CONTENTS

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

1 STABILITY

2 ROUTH HURWITZ CRITERION

3 COMPENSATORS

4 NYQUIST PLOT

4.1 Polar plot

4.1. Sketch the Polar Plot for

$$G(s) = \frac{1}{(1 + s)(1 + 2s)} \quad (4.1.1)$$

Solution: Then the given open loop Transfer Function is

$$G(s) = \frac{1}{(1 + s)(1 + 2s)} \quad (4.1.2)$$

Now we have to substitute s=jω

$$G(\jmath\omega) = \frac{1}{(1 + \jmath\omega)(1 + 2\jmath\omega)} \quad (4.1.3)$$

4.2. Then find the Magnitude of the Transfer Function
Solution:

$$|G(\jmath\omega)| = \frac{1}{\sqrt{(1 + (\omega^2))(1 + (2\omega)^2}} \quad (4.2.1)$$

4.3. Next find the Phase of Transfer Function
Solution:

$$\angle G(\jmath\omega) = \angle G(\jmath\omega)_{num} - \angle G(\jmath\omega)_{den} \quad (4.3.1)$$
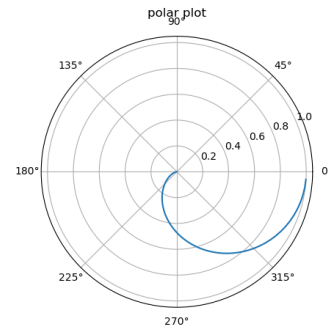

Fig. 4.4: Polar plot of given transfer function

$$\angle G(\jmath\omega) = -\tan^{-1}(\omega) - \tan^{-1}(2\omega) \quad (4.3.2)$$

4.4. Polar plot is drawn based on this magnitude and phase of transfer function
Solution:
For ω=0

$$|G(\jmath\omega)| = 1 \quad (4.4.1)$$
$$\angle G(\jmath\omega) = 0 \quad (4.4.2)$$

For w= ∞

$$|G(\jmath\omega)| = 0 \quad (4.4.3)$$
$$\angle G(\jmath\omega) = -\pi \quad (4.4.4)$$

Next Polar Plot is drawn by varying ω from 0 to ∞.

4.5. Verify the Polar Plot by running the following Code

codes/ ee18btech11012_1.pyc

4.6. What actually is a polar plot
The polar plot of the frequency response of a system is the line traced out as the frequency is changed from 0 to infinity by the tips of the phasors whose lengths represent the magnitude, i.e. amplitude gain, of the system and which are drawn at angles corresponding to their phase

4.7. Uses of Polar plots in control systems:
1.This is a technique which comes under frequency domain analysis.
2.It can capture the system behavior over the entire frequency range in a single plot.
3.Much easier to determine both $\omega_{pc} and \omega_{gc}$.

4.Here we will have to work with open loop transfer function G(s)H(s) (and not with closed loop transfer function and unlike Bode plot we need not required to convert G(s)H(s) to the time constant form).

5.polar plot tells about the magnitude and phase contribution of system at various frequency of a transfer function which is important in control systems.

6.Polar plot consists of concentric circles and radial lines showing the magnitude and phase of transfer function respectively.

7.If we know type and order of a transfer function,we can easily draw its magnitude versus phase plot using polar plot.

8.This is half of Nyquist plot running over positive frequencies.