Homework Assignment #2

ECE 6530: Digital Signal Processing
September 7, 2023

Miguel Gomez U1318856
Homework set #2

Due Date: Sep 14, 2023
(100 points)

1

2.7 - Answer subquestions (1) through (5) for parts (a) through (e). (10 points)

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a) $y(n) = \cos(x(n))$

b) $y(n) = \sum_{k=-\infty}^{n+1} x(k)$

c) $y(n) = x(n)\cos(\omega_0 n)$

d) $y(n) = x(-n+2)$

e) $y(n) =$Trun$[x(n)]$ where Trun$[x(n)]$ denotes the integer part of $x(n)$, obtained by truncation.

2

2.11 - Problem 2.11 (10 points)

The following inputoutput pairs have been observed during the operation of a linear system:

$$x_1(n) = \{-1, \underset{\uparrow}{2}, 1\} \quad \overset{\mathcal{T}}{\longleftrightarrow} \quad y_1(n) = \{1, \underset{\uparrow}{2}, -1, 0, 1\}$$

$$x_2(n) = \{1, \underset{\uparrow}{-1}, -1\} \quad \overset{\mathcal{T}}{\longleftrightarrow} \quad y_2(n) = \{-1, \underset{\uparrow}{1}, 0, 2\}$$

$$x_3(n) = \{0, \underset{\uparrow}{1}, 1\} \quad \overset{\mathcal{T}}{\longleftrightarrow} \quad y_3(n) = \{\underset{\uparrow}{1}, 2, 1\}$$

Can we draw any conclusions regarding the linearity of the system. What is the impulse response of the system?

3

2.16 - Problem 2.16 part (b3) and (b11) (10 points)

a) If $y(n) = x(n) * h(n)$, show that $\sum_y = \sum_k \sum_h$, where $\sum_x = \sum_{-\infty}^{\infty} x(n)$.

b) Compute the convolution $y(n) = x(n) * h(n)$ of the following signals and check the correctness of the results by using the test in (a).

b3) $x(n) = \{0, 1, -2, 3, -4\}$, $h(n) = \left\{\frac{1}{2}, \frac{1}{2}, 1, \frac{1}{2}\right\}$

b11) $x(n) = \left(\frac{1}{2}\right)^n u(n)$, $h(n) = \left(\frac{1}{4}\right)^n u(n)$

4

2.24 - Problem 2.24. (10 points)

The discrete-time system:

$$y(n) = ny(n-1) + x(n), \qquad n \geq 0$$

:is at rest [i.e., $y(1) = 0$]. Check if the system is linear time invariant and BIBO stable.

5

2.27 - Problem 2.27. Determine the homogeneous, particular and total solutions. (15 points)
Determine the particular solution of the difference equation:

$$y(n) = \frac{5}{6}y(n-1) - \frac{1}{6}y(n-2) + x(n)$$

when the forcing function is $x(n) = 2u(n)$.

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2.31 - Problem 2.31. (10 points)
Determine the impulse response of the following causal system:

$$y(n) - 3y(n-1) - 4y(n-2) = x(n) + 2x(n-1)$$

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2.46 - Problem 2.46. (10 points)
Determine the direct form II realization for each of the following LTI systems:

a) $2y(n) + y(n-1) - 4y(n-3) = x(n) + 3x(n-5)$
b) $y(n) = x(n) - x(n-1) + 2x(n-2) - 3x(n-4)$

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2.49 - Problem 2.49 part (a). Assume that the system is relaxed. (10 points)
A discrete-time system is realized by the structure shown in Fig. P49.

a) Determine the impulse response.

b) Determine a realization for its inverse system, that is, the system which produces $x(n)$ as an output when $y(n)$ is used as an input.

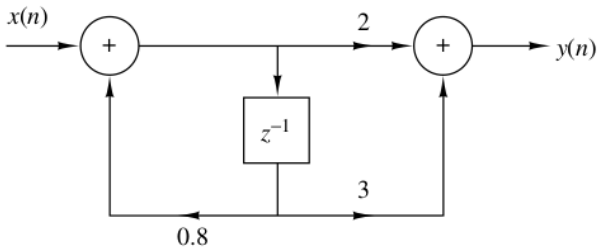

Figure 1: Figure P49 from textbook

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2.52 - Problem 2.52 part (a). (15 points)
Consider the systems shown in Fig. P52.

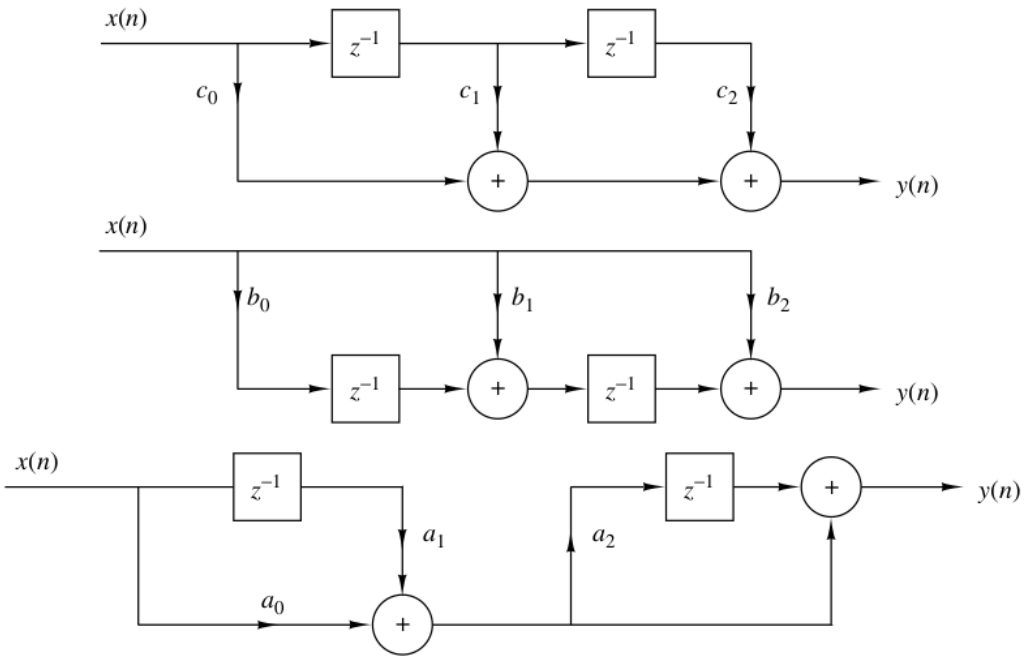

Figure 2: Figure P52 from textbook

a) Determine and sketch their impulse responses $h1(n)$, $h2(n)$, and $h3(n)$.

b) Is it possible to choose the coefficients of these systems in such a way that:

$$h_1(n) = h_2(n) = h_3(n)$$
