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

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

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:

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

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

$$1 + G(s_1)H(s_1) = 0 \tag{3.1.3}$$

$$G(s_1) = -1 \tag{3.1.4}$$

$$|G(s_1)| = 1 \tag{3.1.5}$$

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

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

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

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

$$K = 25.05 \tag{3.1.10}$$

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

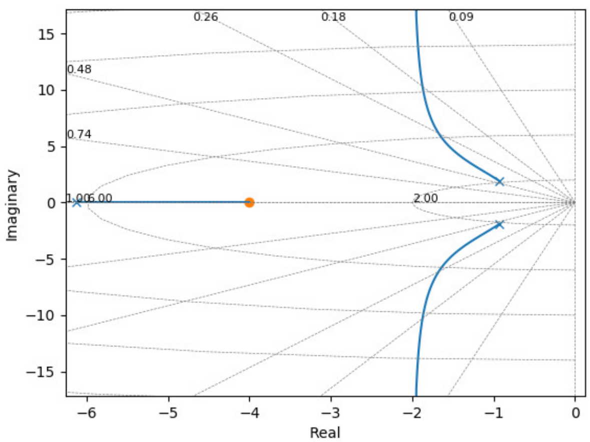

Fig. 3.1: Root locus plot for verification

$$Z_1 = -4, P_1 = -6.13, P_2 = -1 + j2, P_3 = -1 - j2$$

```
codes/ee18btech11052.py
```

3.2 Example

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4.1 Routh Array

4.2 Marginal Stability

4.3 Stability

5 State-Space Model

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6 Nyquist Plot

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