Control Systems LAB Digital Assignment 8

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Faculty: **Professor Dhanamjayalu C**

Course: **EEE-3001**

Course Name: **Control Systems Lab**

Lab Slot: **L45 + L46**

Stability Determination using Polar Plot

Exp No: 8

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AIM

1. Stability determination of a system using Polar Plot

APPARATUS REQUIRED

Personal Computer with MATLAB.

THEORY

1. Polar plot is a plot which can be drawn between magnitude and phase. Here, the magnitudes are represented by normal values only. The polar form G(jw)H(jw)=—G(jw)H(jw)—angle(G(jw)H(jw)) The Polar plot is a plot, which can be drawn between the magnitude and the phase angle of G(jw)H(jw) by varying w from zero to . The plot consists of concentric circles and radial lines. The concentric circles and the radial lines represent the magnitudes and phase angles respectively. These angles are represented by positive values in anti-clock wise direction. Similarly, we can represent angles with negative values in clockwise direction. For example, the angle 270^{o} in anti-clock wise direction is equal to the angle 90^{o} in clockwise direction.

PROBLEM STATEMENT

Write a program in MATLAB to obtain the Polar Plot of the following function

$$G(s)H(s) = \frac{1}{(1+s)(1+2s)(1+3s)}$$

PROCEDURE

1. Enter the command window of the MATLAB
2. Create a new M-file by selecting File-New-M-file
3. type and save the program
4. Execute the program by either pressing F5 or Debug-Run
5. View the results
6. Analyze the stability of the system.

SOLUTION

$$G(s)H(s) = \frac{1}{(1+s)(1+2s)(1+3s)}$$

$$= \frac{1}{(1+2s+s+2s^2)(1+3s)}$$

$$= \frac{1}{1+3s+2s^2+3s+9s^2+6s^3}$$

$$= \frac{1}{6s^3+11s^2+6s+1}$$

```
clc;
close all;
clear all;
num = [1];
den = [6 11 6 1];
G = tf(num,den)
[MAG,PHASE] = bode(G);
PHASE=PHASE(1,:);
MAG = MAG(1, : );
polar(PHASE*pi/180, MAG)
```

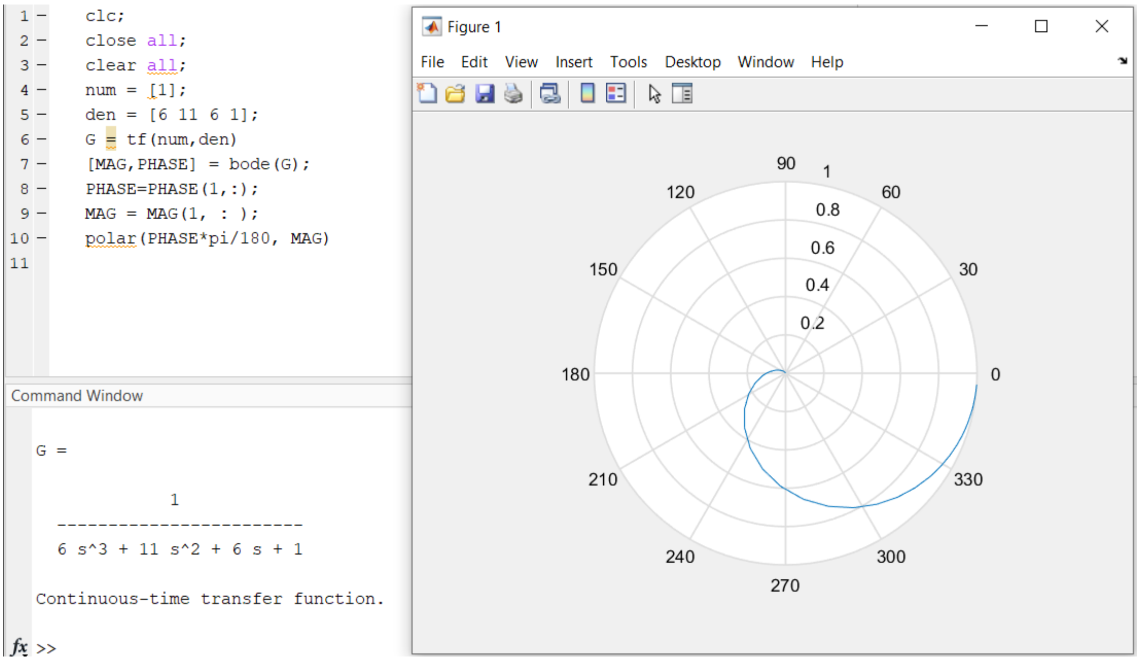
The output of the program will be

```
G =

         1
  -----------------------
  6 s^3 + 11 s^2 + 6 s + 1

Continuous-time transfer function.
```

SYSTEM RESPONSE



POSSIBLE INFERENCES

1. 1. The direction of polar plot will be from $= 0$ to $=$.
2. The polar plots use open loop transfer function, hence the reference point for determining stability is shifted to (-1,0). For closed loop, q(s) = 1 + G(s)H(s) $\rightarrow$ (0, 0) For polar plot, G(s)H(s) $\rightarrow$ (-1,0)
3. If (-1,0) is left of the polar plot or (-1,0) is not enclosed by it then closed loop system is stable. Here closed loop system is corresponding to the open loop transfer function for which the polar plot is sketched.
4. If (-1,0) is on right side of the polar plot or (-1,0) is enclosed by polar plot then closed loop system is unstable.
5. If (-1,0) is on the polar plot then the closed loop system is marginally stable.