Signals and Systems – Spring 2025

Problem Set 6

Issued: Apr. 03, 2025 Due: Apr. 10, 2025

Reading Assignments:

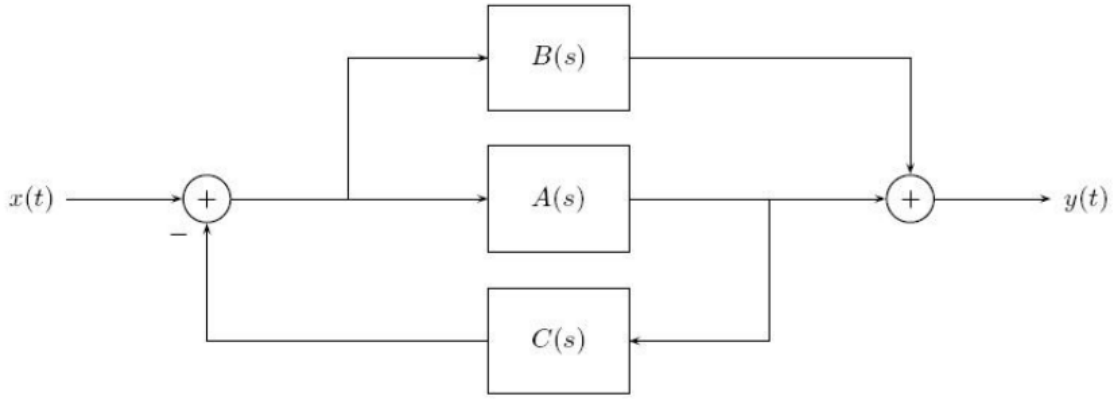
Signals and Systems (OWN), Chapter 9.7-9.8, 10.7-10.8, 11.0-11.2

Problem 1 OWN, Problem 9.50

Problem 2 OWN, Problem 10.59

Problem 3 OWN, Problem 11.50

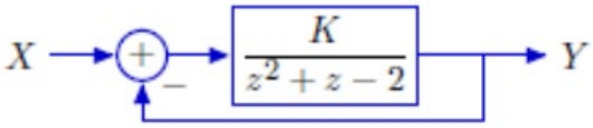
Problem 4 Consider the following block diagram:



Find the transfer function *H(s)=Y(s)/X(s)* of the overall system in terms of *A(s), B(s)* and *C(s)*. Note that the adder on the left side has one minus sign.

Problem 5

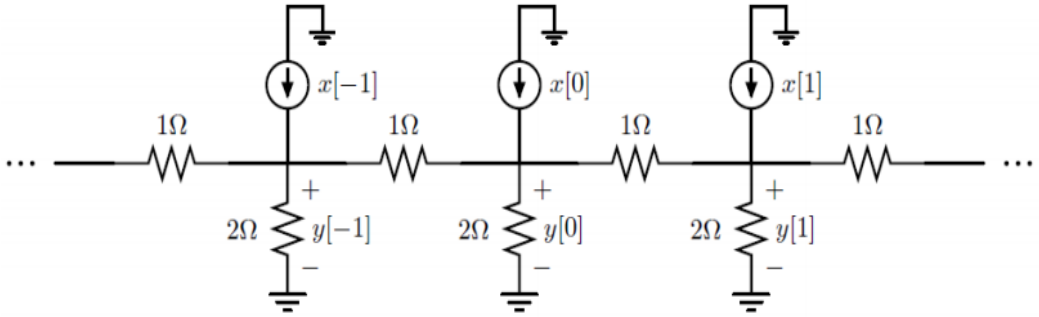
Consider the following feedback system in which the box represents a causal LTI DT system that is represented by its system function.



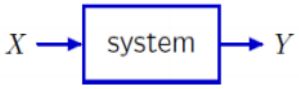
a. Determine the range of K for which this feedback system is stable.
b. Determine the range of K for which this feedback system has real-valued poles.

Problem 6

An infinite network of resistors is excited by an infinite network of current sources as shown below.



We can consider the transformation from x to y as a DT system.



a. Show that this system is linear and "time"-invariant.

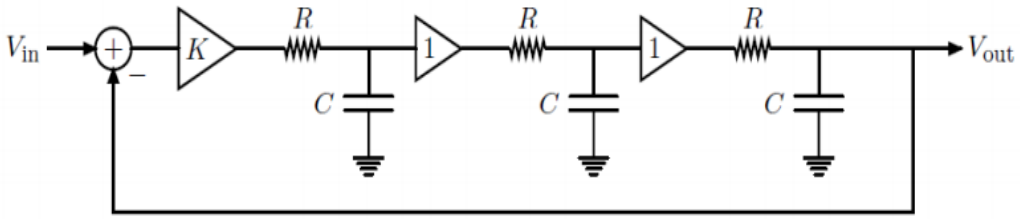
b. Determine the unit-sample response $h[n]$.

c. Determine the system function $H(z)$ and region of convergence.

d. Determine the system's pole(s) and zero(s).

Problem 7

The following feedback circuit was the basis of Hewlett and Packard's founding patent.



a. With $R = 1\,\text{k}\Omega$ and $C = 1\mu\text{F}$, sketch the pole locations as the gain K varies from 0 to ∞, showing the scale for the real and imaginary axes. Find the K for which the system is barely stable and label your sketch with that information. What is the system's oscillation period for this K?

b. How do your results change if R is increased to $10\,\text{k}\Omega$?

Problem 8 OWN, Problem 11.57