Assignment 5: LTI Systems in Transformed Domain*

Signals and Systems (ELC 321)
Department of Electrical and Computer Engineering
The College of New Jersey.

Instructions:

1. This is an optional assignment. Hard copy submission is required by the assigned due date.
2. The assignment questions are extracted from the Text (Signals, Systems, and Transforms, Fifth edition)
3. **Due Date: May 12, 2016**.

Problem 1 (25 Marks)**.** *Consider the system simulation diagram of Figure 1. This figure shows a simulation diagram form used in the area of automatic control*

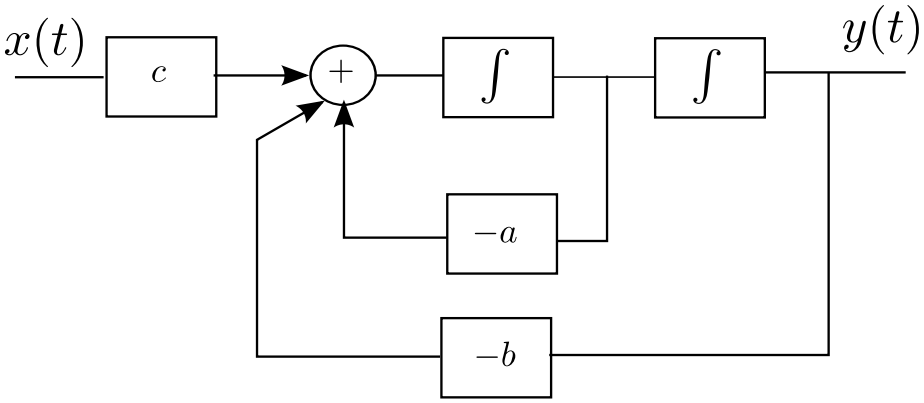

Figure 1: Simulation Diagram for Problem 1

a) Find the differential equation of the system.

b) Find the system transfer function $H(s)$. Assuming zero initial conditions.

c) Suppose that $a = 5$, $b = 6$ and $c = 2$, determine the impulse response $h(t)$ of the system.

d) Determine the stability and causality of the system for the values of a, b and c in (c)

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□

Problem 2 (25 Marks)**.** *An LTI system with input u and output y is represented by the following coupled differential equations.*

$$\dot{x}_1 = x_2 \tag{1}$$
$$\dot{x}_2 = -4x_1 - 5x_2 + 2u \tag{2}$$
$$y = x_1 \tag{3}$$

The variables x_1 and x_2 are generally referred to as the system states.

a) Draw a simulation diagram for this system.

b) Find the transfer function of the system.

c) Find the unit impulse response $h(t)$ for the system.

d) Determine if the system is causal and stable.

□

Problem 3 (25 Marks)**.** *The simulation diagram of Fig.2 describes an echo generating system with input $x[n]$ and output $y[n]$. Each successive echo is represented by a delayed and scaled version of the output, which is fed back to the input. The coefficients a and b are attenuation factors while D denotes a unit delay operator.*

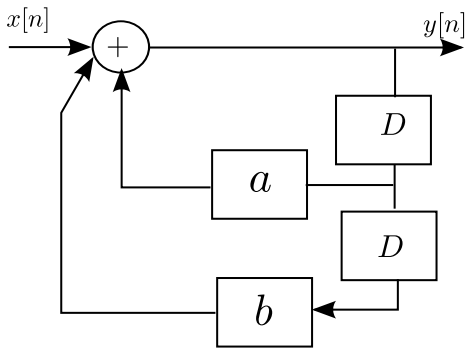

Figure 2: Sequence for Problem 1

a) Write the difference equation describing the system.

b) Determine the transfer function $H(z)$ of the echo system.

c) Suppose that $a = 0.5$ and $b = 0.25$, determine the system stability and causality.

d) Find the unit-step response of the system.

□

Problem 4 (25 Marks)**.** *Consider the discrete-time system described by the following difference equation*

$$y[n] - 0.7y[n-1] = 3x[n] - 2.2x[n-1]. \tag{4}$$

where $x[n]$ is the input sequence and $y[n]$ is the output sequence.

a) Draw the Direct Forms I and II block diagrams for this system

b) Determine the impulse response $h[n]$, $0 \leq n \leq 4$ for the system.

c) Find the unit-step response of the system.

d) Suppose that the system input $x[n]$ is given by $x[n] = 0.8^n \mu[n]$ and $y[-1] = 0$. Solve for $y[n]$ as a function of n.

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