Control Systems LAB Digital Assignment 7

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Faculty: **Professor Dhanamjayalu C**

Course: **EEE-3001**

Course Name: **Control Systems Lab**

Lab Slot: **L45 + L46**

Stability Determination using Nyquist Plot

Exp No: 7

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AIM

1. Stability determination of a system using Nyquist plot

THEORY

1. Nyquist plots are the continuation of polar plots for finding the stability of the closed loop control systems by varying from – to . That means, Nyquist plots are used to draw the complete frequency response of the open loop transfer function. The Nyquist stability criterion works on the principle of argument. It states that if there are P poles and Z zeros are enclosed by the 's' plane closed path, then the corresponding G(s)H(s) plane must encircle the origin P-Z times. So, we can write the number of encirclements N as

   N=P-Z

2. If the enclosed 's' plane closed path contains only poles, then the direction of the encirclement in the G(s)H(s) plane will be opposite to the direction of the enclosed closed path in the 's' plane.

3. If the enclosed 's' plane closed path contains only zeros, then the direction of the encirclement in the G(s)H(s) plane will be in the same direction as that of the enclosed closed path in the 's' plane

4. Nyquist stability criterion states the number of encirclements about the critical point (1+j0) must be equal to the poles of characteristic equation, which is nothing but the poles of the open loop transfer function in the right half of the 's' plane. The shift in origin to (1+j0) gives the characteristic equation plane

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

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

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

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

The output of the program will be

```
fun =

       1

  ----------------

  s^3 + 3 s^2 + 2 s


Continuous-time transfer function.
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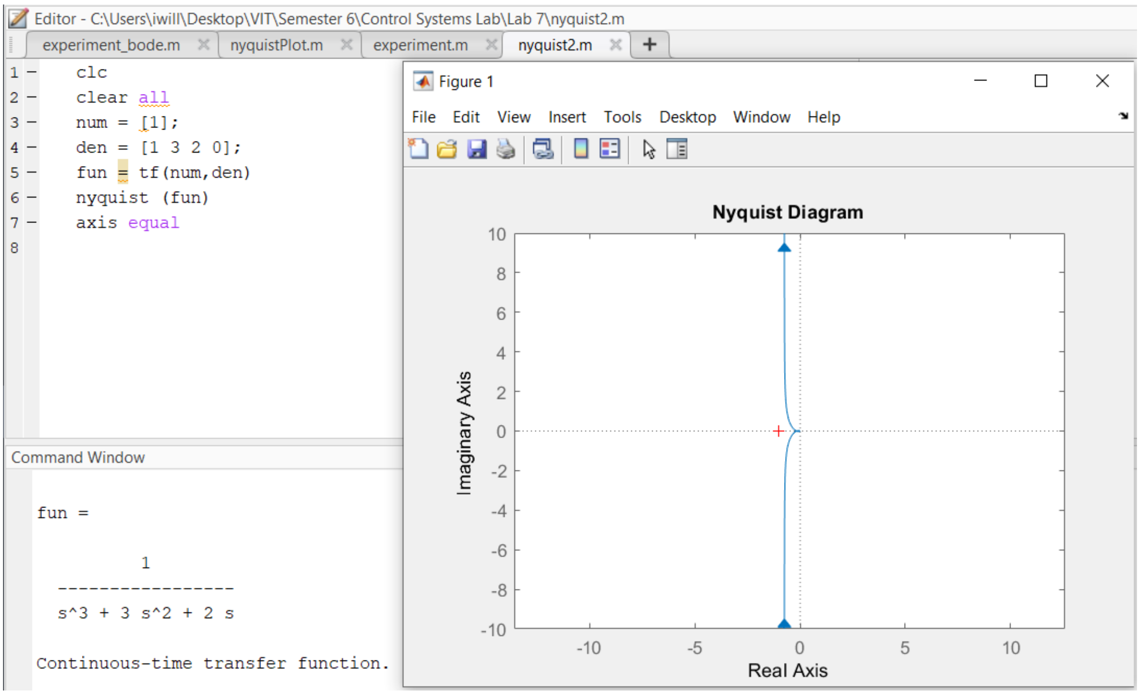
SYSTEM RESPONSE



POSSIBLE INFERENCES

1. The frequency at which the Nyquist plot intersects the negative real axis (phase angle is 180º) is known as the phase cross over frequency. It is denoted by pc.
2. The frequency at which the Nyquist plot is having the magnitude of one is known as the gain cross over frequency. It is denoted by gc.
3. If the phase cross over frequency pc is greater than the gain cross over frequency gc, then the control system is stable.
4. If the phase cross over frequency pc is equal to the gain cross over frequency gc, then the control system is marginally stable.
5. If phase cross over frequency pc is less than gain cross over frequency gc, then the control system is unstable.
6. The gain margin ‘GM’ is equal to the reciprocal of the magnitude of the Nyquist plot at the phase cross over frequency.
7. The phase margin ‘PM’ is equal to the sum of 180º and the phase angle at the gain cross over frequency.
8. If the gain margin ‘GM’ is greater than one and the phase margin ‘PM’ is positive, then the control system is stable.
9. If the gain margin ‘GM’ is equal to one and the phase margin ‘PM’ is zero degrees, then the control system is marginally stable.

10. If the gain margin ‘GM’ is less than one and/or the phase margin ‘PM’ is negative, then the control system is unstable.