Control System: Homework 09 for Units 6D-6G: Bode Plot

Assigned: May 21, 2021

Due: May 28, 2021 (11pm)

1. (Nyquist plot)

22. (a) For $\omega = 0.1$ to 100 rad/sec, sketch the phase of the minimum-phase system

$$\left. G(s) = \frac{s+1}{s+10} \right|_{s=j\omega}$$

and the nonminimum-phase system

$$\left. G(s) = -\frac{s-1}{s+10} \right|_{s=j\omega},$$

noting that $\angle(j\omega - 1)$ decreases with ω rather than increasing.

(b) Does a RHP zero affect the relationship between the -1 encirclements on a polar plot and the number of unstable closed-loop roots in Eq. (6.28)?

(c) Sketch the phase of the following unstable system for $\omega = 0.1$ to 100 rad/sec:

$$G(s) = \left. \frac{s+1}{s-10} \right|_{s=j\omega}.$$

(d) Check the stability of the systems in (a) and (c) using the Nyquist criterion on $KG(s)$. Determine the range of K for which the closed-loop system is stable, and check your results qualitatively using a rough root-locus sketch.

2. (Stability margin)

27. Consider the system given in Fig. 6.91.

(a) Use MATLAB to obtain Bode plots for $K = 1$ and use the plots to estimate the range of K for which the system will be stable.

(b) Verify the stable range of K by using margin to determine PM for selected values of K.

(c) Use rlocus and rlocfind to determine the values of K at the stability boundaries.

(d) Sketch the Nyquist plot of the system, and use it to verify the number of unstable roots for the unstable ranges of K.

(e) Using Routh's criterion, determine the ranges of K for closed-loop stability of this system.

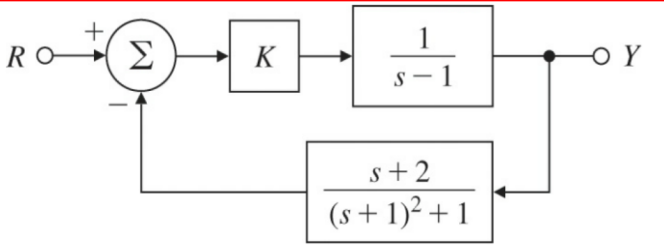

Fig. 6.91 Control system for Problem 6.27

3. (Gain margin and phase margin)

36. For the system shown in Fig. 6.96, determine the Nyquist plot and apply the Nyquist criterion.

    (a) to determine the range of values of K (positive and negative) for which the system will be stable, and

    (b) to determine the number of roots in the RHP for those values of K for which the system is unstable. Check your answer using a rough root-locus sketch.

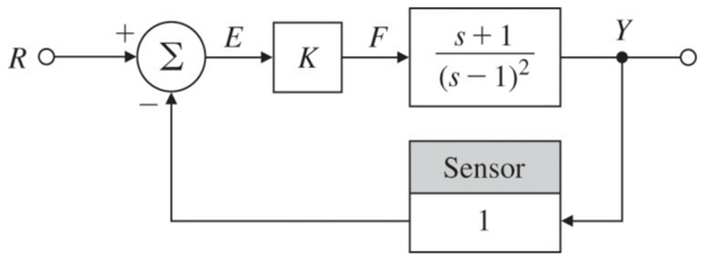

Fig. 6.96 Control system for Problem 6.36

4. (Gain-Phase relation)

41. The frequency response of a plant in a unity feedback configuration is sketched in Fig. 6.99. Assume the plant is open-loop stable and minimum phase.

    (a) What is the velocity constant K_v for the system as drawn?

    (b) What is the damping ratio of the complex poles at $\omega = 100$?

    (c) What is the PM of the system as drawn? (Estimate to within $\pm 10^o$.)

Figure 6.99: Magnitude frequency response for Prc