EENG307: Intro to Feedback Control

Fall 2020

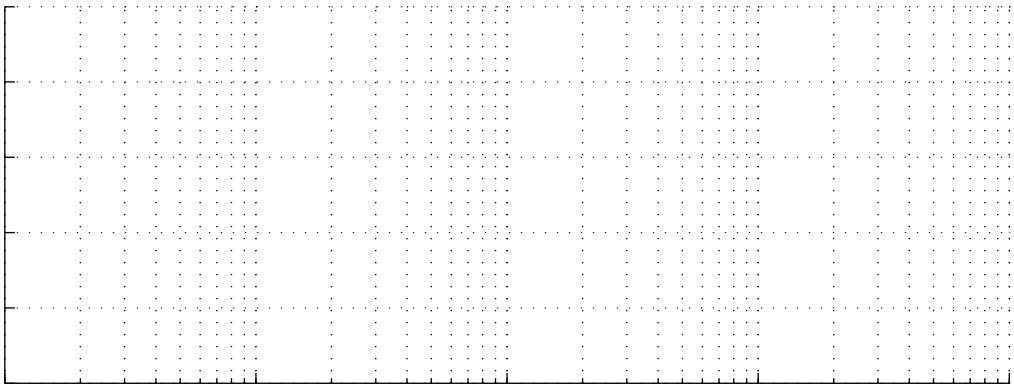
Homework Assignment #10

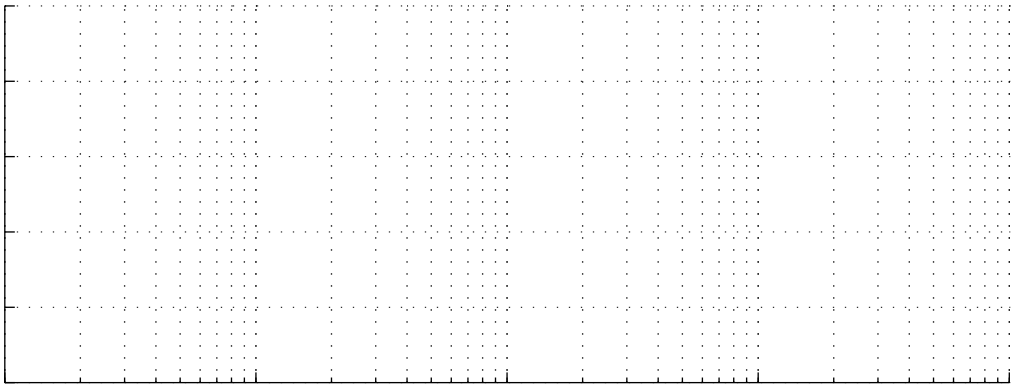
Due: Monday, Nov 16th, 11:59pm

1. Using the provided log axes, sketch the Bode plot (using linear approximation rules) for the system

$$G(s) = 4000\frac{s^2 + 4s + 4}{s(s + 10)(s + 100)}.$$

For full credit, label and scale each axis. Indicate the slope of each segment, and the magnitude and phase at each break point.





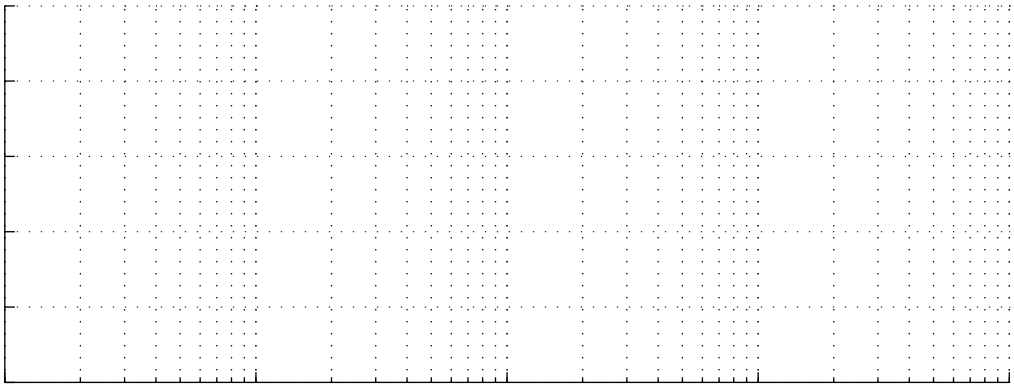
2. Using the provided graph paper, plot the frequency response of the system

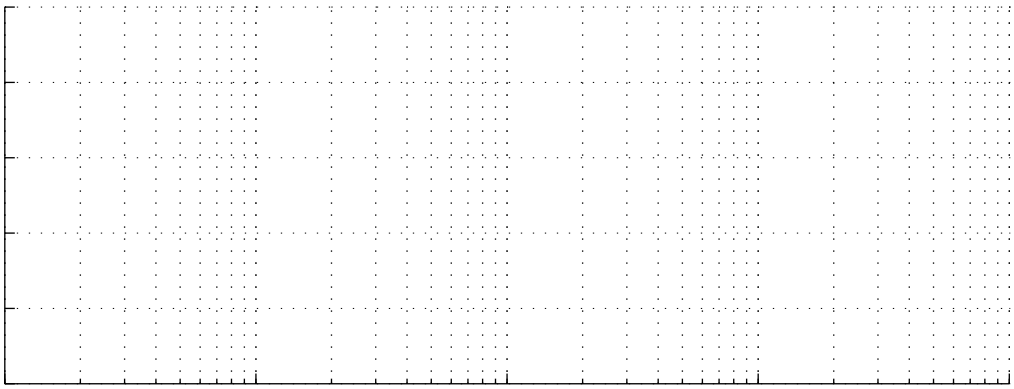
$$G(s) = \frac{s}{(s - 10)(s^2 + 1s + 4)}$$

using standard linear Bode plot approximations.

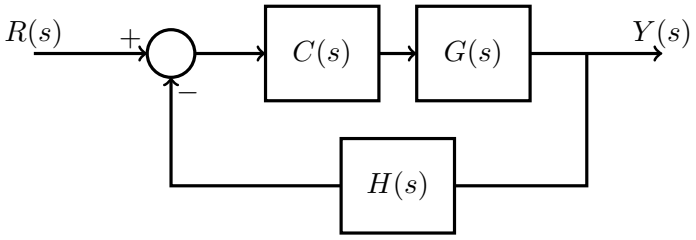
(a) Label and scale all axes, indicate the slope of each segment, and indicate the magnitude/phase at each break point.

(b) According to your sketch, what is $|G(j\omega)|$ and $\angle G(j\omega)$ for $\omega = 3$?





3. Consider the following feedback system.



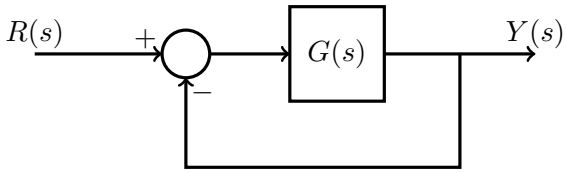
Suppose

$$L(s) = H(s)G(s)C(s) = \frac{K}{s^3 + 9s^2 + 30s + 40}$$

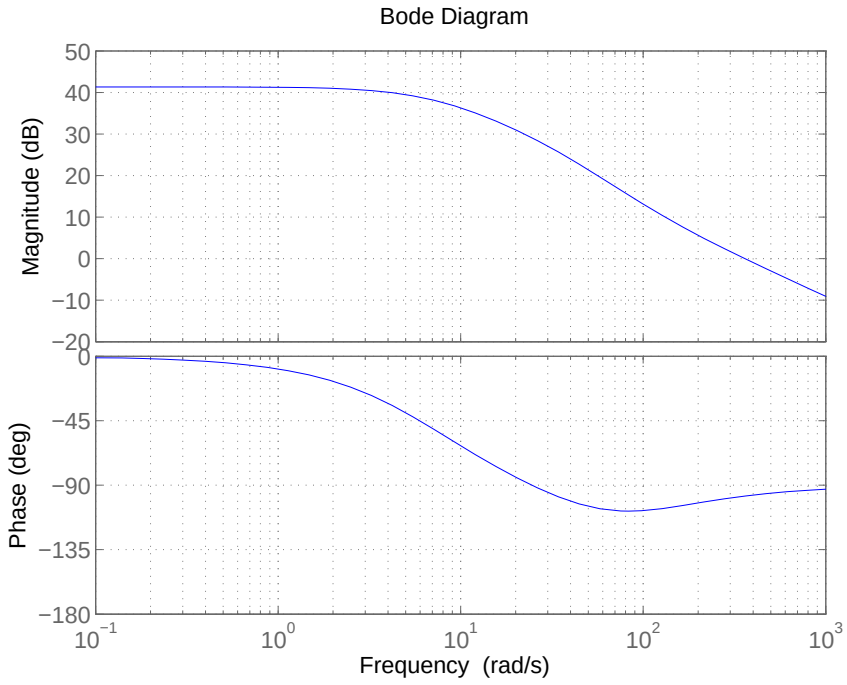
(a) Using MATLAB, find the Bode plots for $K = 50$ and $K = 500$.

(b) By hand, sketch the Nyquist plots for each case, and evaluate if the closed loop system is stable.

4. Consider the following feedback system.

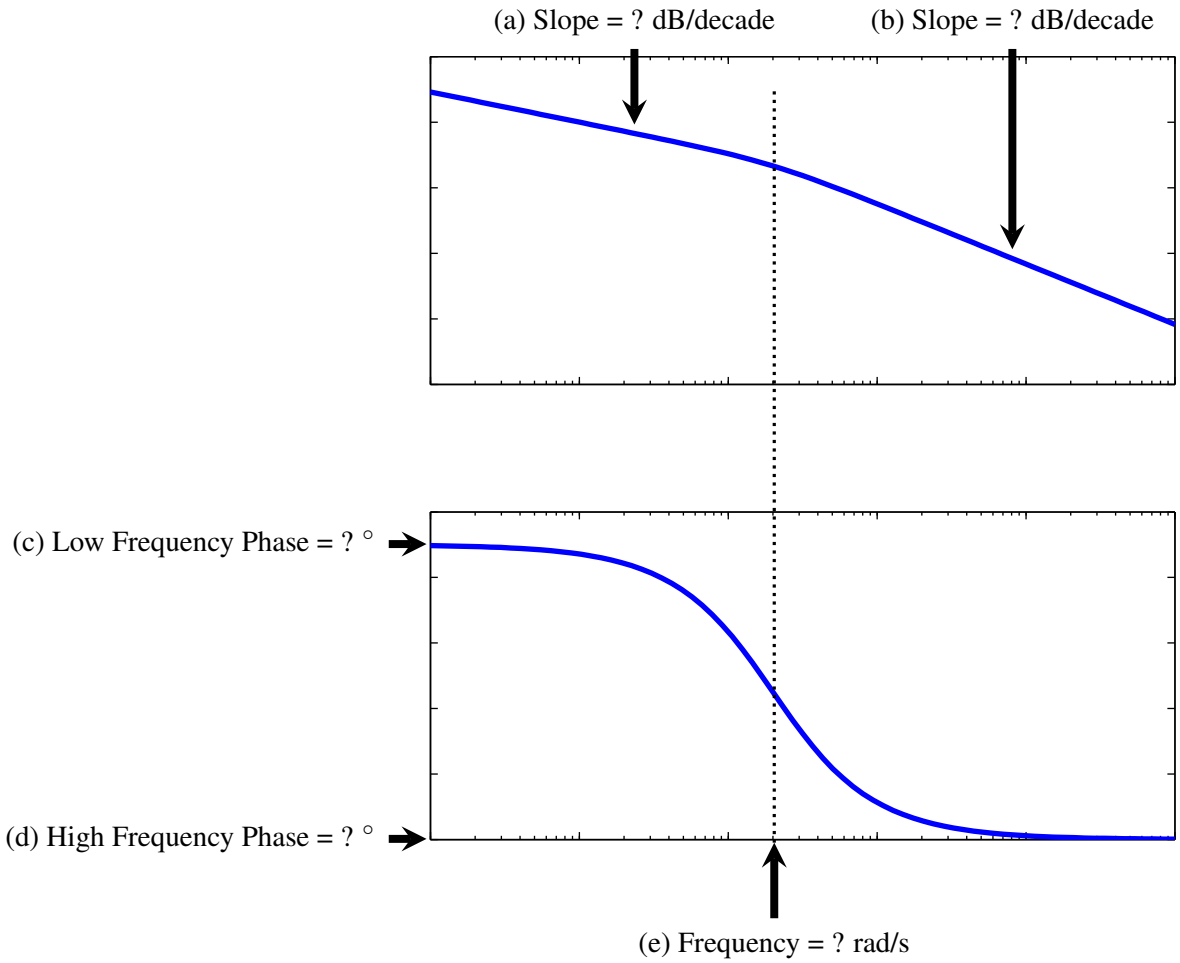


$G(s)$ is a BIBO stable system, and the frequency response for $G(s)$, is shown below. Sketch the Nyquist plot and explain why the closed loop system is stable.

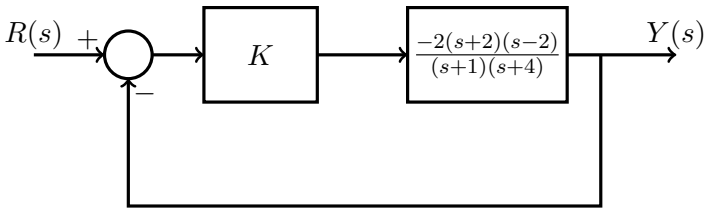


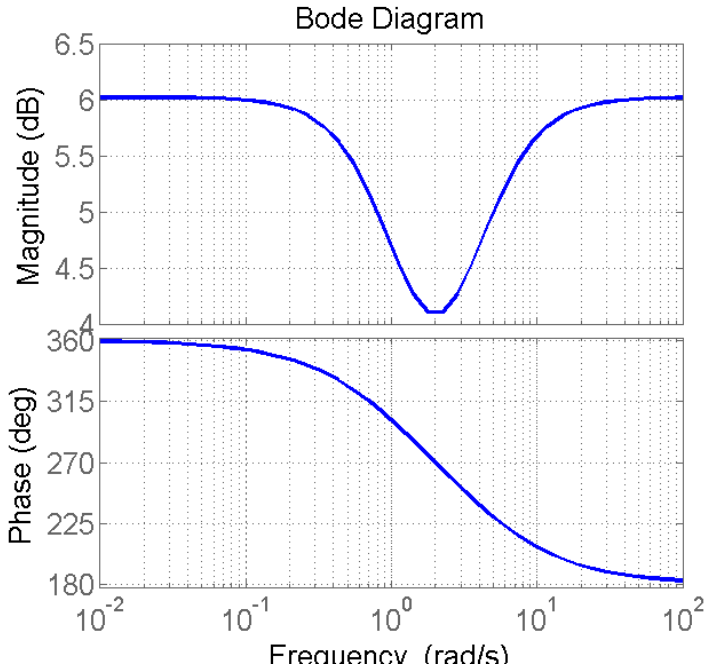
5. Quiz Question Friday: Find the following quantities indicated below if this is the Bode plot for the system

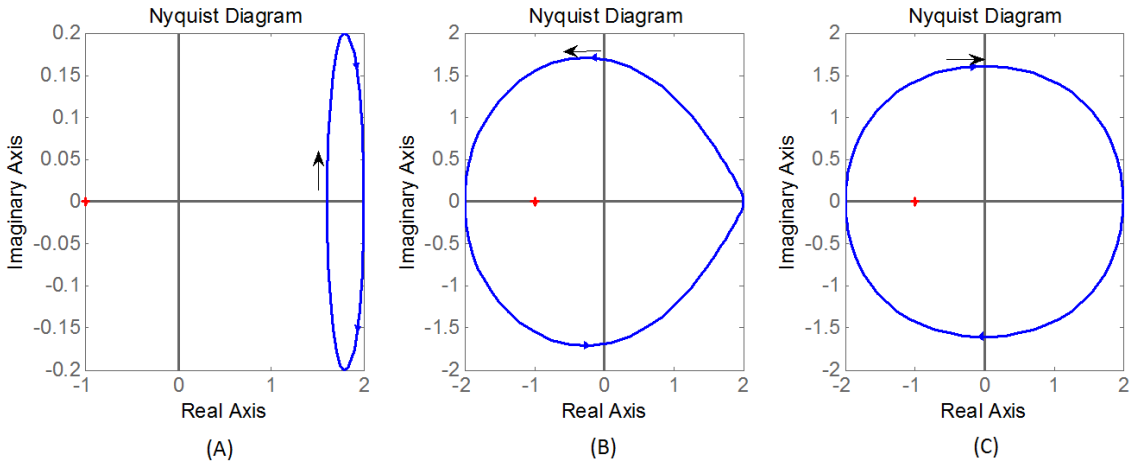
$$G(s) = \frac{2000}{s(s+200)}$$



6. Quiz Question Monday: A unity gain feedback system with $K = 1$ and its Bode plot are shown below.
   (a) Based on clues from the Bode plot magnitude and phase, determine which of the Nyquist plots is correct. (Note that arrows have been added to indicate directionality.)
   (b) Based on your answer to (a) and the Nyquist stability criterion, is the closed-loop system stable?

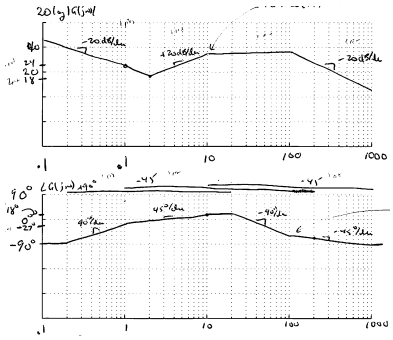



Bode Diagram
Magnitude (dB)
Phase (deg)
Frequency (rad/s)


Nyquist Diagram
Imaginary Axis
Real Axis
(A)
Nyquist Diagram
Imaginary Axis
Real Axis
(B)
Nyquist Diagram
Imaginary Axis
Real Axis
(C)

Solutions:

1.



2. $|G(j3)| = 0.034$, $\angle G(j3) = -174.5^\circ$

3. (b) For $K = 50$, stable. For $K = 500$, unstable.

4. No encirclements and no open loop unstable poles implies closed loop stable