

6.302 Lab 1C Report

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1.

$$P_o = 2.64$$

$$\omega_d = \frac{2\pi}{0.255} = 25.1$$

$$\zeta = \sqrt{\frac{(\ln P_o - 1)^2}{\pi^2 + (\ln P_o - 1)^2}} = 0.155$$

$$\omega_n = \frac{\omega_d}{\sqrt{1 - \zeta^2}} = 25.4$$

In the prelab, I calculated that ω_n should be about 23 radians per second, which is very close to the 25.4 radians per second I measured in lab. In the prelab, I calculated $\zeta = 0.0376$ which is much much smaller than what I measured in lab. The discrepancy results from the fact that my prelab calculations did not account for friction and other mechanical damping that increases the damping ratio.

2.

$$M_p = \frac{1.006}{K_p 0.125} = 2.50$$

$$\omega_p = 2\pi 4.1 \text{ Hz} = 25.76$$

$$\zeta = \sqrt{\frac{1 \pm \sqrt{1 - \frac{1}{M_p^2}}}{2}} = 0.205$$

$$\omega_n = \frac{\omega_p}{\sqrt{1 - 2\zeta^2}} = 26.9$$

The value of ζ I measured was close to what I calculated in the prelab: 0.205 versus 0.155. The value of ω_n was also close: 23 radians versus 26.9 radians.

3.

$$t_p = \text{time to peak} = 136\text{ms}$$

$$P_o = 1.13$$

$$\zeta = \sqrt{\frac{(\ln P_o - 1)^2}{\pi^2 + (\ln P_o - 1)^2}} = 0.541$$

$$\omega_n = \frac{\pi}{t_p \sqrt{1 - \zeta^2}} = 27$$

It was very hard to measure the ring frequency of the step response because the oscillatory transient died away so quickly that I couldn't actually see any oscillation.

$$M_p = \frac{0.353}{K_p 0.300} = 0.364$$

The percent overshoot I measured was very similar to what I expected, but the magnitude peak value is far below what I expected: 0.538 versus 0.541.

The Matlab plot of the step response differs from what I measured in lab. The step response I measured in lab had a small overshoot and then settled to its final value with no ringing. Like what I measured, the Matlab plot shows no ringing but it shows no peak overshoot as well. The Matlab Bode plot shows a smooth degradation, but I definitely measured some magnitude peaking. In general, the modeled system seems to respond much slower than what I measured in the lab.

4. I measured a steady state error of 0.025 volts, which is much larger than the 0.003 volt error I estimated in the prelab.