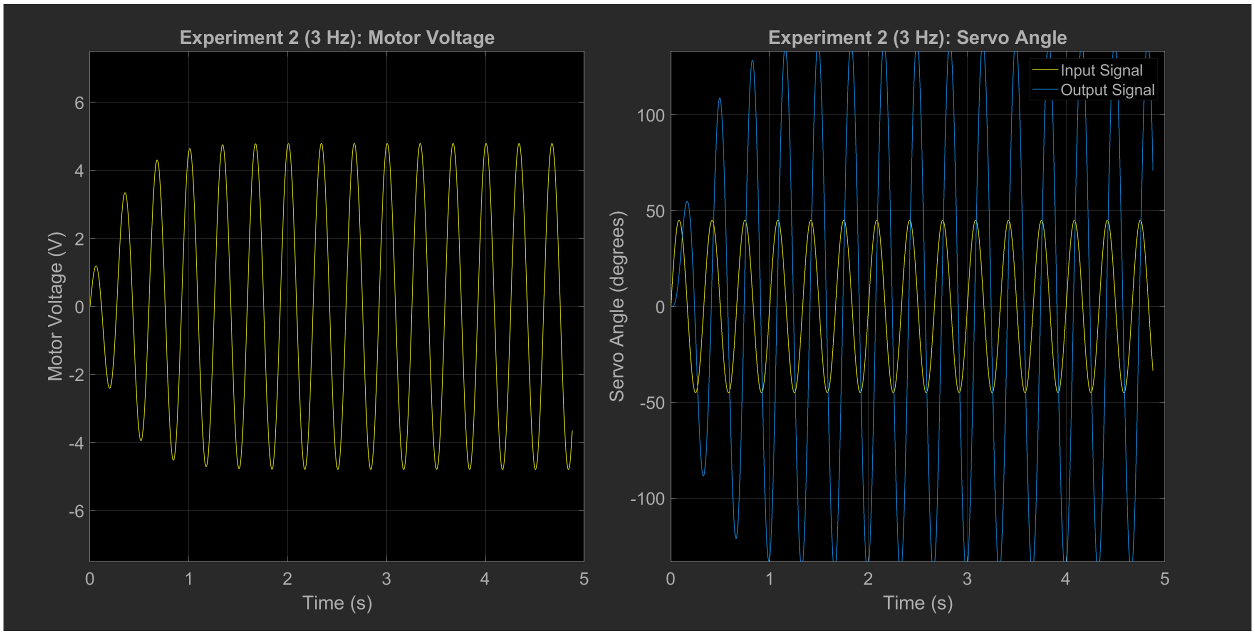

Figure 5: Motor Voltage and Servo Angle for 3 Hz Input Signal

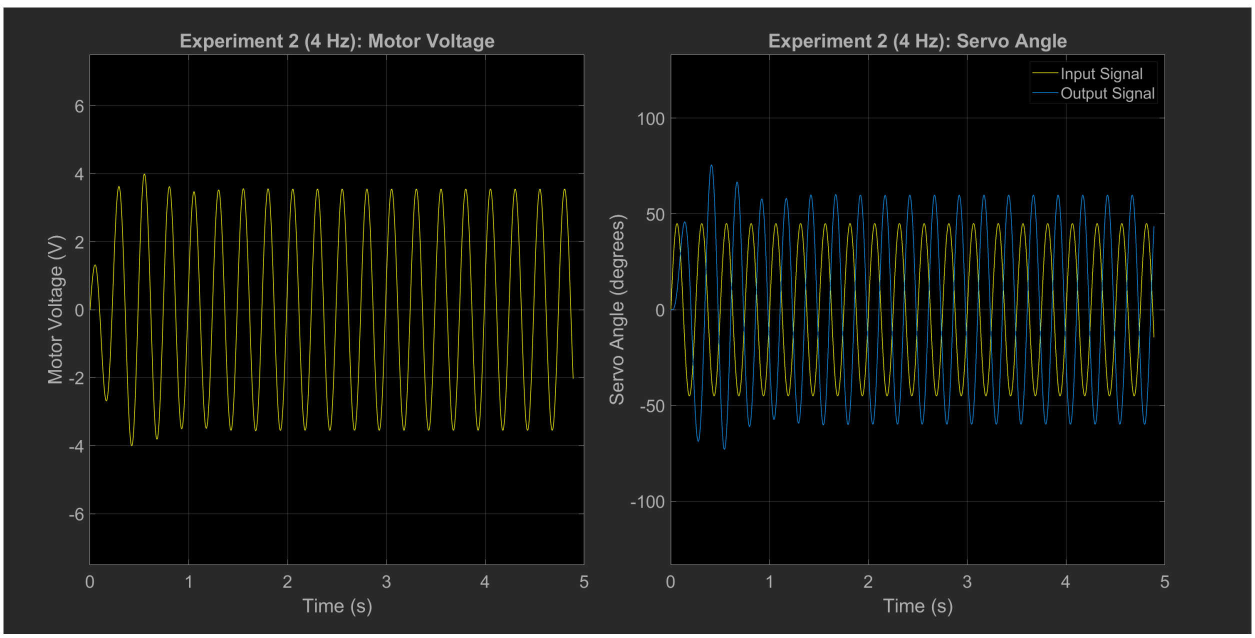

Figure 6: Motor Voltage and Servo Angle for 4 Hz Input Signal

frequency ω_p.

$$\begin{aligned} M_p &= \frac{139.9}{45} & \omega_p &= 2\pi 3.06 \\ &= 3.109 & &= 19.227 \end{aligned}$$

We can determine ζ and ω_n by using the equations derived in the prelab which relate them

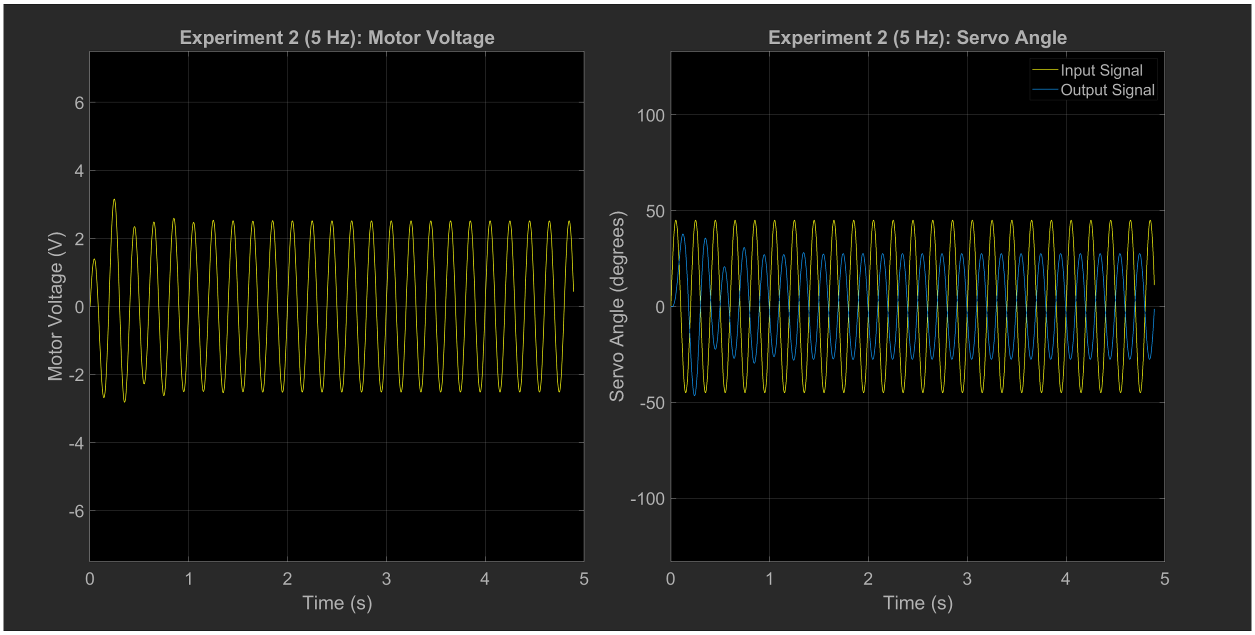

Figure 7: Motor Voltage and Servo Angle for 5 Hz Input Signal

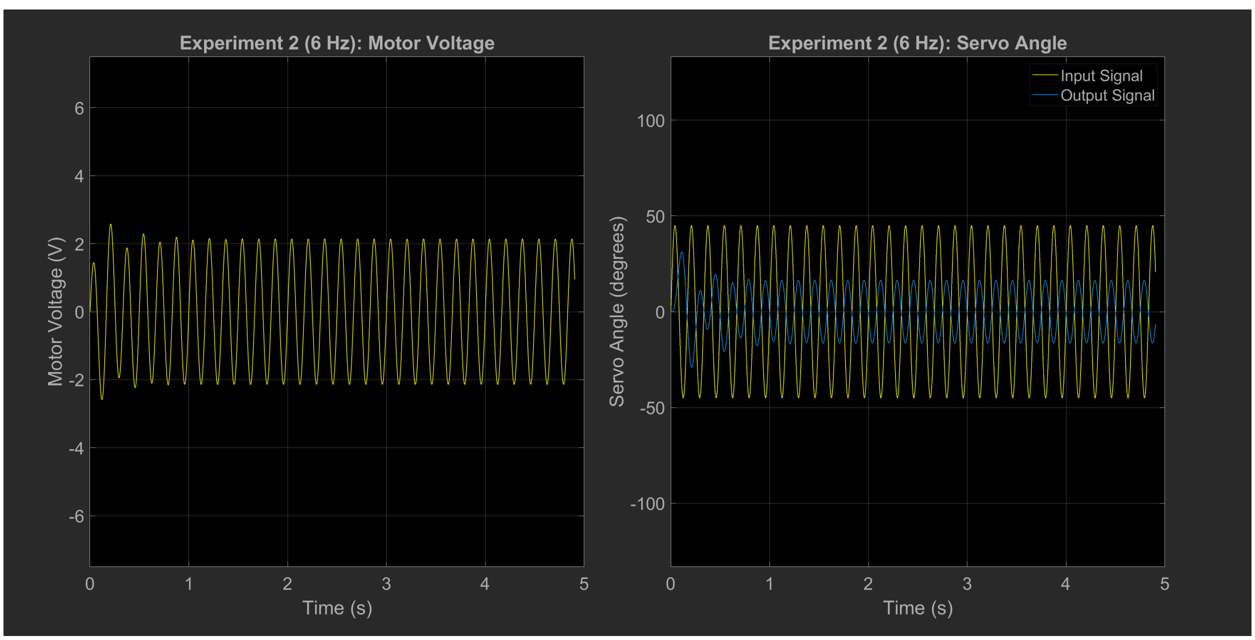

Figure 8: Motor Voltage and Servo Angle for 6 Hz Input Signal

to M_p and ω_p.

$$\zeta = \sqrt{\frac{-4M_p^2 + \sqrt{14M_p^4 - 16M_p^2}}{-8M_p^2}} \qquad \omega_n = \frac{\omega_p}{\sqrt{1-2\zeta^2}}$$
$$= 0.163 \qquad\qquad = 19.759$$

We can determine the motor parameters A and τ_m by using the equations derived in the prelab which relate them to ζ and ω_n.

$$\begin{aligned} A &= \frac{\omega_n/2\zeta}{K} & \tau_m &= \frac{1}{2\omega_n\zeta} \\ &= 30.303 & &= 0.155 \end{aligned} \tag{2}$$

The values of A and τ_m were determined to be 30.303 and 0.155 in Equation 2.

Comparison of Results and Discussion of Potential Discrepancies

Our values for A and Tm were pretty close to each other using the 2 different methods. The discrepancies could've come from the non-linear effects of the motor or some shit xd.

Discussion on Improving the Accuracy of the Estimation of Model Parameters

Who knows xd Well for starters I think you'd want to reduce the non-linear effects of the motor as much as you could, so maybe you could increase the P-gain a little more.