

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 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.

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

$$H(s) = 1. \quad (6.1.2)$$

6.2. Solution:

Nyquist Stability:

$$N = Z - P \quad (6.2.1)$$

where Z is number of unstable poles of closed loop transfer function, P is number of unstable poles of open loop transfer function. and N is number of clockwise encirclement of $-1 + j0$.
Closed Loop Transfer Function:

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

$$Z = 0, P = 0 \quad (6.2.3)$$

$$N = 0 \quad (6.2.4)$$

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

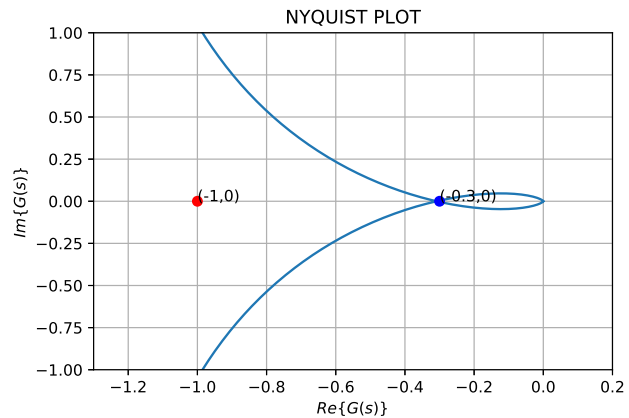


Fig. 6.2

The following code generates Fig 6.2

```
codes/ee18btech11050_1.py
```

7 COMPENSATORS

7.1 *Phase Lead*

7.2 *Lag Lead*

7.3 *Example*

8 GAIN MARGIN

8.1 *Introduction*

8.2 *Example*

8.3 *Example*

9 PHASE MARGIN

9.1 *Intoduction*

9.2 *Example*

10 OSCILLATOR

10.1 *Introduction*

10.2 *Example*

11 ROOT LOCUS

11.1 *Introduction*

11.2 *Example*

11.3 *Example*

12 POLAR PLOT

12.1 *Introduction*