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

1 Signal Flow Graph

1.1 Mason's Gain Formula

1.2 Matrix Formula

2 Bode Plot

2.1 Introduction

2.2 Example

3 Second order System

3.1 Damping

3.2 Example

4 Routh Hurwitz Criterion

4.1 Routh Array

4.2 Marginal Stability

4.3 Stability

4.4 Example

5 State-Space Model

5.1 Controllability and Observability

5.2 Second Order System

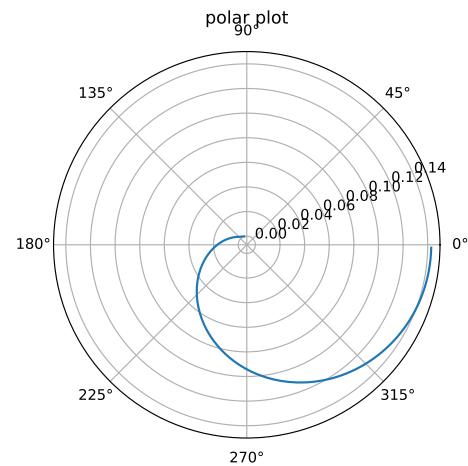## 5.3 Example

5.4 Example

6 Nyquist Plot

6.1 Polar plots

6.1. Plot the polar plot of

$$G(s) = \frac{1}{(s+1)(s+2)(s+3)}. \qquad (6.1.1)$$

Solution: For polar plot we have to plot magnitude of $G(s)$ versus its phase by varying ω from 0 to ∞. The polar plot looks like,
The following python code generates the above polar plot:

codes/ee18btech11033.py

polar plot

6.2. Consider the above open loop transfer function

$$G(s) = \frac{1}{(s+1)(s+2)(s+3)}. \qquad (6.2.1)$$

Is the system stable(using polar plot)?
Solution: The polar plots are for open loop transfer function,hence the reference point for determining stabilityis shifted to (-1,0). Since for the above question (-1,0) is not enclosed by polar plot,the closed loop system is stable.

7 Compensators

7.1 Phase Lead

7.2 Example

8 Gain Margin

8.1 Introduction

8.2 Example

9 Phase Margin

10 Oscillator

10.1 Introduction

10.2 Example