VASAVI COLLEGE OF ENGINEERING

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(Affiliated to Osmania University)

Hyderabad - 500 031.

DEPARTMENT OF : ECE

NAME OF THE LABORATORY : CSE

Name G.Sri Ganga Pranav Roll No. 1602-21-735-117 Page No.

Stability of open loop/closed loop system using Nyquist plot

Aim:- To analyse the stability of open loop/closed loop system using Nyquist plot

Apparatus:

Tools required:- A PC loaded with MATLAB

Theory:-

Nyquist plot is crucial for analyzing the stability of both open loop and closed loop systems. It provides a graphical representation of the system's frequency response

For open-loop systems, the nyquist plot helps determine stability by examining how the system's frequency response behaves as frequency varies. Specifically it allows engineers to evaluate if the system's transfer function encircles the critical point of $-1+j0$ in the complex plane. If it does, the system is unstable.

In closed loop systems, the Nyquist plot is used to analyze the stability of the feedback system. By plotting the transfer function of the open loop system and the transfer function of feedback loop, engineers can determine stability by checking if the Nyquist plot encloses the critical point. If the plot encircles the critical point in the clockwise direction, the system is unstable.

(i) $G(s) = \frac{1}{(s+1)^2} = \frac{1}{(1+s)(1+s)}$.

$$Mag = \frac{1}{\sqrt{1+\omega^2}\sqrt{1+\omega^2}} = \frac{1}{1+\omega^2} \qquad Phase = -2\tan^{-1}(\omega)$$

At $\omega = 0$, $Mag = 1$, $phase = 0^\circ$

At $\omega = \infty$, $Mag = 0$, $phase = -180^\circ$

Here we have only poles

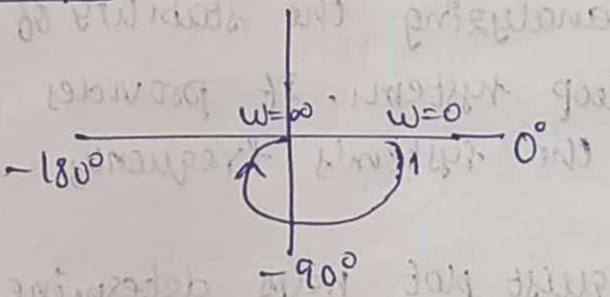
$\Rightarrow$ Starting point: clockwise

$Sph - Eph = 0^\circ - (-180^\circ) = 180^\circ = +ve$

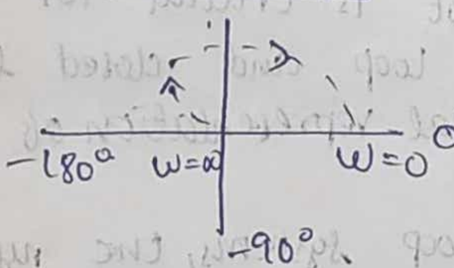
$\Rightarrow$ Ending point: clockwise

Magnitude starts at 1 and ends at 0.

Polar plot :-



Inverse polar plot :-



$N = 0$ (number of encirclements around $(-1, j0)$ is 0)

$P = 0$; $N = P - Z \Rightarrow Z = 0$

$\Rightarrow$ System is stable since $P = 0$, $Z = 0$.

(ii) $G(s) = \frac{s}{s+1}$

		$\omega = 0$	$\omega = \infty$
Mag:	$\frac{\omega}{\sqrt{\omega^2+1}}$	0	1
phase:	$90 - \tan^{-1}(\omega)$	90°	0°

SP ~~Sph~~ : pole : clockwise

~~EP Eph~~ : EP : $Sph - Eph = 90^\circ - 0^\circ = 90^\circ \Rightarrow +ve$

$\Rightarrow$ clockwise

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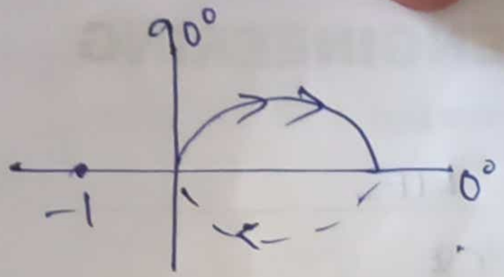
Program:-

```
clc;
clear;
close all;
s=tf('s')
g= 1/((s+1)*(s+1))
cl1 = feedback(g,1)
nyquist(g)
figure;
g2 = s/(s+1)
nyquist(g2)
cl2 = feedback(g2,1)
figure;
g3 = (4*s+1)/(s*s*(s+1)*(2*s+1))
nyquist(g3)
axis([-20 2 -5 5])
cl3=feedback(g3,1)
figure;
stepplot(g);
figure;
stepplot(g2);
figure;
stepplot(g3);
figure;
```



N = no. of encirclements around $(-1, j0)$ is 0

$= 0$

$P = 0, \; Z = 0$

$\Rightarrow$ system is stable since $P = 0, Z = 0$

(iii) $G(s) = \dfrac{4s+1}{s^2(s+1)(2s+1)}$

Mag : $\dfrac{\sqrt{1+16\omega^2}}{\omega^2\left(\sqrt{\omega^2+1}\,\sqrt{4\omega^2+1}\right)}$

phase :- $\tan^{-1}(4\omega) - 2\tan^{-1}(0) - \tan^{-1}(\omega) - \tan^{-1}(2\omega)$

	Mag	phase
$\omega = 0$	∞	$-180°$
$\omega = \infty$	0	$-270°$

zeroes : $-1/4$

Poles : $-1, -1/2$

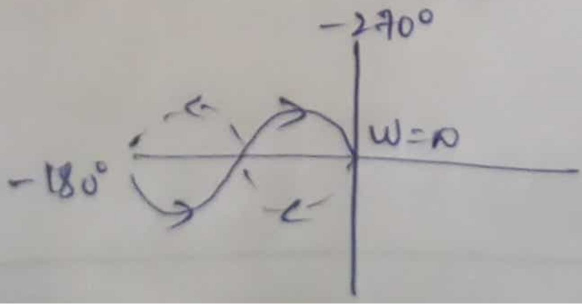
Zero is nearer to origin

$\Rightarrow$ starting point : clockwise

$Sph - Eph = -180° + 270°$

$= 90° = +ve$

$\Rightarrow$ clockwise



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```
stepplot(cl1);
figure;
stepplot(cl2);
figure;
stepplot(cl3);
figure;
pzmap(g);
figure;
pzmap(g2);
figure;
pzmap(g3);
```

Result:- Analyzed the open loop/closed loop system stability using nyquist plot