

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 MASON'S GAIN FORMULA

2 BODE PLOT

2.1 Introduction

2.2 Example

3 SECOND ORDER SYSTEM

3.1 Damping

3.1. The open-loop transfer function of a plant in a unity feedback configuration is given as

$$G(s) = \frac{K(s+4)}{(s+8)(s^2-9)} \quad (3.1.1)$$

The value of the gain $K(>0)$ for which $-1+j2$ lies on the root locus is

Solution: The closed loop transfer function for a negative feed back system is:

$$F(s) = \frac{G(s)}{1+G(s)H(s)} \quad (3.1.2)$$

Since it is a unity feed back system, $H(s) = 1$, and now using the characteristic equation at $s_1 = -1+j2$

$$1+G(s_1)H(s_1) = 0 \quad (3.1.3)$$

$$G(s_1) = -1 \quad (3.1.4)$$

$$|G(s_1)| = 1 \quad (3.1.5)$$

$$G(s_1) = \frac{K(s_1+4)}{(s_1+8)(s_1^2-9)} \quad (3.1.6)$$

$$G(s_1) = \frac{K(s_1+4)}{(s_1+8)(s_1+3)(s_1-3)} \quad (3.1.7)$$

$$G(s_1) = \frac{K(3+j2)}{(7+j2)(2+j2)(-4+j2)} \quad (3.1.8)$$

$$|G(s_1)| = \frac{K\sqrt{13}}{\sqrt{51}\sqrt{8}\sqrt{20}} = 1 \quad (3.1.9)$$

$$K = 25.05 \quad (3.1.10)$$

$$F(s) = \frac{25.05(s+4)}{s^3+8s^2+16.05s+28.2} \quad (3.1.11)$$

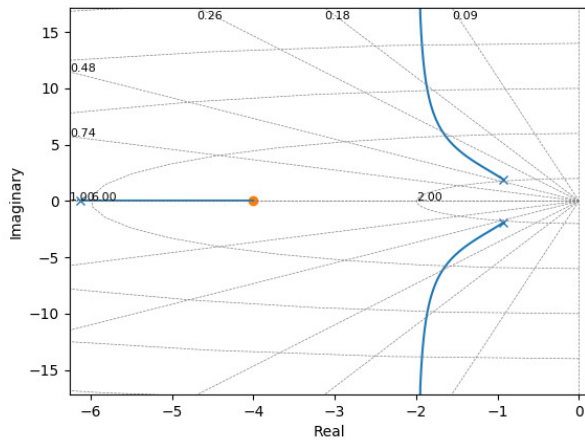


Fig. 3.1: Root locus plot for verification

$$Z_1 = -4, P_1 = -6.13, P_2 = -0.93 + j1.93, P_3 = -0.93 - j1.93$$

codes/ee18btech11052.py

3.2 Example

4 ROUTH HURWITZ CRITERION

4.1 Routh Array

4.2 Marginal Stability

4.3 Stability

5 STATE-SPACE MODEL

5.1 Controllability and Observability

5.2 Second Order System

6 NYQUIST PLOT

7 PHASE MARGIN

8 GAIN MARGIN

9 COMPENSATORS

9.1 Phase Lead

10 OSCILLATOR