MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.302 Feedback Systems
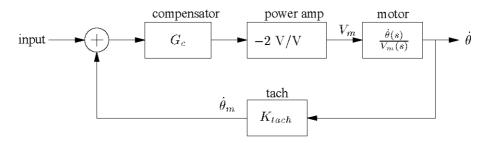
Spring Term 2007

Prelab 1B

Issued : February 23, 2007

Due : Thursday, March 1, 2007

Introduction

The purpose of this lab is to use the mathematical model obtained for the servomechanism to design a velocity control loop. You will need a copy of all the motor parameters determined in Lab 1A. Be sure to include the inertia of the flywheel in all of your calculations. Measurements will be made next week to verify calculated results. This prelab **must** be done before you go into lab.
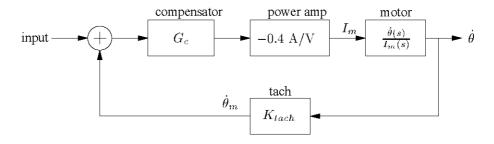
Pre-Lab Calculations

Consider the following velocity control loop:

1. For a proportional control compensator (i.e. G_c is a constant gain), write an expression for the closed loop transfer function and calculate the value of G_c required to yield a closed loop dominant mode with a time constant of 35 ms. Neglect the electrical time constant, and don't forget the flywheel!

2. How does the compensator gain affect the closed loop time constant?

3. Calculate the steady state error of the above system when driven with a unit step input. What is the DC closed loop gain of the system?

4. A proportional plus integral (P+I) compensator has the following form:

$$G_c(s) = G\frac{\tau s + 1}{\tau s}$$

Calculate the steady state error to a unit step input and sketch the response of $\dot{\theta}$.

1

5. Now consider driving the motor with the power amplifier in the current drive (-0.4 A/V) setting. For a proportional gain compensator, write an expression for the closed loop transfer function and calculate the value of G_c required for a dominant-mode time constant of 35 ms.

6. Calculate the steady state error of this system when driven with a unit step input and sketch the unit step response of $\dot{\theta}$. What is the DC closed loop gain of the system?

Useful Formulae

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

Cite as: James Roberge, course materials for 6.302 Feedback Systems, Spring 2007.
MIT OpenCourseWare (http://ocw.mit.edu/), Massachusetts Institute of Technology. Downloaded on [DD Month YYYY].