Control Systems

G V V Sharma*

Contents

***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
```

*The author is with the Department of Electrical Engineering, Indian Institute of Technology, Hyderabad 502285 India e-mail: gadepall@iith.ac.in.

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 Peak Overshoot

3.3 Example

3.4 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

6.3 Example

6.1. Using Nyquist Criterion, find out whether this system is stable or not.

$$G(s) = \frac{50}{s(s+3)(s+6)} \tag{6.1.1}$$

$$H(s) = 1. \tag{6.1.2}$$

6.2. **Solution:**

Nyquist Stability:

$$N = Z - P \tag{6.2.1}$$

Closed Loop Transfer Function:

$$T(s) = \frac{50}{s^3 + 9s^2 + 18s + 50} \tag{6.2.2}$$

$$Z = 0, P = 0 \tag{6.2.3}$$

$$N = 0 \tag{6.2.4}$$

Thus, system is stable, which can be verified from Nyquist Plot in Fig 6.2

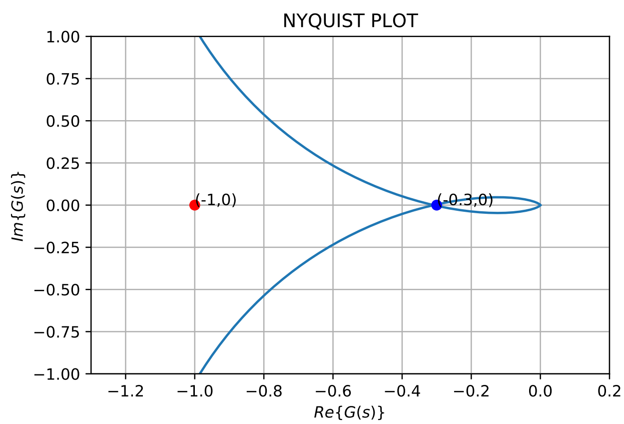

Fig. 6.2

The following code generates Fig 6.2

```
codes/ee18btech11050_1.py
```