Control Systems

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Contents

***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 PID Controller

1.1 Introduction

2 Polar Plot

2.1 Introduction

2.1. Sketch the direct polar plot for a unity feedback system with open loop transfer function

$$G(s) = \frac{1}{s(1+s)^2} \tag{2.1.1}$$

Solution: The polar plot is obtained by plotting (r, ϕ)

$$r = |H(\jmath\omega)||G(\jmath\omega)| \tag{2.1.2}$$

$$\phi = \angle H(\jmath\omega)G(\jmath\omega), 0 < \omega < \infty \tag{2.1.3}$$

The following code plots the polar plot in Fig. 2.1

```
codes/ee18btech11002/polarplot.py
```

2.2. Sketch the inverse polar plot for (2.1.1)
Solution: The above code plots the polar plot in Fig. 2.2 by plotting $\left(\frac{1}{r}r, -\phi\right)$

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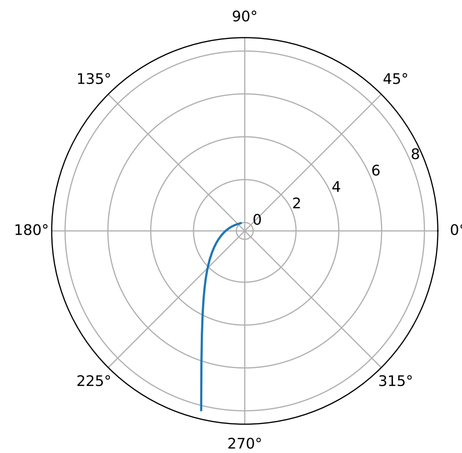

Fig. 2.1: Polar Plot

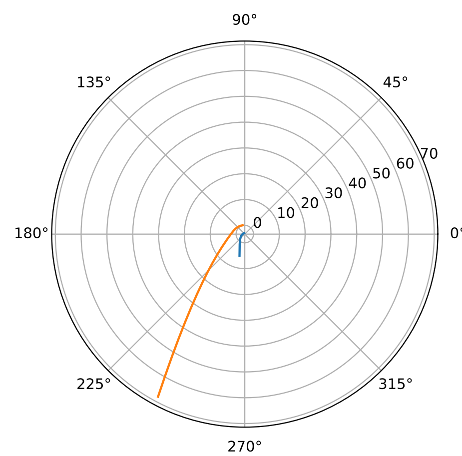

Fig. 2.2: Inverse Polar Plot

2.2 Example

2.3 Example

2.1. Sketch the Polar Plot of

$$G(s) = \frac{1}{s(1+s^2)} \tag{2.1.1}$$

Solution: From ,

$$G(\jmath\omega) = \frac{1}{\jmath\omega(1-\omega^2)} \tag{2.1.2}$$

$$\left|G(\jmath\omega)\right| = \frac{1}{\left|\omega(1-\omega^2)\right|} \tag{2.1.3}$$

$$\angle G(\jmath\omega) = \begin{cases} \frac{\pi}{2} & \omega > 1 \\ -\frac{\pi}{2} & 0 < \omega < 1 \end{cases} \tag{2.1.4}$$

The corresponding polar plot is generated in Fig. 2.1 using

codes/ee18btech11023.py

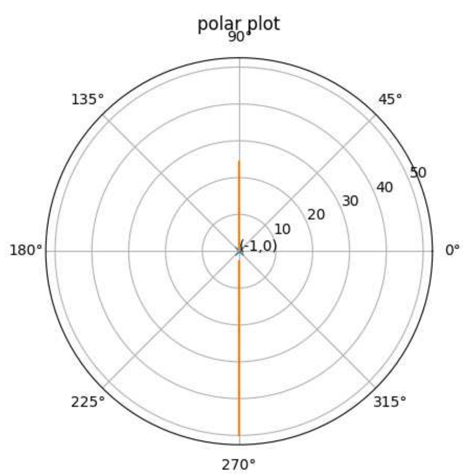

Fig. 2.1

2.2. Stability

for the given transfer function

$$G(s) = \frac{1}{s(1+s^2)} \tag{2.2.1}$$

The polar plots use open loop transfer function, hence the reference point for determining stability is shifted to (–1, 0)

If (–1,0) is exactly on the polar plot then the system is marginally stable polar plot useful to find the stability of given transfer function from the graph we can see that (-1,0) is lying exactly on polar plot

so the system is marginally stable