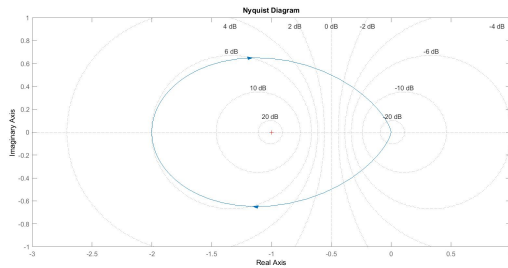


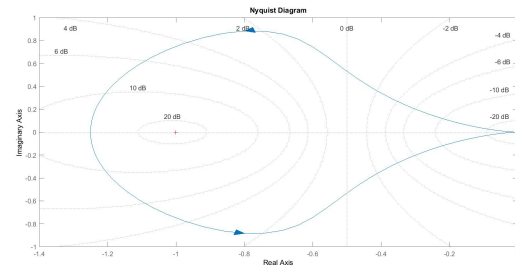
8 Nyquist Design

8.1 Nyquist Stability Analysis

Consider a standard closed-loop system characterized by the loop transfer function $L(s)$. The stability of the closed-loop system can be predicted by applying the Nyquist stability criterion, which involves analyzing the Nyquist plots of $L(s)$. Below are the Nyquist plots for two different loop transfer functions, labeled as (a) and (b). Use the Nyquist stability theorem to determine the number of poles in the right-half plane (RHP) for the closed-loop system based on these plots. Then, classify each system as either stable or unstable.



(a) Nyquist plot for $L(s)$ in scenario (a)



(b) Nyquist plot for $L(s)$ in scenario (b)

Solution :

(a) Unstable.

$$\text{Steps: } P_{CL} = P_{OL} - N_{CCW} = 1 - (-1) = +2.$$

(b) Stable.

$$\text{Steps: } P_{CL} = P_{OL} - N_{CCW} = 1 - 1 = 0.$$

GPT Answer :

The Nyquist stability criterion indicates that a closed-loop system is stable if the Nyquist plot of $L(s)$ does not encircle the $-1 + 0j$ point, assuming no open-loop poles in the RHP. Based on the provided plots:

- (a) The Nyquist plot does not encircle the critical point, but it is unclear if it touches or passes through it. Assuming it does not, the system would be stable with zero poles in the RHP.
- (b) The Nyquist plot is clear of the critical point, indicating zero poles in the RHP and hence the system is stable.

Confidence Level: 75%

Misreading the plot

Claude Answer :

In both scenarios, we need to determine the number of closed-loop poles in the right-half plane (RHP) using the Nyquist stability criterion: $Z = P - N$, where P is the number of open-loop poles in the RHP, and N is the number of counterclockwise encirclements of the -1 point by the Nyquist plot.

Scenario (a): The Nyquist plot has one clockwise encirclement of the -1 point, so $N = -1$. We are given that the open-loop system has one pole in the RHP, so $P = 1$. Applying the Nyquist stability criterion: $Z = P - N = 1 - (-1) = 2$ The closed-loop system has two poles in the RHP, making it unstable.

Scenario (b): The Nyquist plot has one counterclockwise encirclement of the -1 point, so $N = 1$. The open-loop system has one pole in the RHP, so $P = 1$. Using the Nyquist stability criterion: $Z = P - N = 1 - 1 = 0$ The closed-loop system has no poles in the RHP, making it stable.

Confidence Level: 95%

Correct