6.302 Feedback Systems

Spring Term 2007
Lab 1B

Issued : February 23, 2007
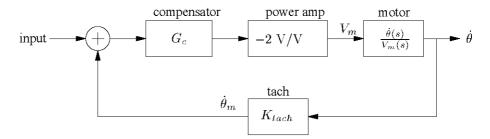Due : Friday, March 9, 2007

Introduction

The goal of the laboratory is the design of a velocity control loop through the use of the mathematical model obtained for the servomechanism in Lab 1A. Measurements are made in the laboratory to verify results calculated in the prelab. Use a motor station with a flywheel on the servo for the entire lab.

Equipment

For this lab, you will need to pick up the following items from the equipment desk: five BNC cables, 3 BNC T-connectors, and a 2 μF capacitor.

Measurements

Configure the servomechanism as shown below. Use the "Summing Amp / Compensator" section in the center of the box. Set its switch to the "flat" setting and dial in the value of gain that you calculated in the prelab. Note that the potentiometer can be used to set the compensator gain in the range between 0 and 10 (a pot setting of "542" would thus correspond to a compensator gain of 5.42).

1. Drive the system input with a *square wave* of voltage and display $\dot{\theta}_m$ to measure the 10%–90% risetime of the motor velocity. Compare your measurement with the calculated value from the prelab. Be sure that you don't over-drive and saturate the system while taking your rise time measurement. By observing V_m, determine the input drive amplitude which is required to momentarily saturate the system.

2. Drive the system with a *sine wave* of voltage and find the frequency where the magnitude of the closed loop gain has dropped to 0.707 of its DC value (this is the 3dB frequency). How does this frequency relate to the time constant measured in the preceding step response?

3. Drive the system with a *square wave* of voltage and measure the steady state error to a unit step input. It may be helpful to use the "channel math ($\pm$)" function of the oscilloscope in facilitating this measurement.

Place a 2 μF capacitor across the "C_{lag}" terminals of the compensator and move its switch to the "P+I" setting. The system is now configured with a proportional plus integral controller.

4. Measure the steady state error of the system in response to a unit step input, and compare this with the result obtained with the proportional controller.

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Move the compensator switch back to the "flat" position and remove the capacitor. Dial in the compensator gain calculated in the prelab for the loop configuration with a current-driven motor. Move the power amplifier switch to the "−0.4 A/V" setting.

5. Measure the 10%–90% rise time (with a square wave input), the 3dB frequency (with a sinusoidal input), and the steady state error to a step (with a square wave input) of the system. Compare the results with those obtained in the voltage driven case. Are the results as you expected? Explain.

Write Up

The write up for this lab should be prepared in the same spirit as last week's: short, simple, and informal.

Useful Formulae

$$
\begin{aligned}
\omega_d &= \omega_n\sqrt{1-\zeta^2} \\
P_o &= 1 + \exp\left(\frac{-\pi\zeta}{\sqrt{1-\zeta^2}}\right) \\
t_p &= \frac{\pi}{\omega_d} = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} \\
M_p &= \frac{1}{2\zeta\sqrt{1-\zeta^2}} \\
\omega_p &= \omega_n\sqrt{1-2\zeta^2}
\end{aligned}
$$