

Control Systems

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Abstract—This manual is an introduction to control systems based on GATE problems. Links to sample Python codes are available in the text.

Download python codes using

svn co <https://github.com/gadepall/school/trunk/control/codes>

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1 SIGNAL FLOW GRAPH

1.1 Mason's Gain Formula

1.2 Matrix Formula

1.3 Example

2 BODE PLOT

2.1 Introduction

2.2 Example

2.3 Phase

3 SECOND ORDER SYSTEM

3.1 Damping

3.2 Example

3.3 Settling Time

4 ROUTH HURWITZ CRITERION

4.1 Routh Array

4.2 Marginal Stability

4.3 Stability

4.4 Example

4.5 Example

5 STATE-SPACE MODEL

5.1 Controllability and Observability

5.2 Second Order System

5.3 Example

5.4 Example

5.5 Example

5.6 Example

5.7 Example

6 NYQUIST PLOT

6.1 Introduction

6.2 Example

7 COMPENSATORS

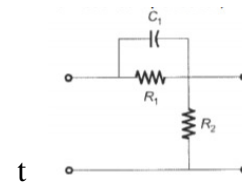
7.1 Phase Lead

7.2 Lag Lead

7.3 Example

☐ lead Compensator network includes a parallel combination of R and C in feed-forward path. If the transfer function of compensator is

$$G_c(s) = \frac{s+2}{s+4}$$



This is the circuit of lead compensator with parallel RC combination.

, the value of RC is ?

And also find the value of RC for a lead compensator used in previous example.

$$G_c(s) = \frac{3(s + \frac{1}{3})}{s + 1}$$

Solution:

The transfer function for the following circuit is

$$T(s) = \frac{V_o}{V_i}$$

Let

$$\alpha = \frac{R_2}{R_1 + R_2}$$

and

$$\tau = R_1 C$$

Now our T(s) is

$$T(s) = \frac{R_2}{\frac{\frac{1}{sC}R_1}{\frac{1}{sC} + R_1} + R_2}$$

Simplifying T(s)

$$T(s) = \frac{s + \frac{1}{\tau}}{s + \frac{1}{\tau\alpha}}$$

Comparing with the given

$$G_c(s) = \frac{s+2}{s+4}$$

$$\tau = R_1 C = 0.5$$

for

$$T(s) = \frac{3(s + \frac{1}{3})}{s + 1}$$

here this is a lead compensator with a gain of 3. so we can simply write passive circuit part as.

$$T(s) = \frac{(s + \frac{1}{3})}{s + 1}$$

again by comparing with

$$T(s) = \frac{s + \frac{1}{\tau}}{s + \frac{1}{\tau\alpha}}$$

$$\tau = 3$$

$$RC = 3$$

8 GAIN MARGIN

8.1 Introduction

8.2 Example

8.3 Example

9 PHASE MARGIN

9.1 Introduction

9.2 Example

10 OSCILLATOR

10.1 Introduction

10.2 Example

11 ROOT LOCUS

11.1 Introduction