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
```

1 Signal Flow Graph

1.1 Mason's Gain Formula

1.2 Matrix Formula

2 Bode Plot

2.1 Introduction

2.2 Example

3 Second order System

3.1 Damping

3.2 Example

3.1. The response of the system

$$G(s) = \frac{s-2}{(s+1)(s+3)}, \tag{3.1.1}$$

to the unit step input u(t) is y(t). The value of $\frac{dy}{dt}$ at t=$0^{+}is$:

Solution: Input of the system is u(t), We know that,

$$Y(s) = X(s).H(s) = \left[\frac{1}{s}\right]\left[\frac{s-2}{(s+1)(s+3)}\right] \tag{3.1.2}$$

$$= \frac{s-2}{s(s+1)(s+3)} \tag{3.1.3}$$

$$= \frac{-2}{3s} + \frac{3}{2(s+1)} + \frac{-5}{6(s+3)} \tag{3.1.4}$$

Applying the inverse laplace transform , we get:

$$c(t) = L^{-1}\left[\frac{1}{s}\right] - L^{-1}\left[\frac{1}{1+s}\right] - L^{-1}\left[\frac{1}{(1+s)^2}\right] \tag{3.1.5}$$

$$= \left(\frac{-2}{3} + \frac{3}{2}e^{-t} - \frac{5}{6}e^{-3t}\right)u(t) \tag{3.1.6}$$

On differentiating it we get,

$$\frac{dy(t)}{dt} = \frac{-3}{2}e^{-t} + \frac{5}{2}e^{-3t} \tag{3.1.7}$$

At t = 0^{+}

$$\frac{dy(0^{+})}{dt} = \frac{-3}{2} + \frac{5}{2} = 1 \tag{3.1.8}$$

4 Routh Hurwitz Criterion

4.1 Routh Array

4.2 Marginal Stability

4.3 Stability

4.4 Example

5 State-Space Model

5.1 Controllability and Observability

5.2 Second Order System

5.3 Example

5.4 Example

5.5 Example

6 Nyquist Plot

7 Compensators

7.1 Phase Lead

7.2 Example

8 Gain Margin

8.1 Introduction

8.2 Example

9 Phase Margin

10 Oscillator

10.1 Introduction

10.2 Example

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