

16.06 Lecture 23

Root Locus System Design

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Today's Topics

1. Root loci and system design
2. Pole zero cancellation
3. Feedback compensation
4. Phase lead compensator design

Reading: 6.5, 6.6

1 Root loci and system design

So far, we have drawn root loci for a system, and then chosen a gain to obtain a particular closed-loop pole position.

There is a problem with this approach of using P-control:

What about dynamic compensation? This means $G_c(s)$

There are different kinds of dynamic compensators:

First let us look at the general effect of adding a pole or zero.

Consider the following second-order system:

Now add a pole and redraw the locus:

Instead, add a zero and redraw the locus:

The following general effects can be seen:

2 Pole-zero cancellation

Consider the following system:

$$G(s) = \frac{K}{s(s+1)(s+2)}$$

Draw the root locus:

We will end up with a pair of complex conjugate poles with low damping ratio.

One way to improve the response of the system is to

There is another way. We could put the zero

3 Feedback compensation

Consider a motor position servo

$$G(s) = \frac{K_m}{s^2(T_f s + 1)}$$

with velocity and position feedback.

The closed-loop TF of this system is

The loop gain function of this system is

Let us sketch the loci for different choices of velocity feedback gain K_g :

4 Phase-lead compensator design

We have the following system:

where

Consider the pole-zero diagram:

Phase-lead compensation has a stabilizing effect.

At A_1 , angle of plant =

At A_2 , angle of plant + angle of compensator =

angle of plant =

So the compensator must contribute

From the triangle, we have

Now we can establish a design procedure.

5 Design Procedure

7 steps on handout.

insert phase-lead design procedure here