Faculty of Engineering

Computer and Systems Engineering Department

CSE 371: Control Systems (1)

Instructor: Prof. Wahied Gharieb Ali

Assignment #2

Frequency Domain Analysis

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Section: **3**

Bench Number: **33860**

Fall (2015/2016)

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Problem Formulation

By using MATLAB, find the Bode Diagram, Phase Margin, Gain Margin and Nyquist Diagram, also check for system stability.

Background

Bode Diagram is used for frequency domain analysis.
Phase Margin & Gain Margin curves help to understand the system behavior and help in control design, although used to investigate the stability of the system.
Nyquist Diagram determines the stability of closed loop system from its open loop frequency response and open loop poles.

Problems

a) $G(s) = \frac{(s+2)(s+6)}{s^2+8s+25}$

Bode Diagram of problem (a)

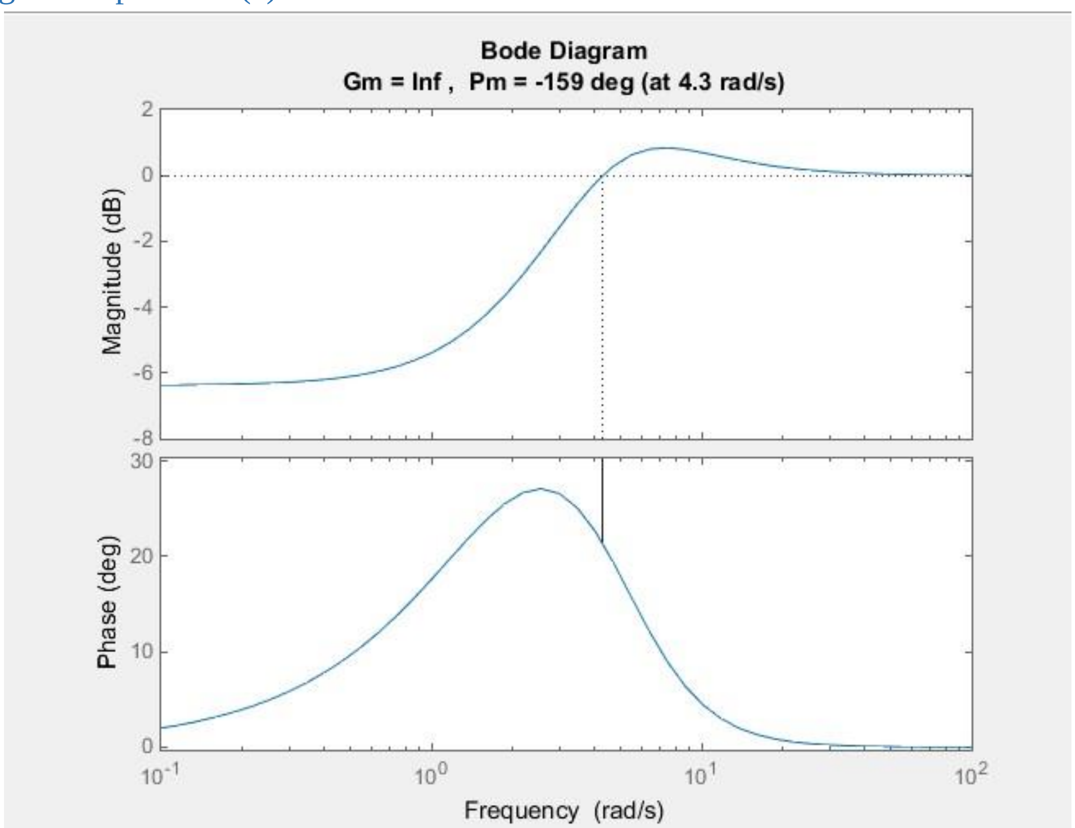

Figure 1: Bode Diagram of problem (a) with PM and GM

Nyquist Diagram of problem (a)

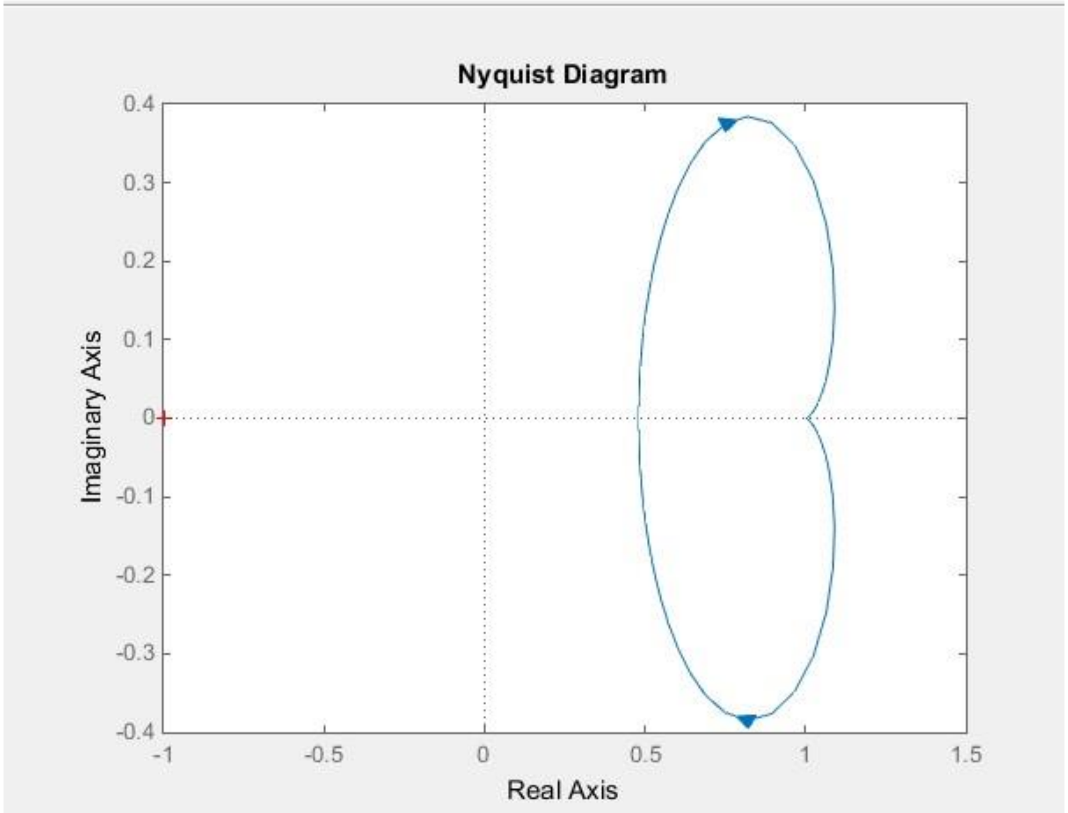

Figure 2: Nyquist Diagram of problem (a)

Since N=0, P=0, Z=0, Therefore system is **stable**

By using MATLAB command “isstable” to check system stability, the answer comes 1 which means system is stable.

Conclusion Since the Nyquist diagram didn’t encircles -1, Therefore the value of N=0 and there is no poles in the right half plan of closed loop system, Therefore Z=0 hence, system is stable.

b) $G(s) = \frac{5(s^2+4)}{s^2+1}$

Bode Diagram of problem (b)

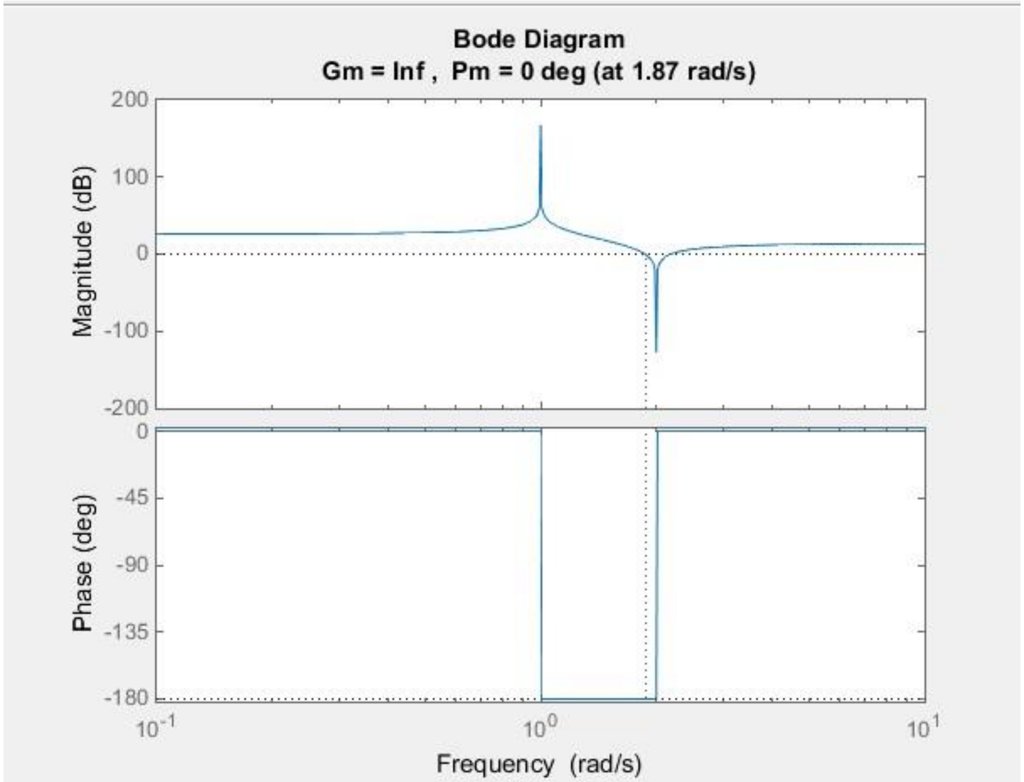

Figure 3: Bode Diagram of problem (b) with PM and GM

Nyquist Diagram of problem (b)

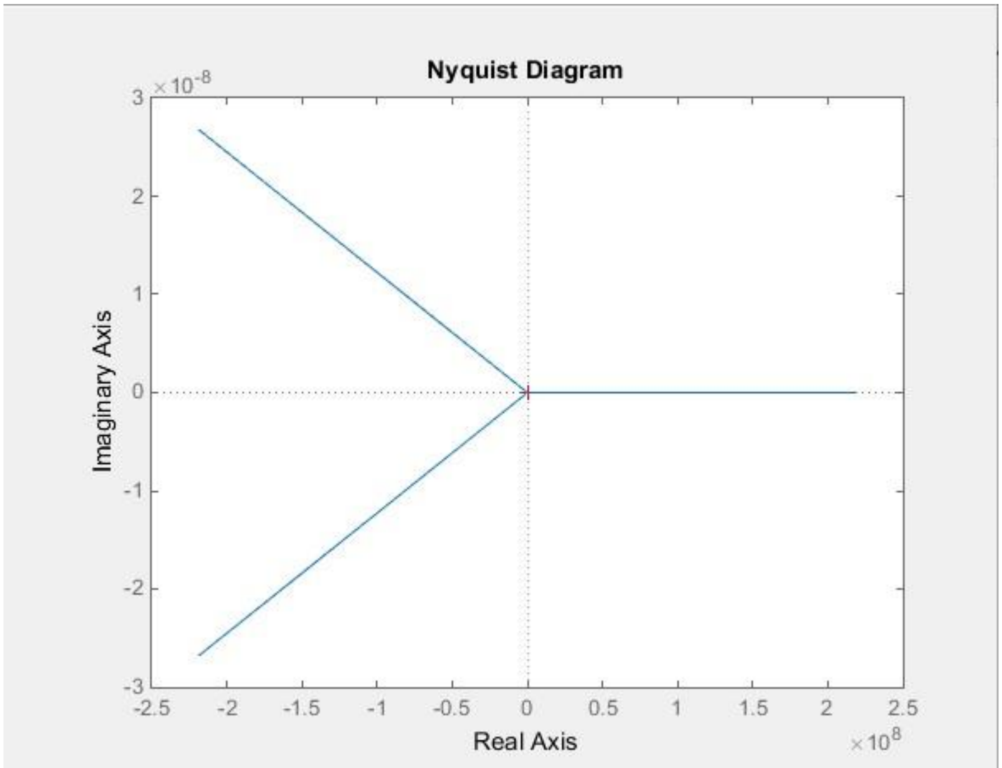

Figure 4: Nyquist Diagram of problem (b)

Since N=0, P=0, Z=0, Therefore system is **stable**

By using MATLAB command "isstable" to check system stability, the answer comes 1 which means system is stable.

Conclusion**:** Since the Nyquist Diagram didn't encircle -1, therefore N=0
and there is no poles in the right half plan of closed loop system, therefore Z=0
but we notice here that the poles are on the imaginary axis which mean that the system is at boundary of stability.

c) $G(s) = \frac{10(s^2+1)}{s^2}$

Bode Diagram of problem (c)

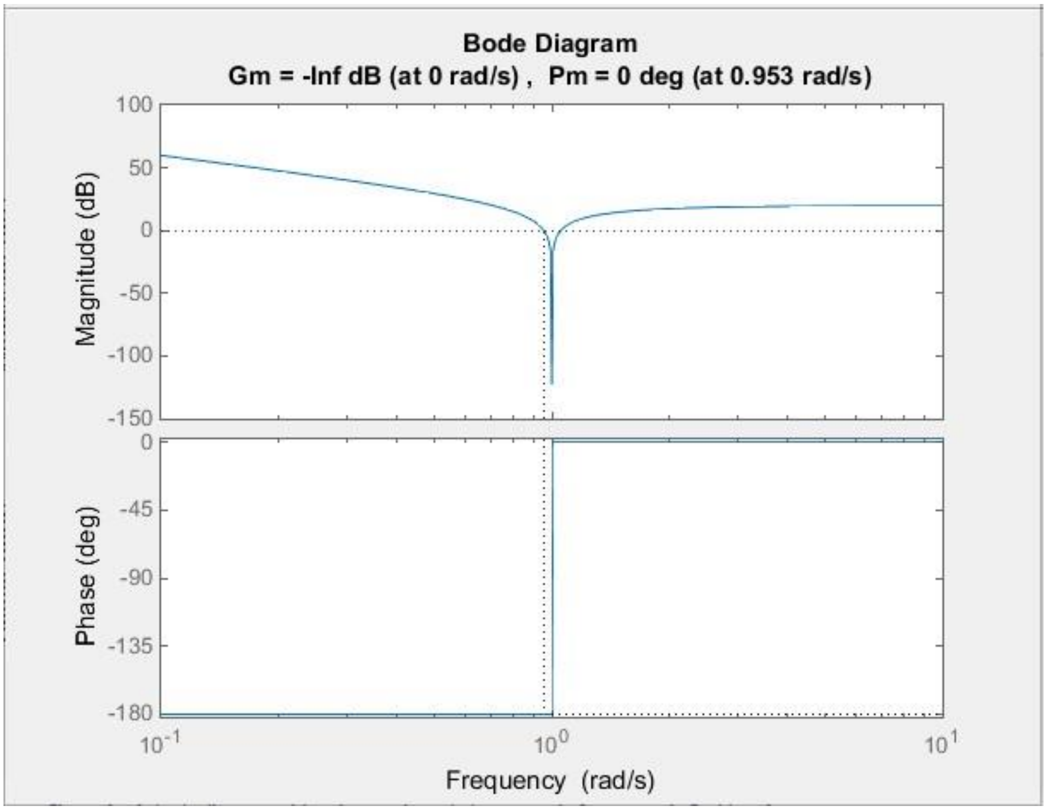

Figure 5: Bode Diagram of problem (c) with PM and GM

Nyquist Diagram of problem (c)

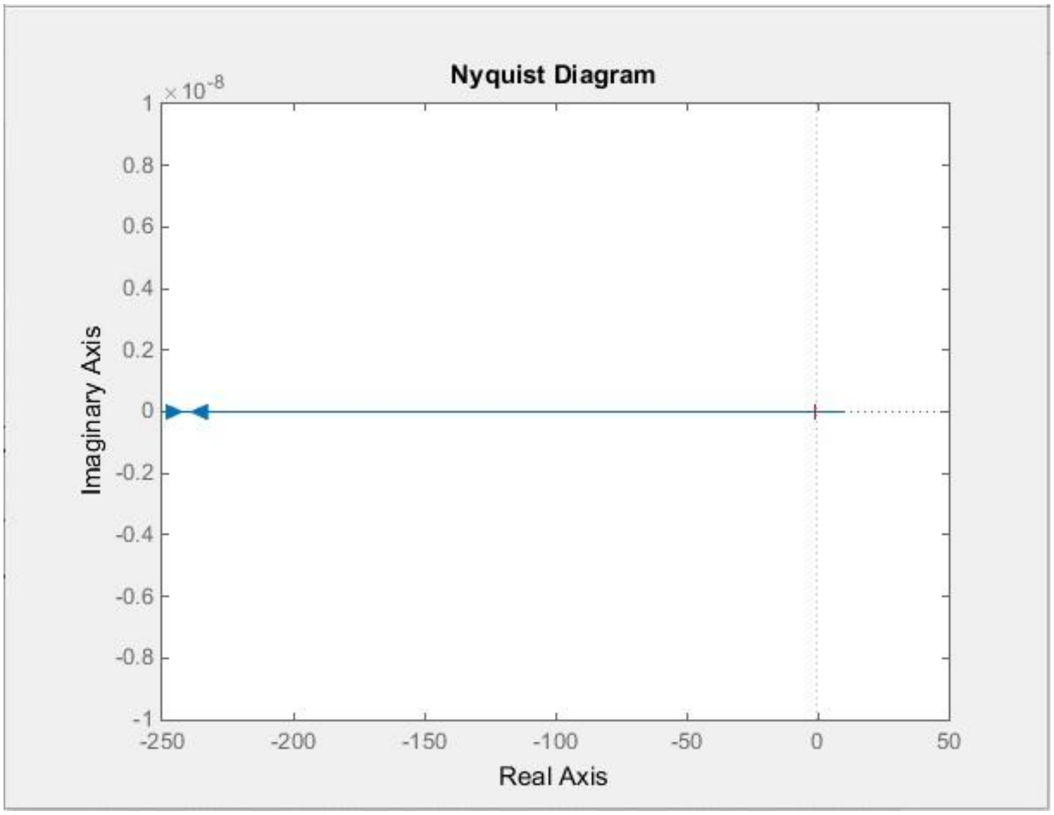

Figure 6: Nyquist Diagram of problem (c)

Since N=1, P=0, Z=0, Therefore condition Z=P+N is not satisfied
hence system is **unstable**

By using MATLAB command "isstable" to check system stability, the answer comes 0 which means system is unstable.

<u>Conclusion</u>**:** Since the Nyquist Diagram encircles -1, therefore N=1

d) $G(s) = \frac{1}{(s+1)^3(s+4)}$

Bode Diagram of problem (d)

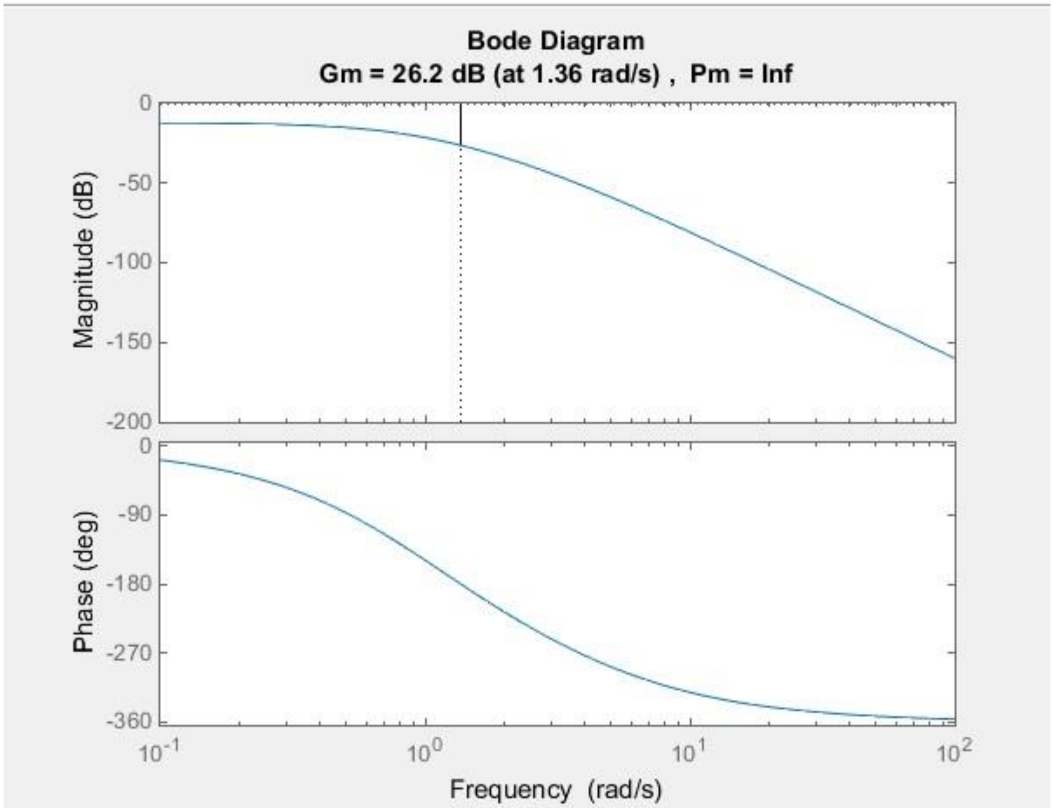

Figure 7: Bode Diagram of problem (d) with PM and GM

Nyquist Diagram of problem (d)

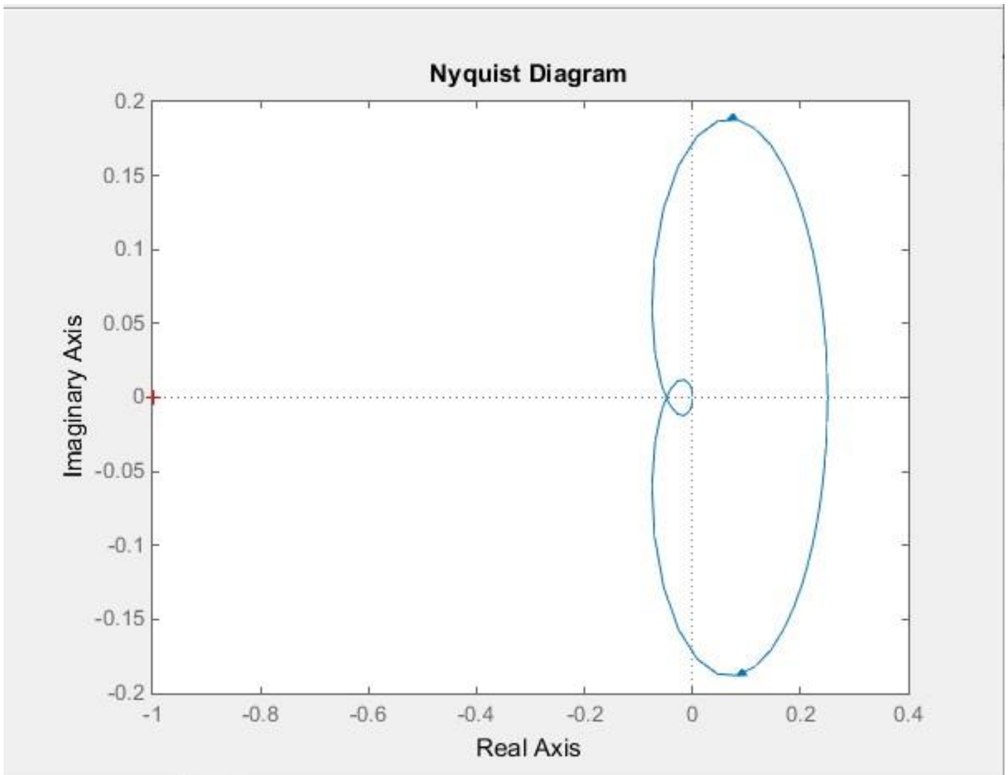

Figure 8: Nyquist Diagram of problem (d)

Since N=0, P=0, Z=0, Therefore system is **stable**

By using MATLAB command "isstable" to check system stability, the answer comes 1 which means system is stable.

Conclusion Since the Nyquist diagram didn't encircles -1, therefore the value of N=0 and there is no poles in the right half plan of closed loop system, Therefore Z=0 hence, system is stable.