

Department of Mechanical Engineering
Massachusetts Institute of Technology
2.14 Analysis and Design of Feedback Control Systems
Fall 2004
Assignment #8
Distributed Thursday November 4, 2004
Due: **Wednesday, November 10** by 5pm in 35-231 Drop Box

Reading: Reading: Nise Chapter 11

Problem 1

Nise Problem 11-23

Problem 2

Nise Problem 11-24

NB: This problem asks you to look at velocity error via the velocity constant K_v , which was defined when we discussed steady-state error a few weeks ago.

Problem 3

Nise Problem 11-26 and Problem 8-50 (Compare PI controller designed using root locus methods to lead – lag controller designed using frequency response methods.)

Please comment on the strengths and weaknesses of the two methods.

Problem 4

Consider the system shown in Nise Problem 5-52 (in Chapter 5). This shows a materials testing machine, of which we have many at MIT and other research labs. These machines are used for many different types of test, but one important test is fatigue, which involves cyclical loading over a range of frequencies.

For the system as shown in Figure P5.36 assuming the controller gain is adjustable:

a) What is range of frequencies over which we could expect the machine to follow a cyclic load command with less than a 5% error if we use gain compensation only?

Looking at the machine transfer function, in a factored form it becomes:

$$G(s) = \frac{15 \times 10^6}{(s + 5)(s^2 + 77s + 4,000,000)}$$

Let's assume that the material under test is the least stiff element of the combination of machine frame, load cell and material. This would mean that if the material under test were changed, the parameters of this transfer function would change.

- b) Using physical reasoning, which of the term(s) in $G(s)$ would change with material stiffness change?
- c) Assume that the material under test is 10 times less stiff than the one for which the model was derived. Using gain compensation only what would the range of frequencies for <5% error be?
- d) If you didn't want to have to readjust the gain every time a new material was under test, how would you design controller?