EECE 5610, Fall 2025, HW# 3, Assigned 9/30, due 10/7

3.3-1. A signal $e(t)$ is sampled by the ideal sampler as specified by (3-3). (creates E*(s) from e(kT)

(a) List the conditions under which $e(t)$ can be completely recovered from $e^*(t)$, that is, the conditions under which *no* loss of information by the sampling process occurs.

(b) State which of the conditions listed in part (a) can occur in a physical system. Recall that the ideal sampler itself is not physically realizable.

(c) Considering the answers in part (b), state why we can successfully employ systems that use sampling.

3.4-2. Find $E^*(s)$ for each of the following functions. Express $E^*(s)$ in closed form.

(a) $e(t) = \varepsilon^{at}$ (b) $E(s) = \dfrac{\varepsilon^{-2Ts}}{s-a}$

(c) $e(t) = \varepsilon^{a(t-2T)}u(t-2T)$ (d) $e(t) = \varepsilon^{a(t-T/2)}u(t-T/2)$

3.4-4. Express the starred transform of $e(t - kT)\,u(t - kT)$, k an integer, in terms of $E^*(s)$, the starred transform of $e(t)$. Base your derivation on (3-3).

3.6-1. (a) Find $E^*(s)$, for $T = 0.1$ s, for the two functions below. Explain why the two transforms are equal, first from a time-function approach, and then from a pole–zero approach.

(i) $e_1(t) = \cos(4\pi t)$

(ii) $e_2(t) = \cos(16\pi t)$

(b) Give a third time function that has the same $E^*(s)$.

3.7-8. A polygonal data hold is a device that reconstructs the sampled signal by the straight-line approximation shown in Fig. P3.7-8. Show that the transfer function of this data hold is

$$G(s) = \frac{\varepsilon^{Ts}\left(1 - \varepsilon^{-Ts}\right)^2}{Ts^2}$$

Is this data hold physically realizable?

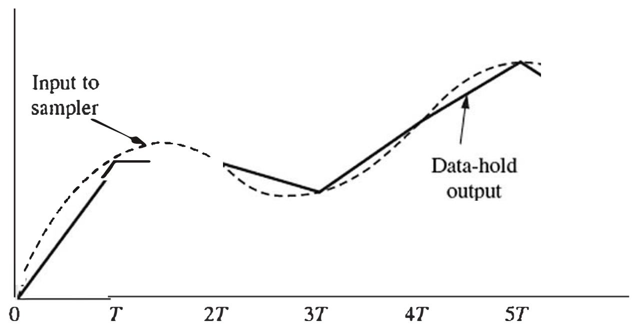

Fig. P3.7-8

4.3-11. The antenna positioning system described in Section 1.5 and Problem 1.5-1 is depicted in Fig. P4.3-11. In this problem we consider the yaw angle control system, where $\theta(t)$ is the yaw angle. The angle sensor (a digital shaft encoder and the data hold) yields $v_o(kT) = [0.4\ \theta(kT)]$, where the units of $v_o(t)$ are volts and $\theta(t)$ are degrees. The sample period is $T = 0.05$ s.

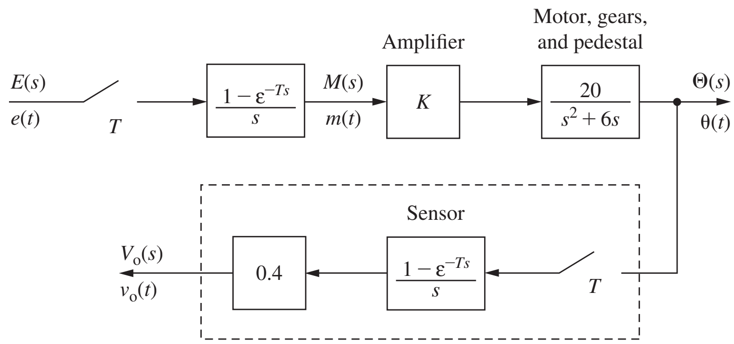

Fig. P4.3-11

(a) Find the transfer function $\Theta(z)/E(z)$.

(b) The yaw angle is initially zero. The input voltage $e(t)$ is set equal to 10 V at $t = 0$, and is zero at each sample period thereafter. Find the steady-state value of the yaw angle.

(c) Note that in part (b), the coefficients in the partial-fraction expansion add to zero. Why does this occur?

(d) The input voltage $e(t)$ is set to a constant value. Without solving mathematically, give a description of the system response.

(e) Suppose in part (d) that you are observing the antenna. Describe what you would see.