

Control Systems

G V V Sharma*

CONTENTS

1	Polar Plot	1
1.1	Introduction	1
1.2	Example	1
1.3	Example	1
1.4	Example	1
1.5	Example	1
1.6	Example	1
1.7	Example	1
2	Bode Plot	1
2.1	Gain and Phase Margin . . .	1
3	PID Controller	2
3.1	Introduction	2

Abstract—The objective of this manual is to introduce control system design at an elementary level.

Download python codes using

svn co <https://github.com/gadepall/school/trunk/control/ketan/codes>

1 POLAR PLOT

1.1 Introduction

1.2 Example

1.3 Example

1.4 Example

1.5 Example

1.6 Example

1.7 Example

2 BODE PLOT

2.1 Gain and Phase Margin

2.1. Using Nyquist criterion, find out whether the system below is stable or not

$$G(s) = \frac{41}{s^2(s+3)} \quad (2.1.1)$$

$$H(s) = (s+4) \quad (2.1.2)$$

Solution: According to the Nyquist criteria the number of unstable closed-loop poles (Z) is equal to the number of unstable open-loop poles (P) plus the number of clockwise encirclements (N) of the point (-1,j0) of the Nyquist plot of G(s)H(s), i.e

$$Z = N + P \quad (2.1.3)$$

Open loop transfer function :

$$G(s)H(s) = \frac{41(s+4)}{s^2(s+3)} \quad (2.1.4)$$

Closed loop transfer function:

$$T(s) = \frac{G(s)}{1 + G(s)H(s)} = \frac{41}{s^3 + 3s^2 + 41s + 164} \quad (2.1.5)$$

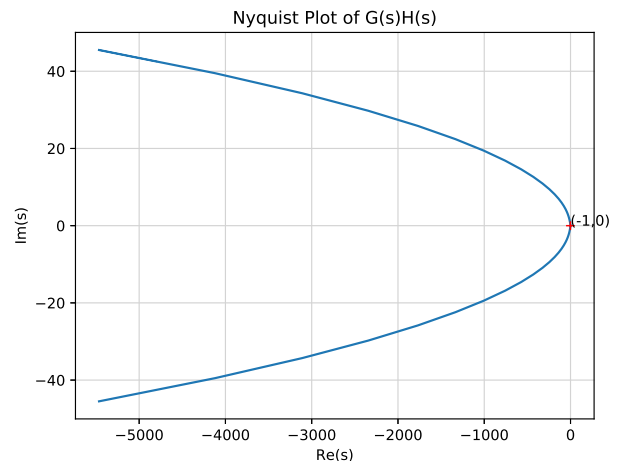


Fig. 2.1.1

*The author is with the Department of Electrical Engineering, Indian Institute of Technology, Hyderabad 502285 India e-mail: gadepall@iith.ac.in. All content in this manual is released under GNU GPL. Free and open source.

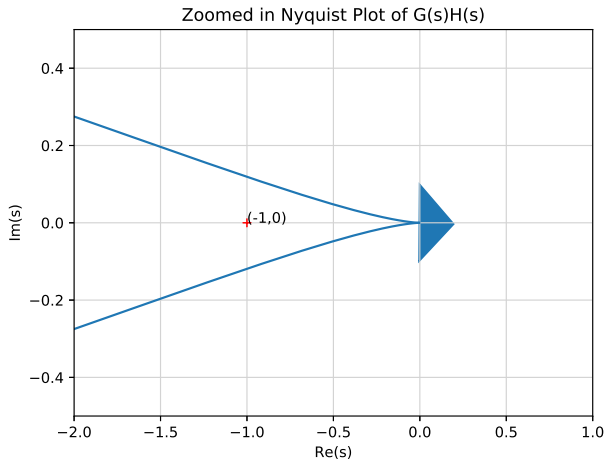


Fig. 2.1.2

In Fig.2.1.2 it can be seen that there is a clockwise encirclement around $(-1+0j)$. As the open loop transfer function has zero pole of multiplicity 2, therefore it should be assumed that the phasor travels 2 times clock-wise along a semicircle of infinite radius.

$$N=2, P=0$$

$$\Rightarrow Z = 2 \quad (2.1.6)$$

Therefore, The system $T(s)$ is unstable as it has two poles on the right side of the s plane. The following code generates the nyquist plot

```
codes/ee18btech11041.py
```

3 PID CONTROLLER

3.1 Introduction