EECE 5610: Homework #6

Due on Dec (2+2)=4, 2022 at 11:59pm
Homework should be submitted via Canvas. Late submission is not accepted.
The actual deadline is Dec 2 but I extended for 2 days (Dec 4)!

Professor Milad Siami

Problem 1

Problem 7.6-3 of the textbook parts (a) and (c).

7.5-4. Consider the robot arm joint control system of Fig. P7.5-4. This system is described in Problem 1.5-4. For this problem, $T = 0.1$ s and $D(z) = 1$. It was shown in Problem 6-7 that

$$\mathcal{Z}\left[\frac{1 - \varepsilon^{-Ts}}{s}\frac{4}{s(s + 2)}\right] = \frac{0.01873z + 0.01752}{(z - 1)(z - 0.8187)}$$

(a) Write the closed-loop system characteristic equation.
(b) Use the Routh–Hurwitz criterion to determine the range of K for stability.
(c) Check the results of part (b) using the Jury test.
(d) Determine the location of all roots of the characteristic equation in both the w-plane and the z-plane for the value of $K > 0$ for which the system is marginally stable.
(e) Determine both the s-plane frequency and the w-plane frequency at which the system will oscillate when marginally stable, using the results of part (d).
(f) Show that the frequencies in part (e) satisfy (7-10).

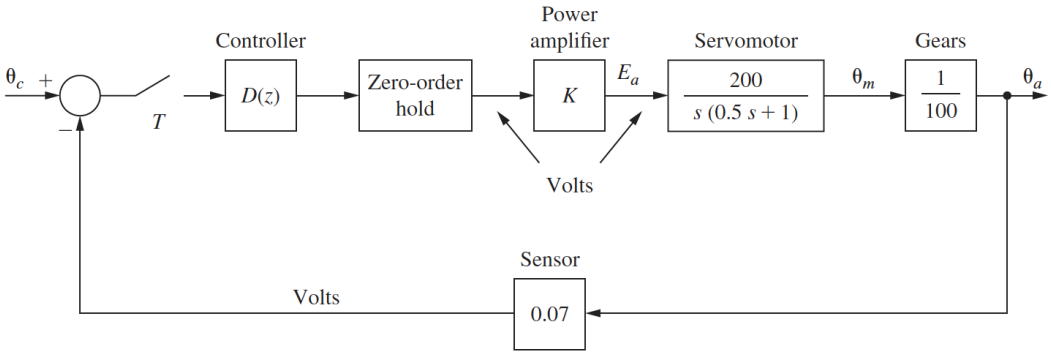

FIGURE P7.5-4 Robot arm joint control system.

Problem 2

Problem 7.8-1 of the textbook parts (a) and (c).

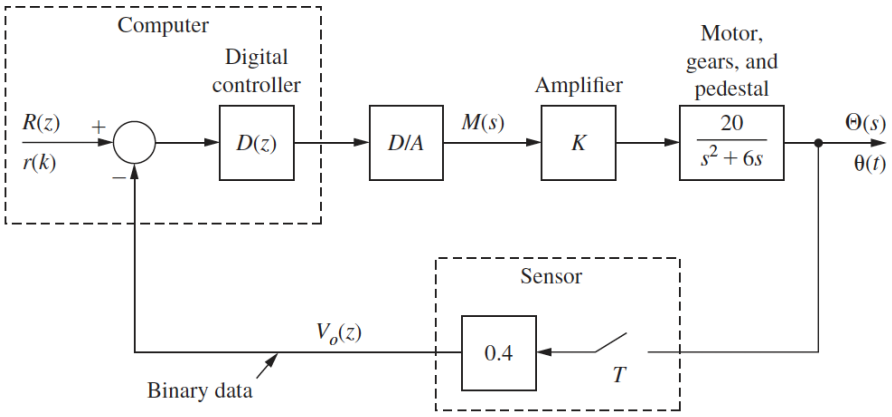

FIGURE P7.5-5 Block diagram for an antenna control system.

7.5-5. Consider the antenna control system of Fig. P7.5-5. This system is described in Problem 1.5-1. For this problem, $T = 0.05$ s and $D(z) = 1$. It was shown in Problem 5.3-15 that

$$\mathcal{Z}\left[\frac{1 - \varepsilon^{-Ts}}{s}\frac{20}{s(s + 6)}\right] = \frac{0.02268z + 0.02052}{(z - 1)(z - 0.7408)}$$

(a) Write the closed-loop system characteristic equation.
(b) Use the Routh–Hurwitz criterion to determine the range of K for stability.
(c) Check the results of part (b) using the Jury test.
(d) Determine the location of all roots of the characteristic equation in both the w-plane and the z-plane for the value of $K > 0$ for which the system is marginally stable.
(e) Determine both the s-plane frequency and the w-plane frequency at which the system will oscillate when marginally stable, using the results of part (d).
(f) Show that the frequencies in part (e) satisfy (7-10).