6.302 Feedback Systems

Spring Term 2007
Lab 1D

Issued : March 23, 2007
Due : Friday, April 14, 2007
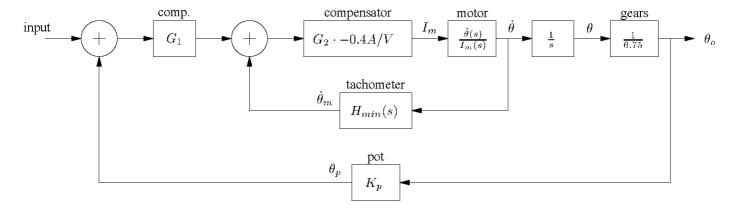
Introduction

The goal of this laboratory is the design of a position control loop using the mathematical model obtained for the servomechanism in lab 1A. Measurements are made in the laboratory to verify results calculated in the prelab.

Equipment

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

Measurements

Configure the servo-mechanism as shown below (remember the flywheel). Set the compensator switches to the "flat" settings and dial in the gain values that you calculated. Note that the compensator gain control dial has an imaginary decimal point after the first digit. 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 measure the peak overshoot and time to first peak of the output shaft position. Find the values of ζ and ω_n that correspond to your measurements. Compare your experimental and calculated values.

2. Drive the system with a *sine wave* of voltage and find the peak magnitude of the closed loop response and the frequency at which this peak occurs. Find the values of ζ and ω_n that correspond to your measurements. Compare your experimental and calculated values.

3. Drive the system with a *triangle wave* of voltage and measure the steady state error to a ramp input. Normalize your error measurement to that which would be obtained from a unit ramp. It may be helpful to use the "Channel Math" function of the oscilloscope to facilitate this measurement.

4. Use MATLAB to plot the error response due to a ramp input into the modelled system. How does the time constant of the error decay relate to the parameters of the system?

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Place a 2 μF capacitor across the "C_{lead}" terminals of the "Tachometer Lead" section of the control box and move the cable providing the tachometric feedback to your minor loop summing amplifier from the $\dot{\theta}_m$ connector to the "$\dot{\theta}_m$ w/lead" connector. The minor loop is now configured with acceleration feedback.

1. Repeat the above measurements on the newly configured system.

2. Use MATLAB to plot the error response due to a ramp input into the modeled system (with the acceleration feedback.) How does the time constant of the error decay relate to the parameters of the system?

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

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