Problem 1  Consider the following feedback configuration.

![Feedback Configuration Diagram](image)

Sketch the root loci for $K > 0$ and $K < 0$ for each of the following:

(a) $G(s) = \frac{1}{s + 1}$.

(b) $G(s) = \frac{1}{(s - 5)(s + 3)}$

(c) $G(s) = \frac{s + 1}{s^2}$. For this part, clearly indicate the point at which the closed-loop system has a double-pole.
Problem 2  Consider the system shown below:

\[ x(t) \rightarrow e(t) \rightarrow K(s) \rightarrow \frac{1}{s(s + 10)} \rightarrow y(t) \]

(a) Compute the steady state tracking error, \( e(\infty) \), due to a unit step input \( x(t) = u(t) \) when \( K(s) = K \). Does the steady state tracking error change as \( K \) changes?

(b) Compute the steady state tracking error, \( e(\infty) \), due to a ramp input \( x(t) = tu(t) \) when \( K(s) = K \). Does the steady state tracking error change as \( K \) changes?

(c) Assume, for this part, that \( K(s) = 1 \). Find systems \( K_f(s) \) and \( K_s(s) \) in the modified system shown below such that the steady state tracking error due to the ramp input \( x(t) = tu(t) \) becomes zero. *Hint: One of the two systems, \( K_f(s) \) and \( K_s(s) \), is a constant gain.* Note that the tracking error is defined to be \( e(t) = x(t) - y(t) \).

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Problem 4  Determine the z-transform for each of the following sequences. Sketch pole-zero plot and indicate the region of convergence. Indicate whether or not the Fourier transform of the sequence exists.

(a) \( x[n] = 2\delta[n + 3] - \delta[n - 2] \)

(b) \( x[n] = 2^n u[n - 1] + 4^n u[-n] \)
Problem 5  For each of the following z-transforms, determine the inverse z-transform

(a) \( X(z) = 12z^{-4} - z^{-1} + 6 + 9z^2 - 8z^5 \)

(b) \( X(z) = \frac{5}{1 + \frac{1}{6}z^{-1} - \frac{1}{6}z^{-2}}, \quad \frac{1}{3} < |z| < \frac{1}{2} \)

Problem 6  Consider a signal \( y[n] \) which is related to two signals \( x_1[n] \) and \( x_2[n] \) by

\[ y[n] = x_1[-n - 2] * x_2[n + 4] \]

where

\[ x_1[n] = \left( -\frac{1}{2} \right)^n u[n] \quad \text{and} \quad x_2[n] = \left( \frac{1}{4} \right)^n u[n]. \]

Determine the z-transform \( Y(z) \) of \( y[n] \), together with its ROC.

Reminder: The first 20 problems in each chapter of O&W have answers included at the end of the text. Consider using these for additional practice, either now or as you study for tests.