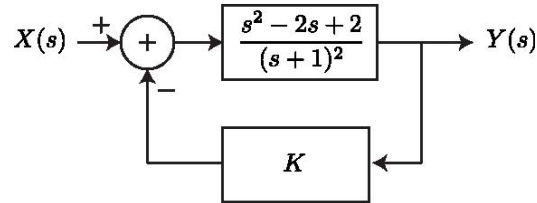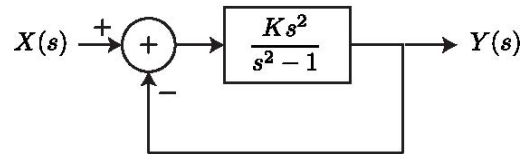# Signals and Systems

Homework Assignment #8

Problem 1. Sketch the locus of closed-loop pole locations for the following systems, where each of the boxes is causal.
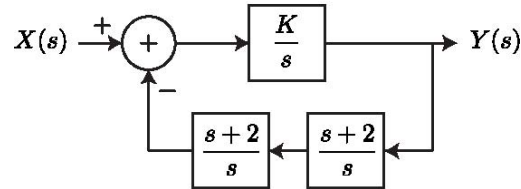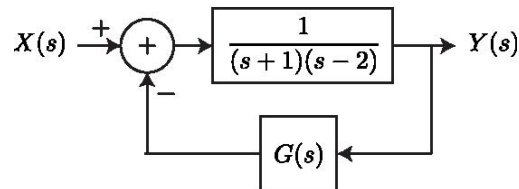
    a.

$$X(s) \xrightarrow{+} \boxed{+} \to \boxed{\dfrac{s^2 - 2s + 2}{(s+1)^2}} \to Y(s)$$

$$\boxed{K}$$

    b.

$$X(s) \xrightarrow{+} \boxed{+} \to \boxed{\dfrac{Ks^2}{s^2 - 1}} \to Y(s)$$

    c.

$$X(s) \xrightarrow{+} \boxed{+} \to \boxed{\dfrac{K}{s}} \to Y(s)$$

$$\boxed{\dfrac{s+2}{s}} \quad \boxed{\dfrac{s+2}{s}}$$

Include separate diagrams for positive values of K and negative values of K.

Problem 2. Do problem 11.57 in the text (Oppenheim and Willsky).

Problem 3. Consider the following feedback system, which is composed of a causal forward path with two poles and a feedback path characterized by $G(s)$.

$$X(s) \xrightarrow{+} \boxed{+} \to \boxed{\dfrac{1}{(s+1)(s-2)}} \to Y(s)$$

$$\boxed{G(s)}$$

    a. Is it possible to stabilize the system using proportional feedback, i.e., for $G(s)$ equal to a real valued number K? If yes, give the range of values of K for which the system is stable. If no, explain why not.

    b. Is it possible to use proportional plus derivative feedback (i.e., $G(s) = K_1 + K_2 s$) to produce a closed-loop impulse response of the form $h(t) = Ate^{-\sigma_1 t}u(t)$ for σ_1 real and positive? If yes, determine values of K_1 and K_2 for such a response, as well as the resulting value of σ_1. If no, explain why not.

c. Is it possible to use proportional plus integral feedback (i.e., $G(s) = K_3 + K_4/s$) to produce a closed-loop impulse response of the form $h(t)= Ate^{-\sigma_2 t}u(t)$ for σ_2 real and positive? If yes, determine values of K_3 and K_4 for such a response, as well as the resulting value of σ_2. If no, explain why not.