

EE150 - Signals and Systems, Fall 2024

Homework Set #2

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**Problem 1. (20 points)**

(a) (5 points)

Given a discrete sequence  $x[n]$ , represent it as the weighted sum of shifted unit impulses.

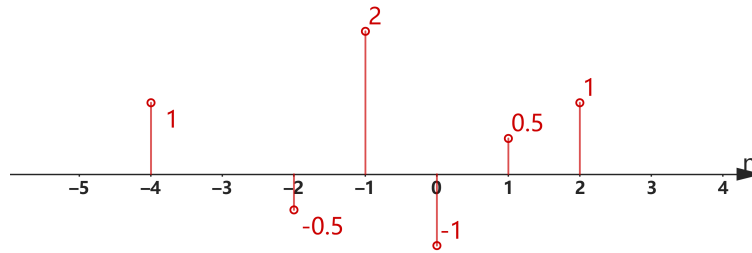


Figure 1

(b) (5 points)

Given  $y[n] = x[n+4] - \frac{1}{3}x[n+3] + 4x[n+1] - 2x[n] + \frac{1}{2}x[n-1] - 3x[n-2]$ , calculate the impulse response  $h[n]$ .

(c) (10 points)

Prove that the output of a discrete LTI system  $y[n]$  is equal to the convolution of the input  $x[n]$  and the impulse response  $h[n]$ .

**Problem 2. (20 points)**

Compute the following convolutions:

- 1)  $x(t) = e^{-2t}u(t)$ , and  $h(t) = u(t) - u(t-1)$ ,
- 2)  $x(t) = \cos(\omega t)$ , and  $h(t) = \delta(t+1) - \delta(t-1)$
- 3)  $x[n] = \{1, 2, 0, 2, 1\}$ ,  $3 \leq n \leq 1$  with itself.
- 4)  $x[n] = (\frac{1}{3})^n u[n]$ , and  $h[n] = u[n+2]$

**Problem 3. (10 points)** Determine the impulse response  $h[n]$  of the overall system.

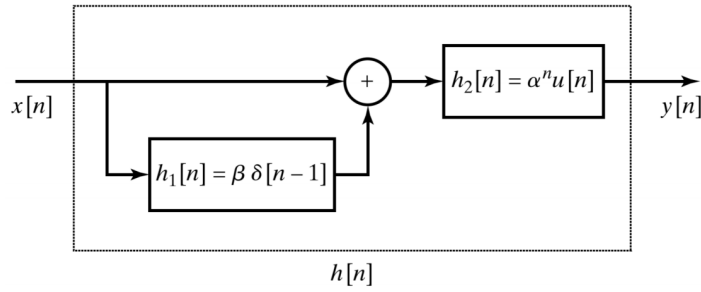


Figure 2

**Problem 4. (20 points)**

Given the impulse response of LTI systems. Determine whether each system is causal, whether each system is stable:

- 1)  $h[n] = (\frac{1}{3})^n u[n]$ ,
- 2)  $h[n] = n(\frac{1}{4})^n u[n-1]$
- 3)  $h(t) = e^{-2t} u(t-1)$ .
- 4)  $h(t) = e^{-2|t|}$

**Problem 5. (30 points)**

Draw block diagram representations for causal LTI systems described by the following differential equations, and determine the system output  $y[n]$  or  $y(t)$ .

- (a)  $y(t) = -\frac{1}{3} \frac{dy(t)}{dt} + 2x(t)$ , and  $x(t) = 3e^{3t} u(t)$
- (b)  $y[n] - \frac{1}{3}y[n-1] = x[n]$ , and  $x[n] = (\frac{1}{2})^n u[n]$