Polynomial design (RST) exercise

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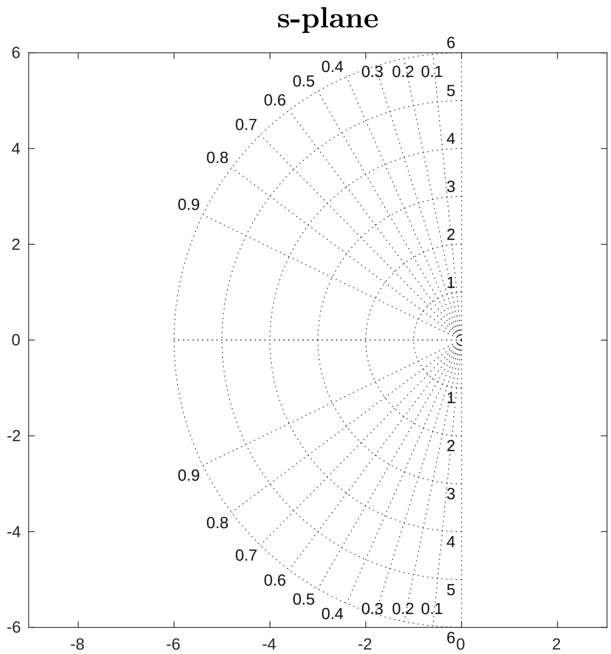
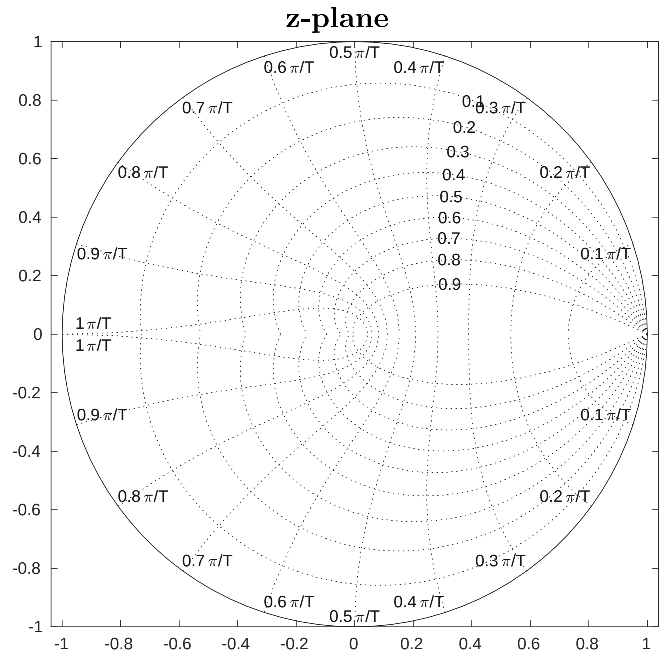
Choosing the closed-loop poles





Plot the poles of the following closed-loop discrete-time systems (as crosses in the z-plane). Plot also the corresponding continous-time poles (in the s-plane) using the sampling period $h = 0.2$. Rank the systems from 1 to 5 according to how desirable the performance of each system is.

a $G_c(z) = \frac{0.026z+0.024}{z(z-0.95)}$

b $G_c(z) = \frac{0.13z+0.12}{z^2-z+0.25}$

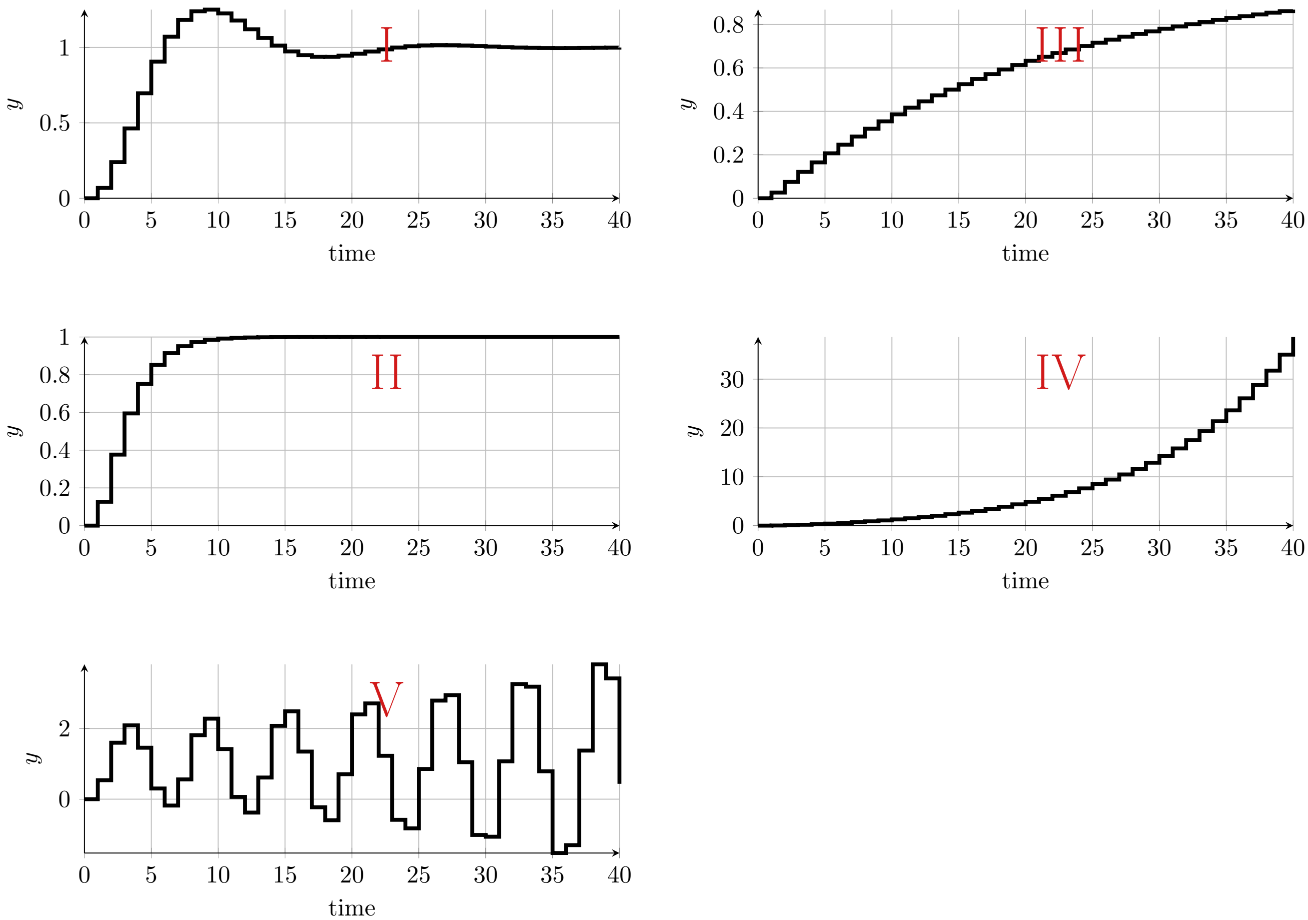
c $G_c(z) = \frac{0.54z+0.52}{(z-0.5)^2+0.81}$

d $G_c(z) = \frac{0.025z+0.025}{(z-0.8)^2-0.09}$

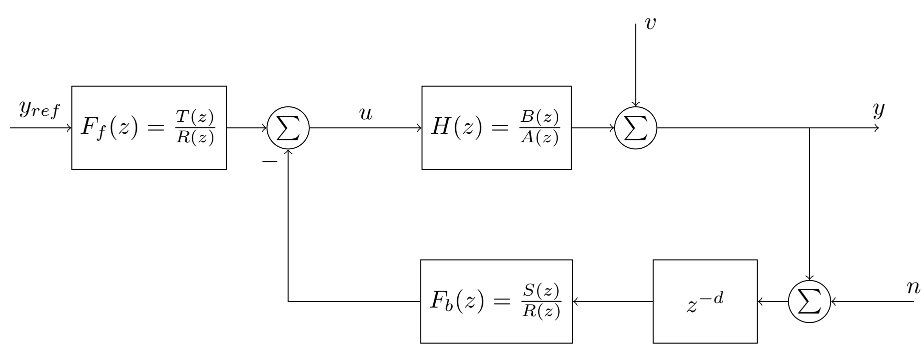
e $G_c(z) = \frac{0.068z+0.062}{(z-0.8)^2+0.09}$

Pole placement and step response

Pair each of the discrete-time systems in the previous exercise with the correct step response below.



Determine the order of the controller



In each of the cases determine the order of the feedback controller $F_b(z) = \frac{S(z)}{R(z)}$ and write out the $R(z)$ and $S(z)$ polynomials. Determine also the order of the observer polynomial $A_o(z)$. You don't have to solve for the controller coefficients.

Case 1

Plant is $H(z) = \frac{b_0 z + b_1}{z^3 + a_1 z^2 + a_2 z}$, desired response to reference signal $H_c(z) = \frac{0.2^2}{z(z-0.8)(z-0.8)}$, observer poles in the origin.

Case 2

Plant is $H(z) = \frac{b_0 z + b_1}{z^3 + a_1 z^2 + a_2 z}$, desired response to reference signal $H_c(z) = \frac{0.2^2}{(z-0.8)^3}$, observer poles in the origin and integral action in the feedback controller (incremental controller).

Case 3

Plant is $H(z) = \frac{b_0 z + b_1}{z^2 + a_1 z + a_2}$ and there is a delay of 2 sampling periods in the feedback path. The desired response to reference signal $H_c(z) = \frac{0.2^2}{(z-0.8)(z-0.8)}$, observer poles in the origin and integral action in the feedback controller (incremental controller).