Signals and Systems – Spring 2025

Problem Set 4

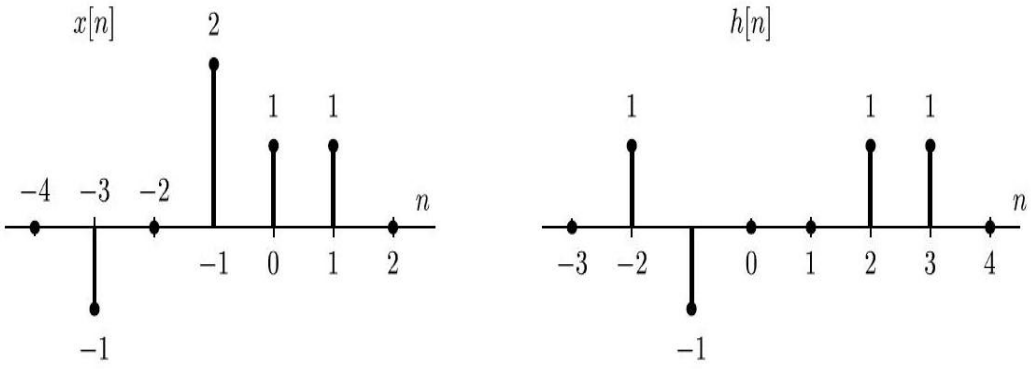
Issued: March 18, 2025 Due: March 25, 2025

Problem 1 **OWN** 2.44 (a) (d)

Problem 2

Compute the convolution $y[n] = x[n] * h[n]$ of each of the two following pairs of signals:

(a). $x[n]$ and $h[n]$ are depicted below



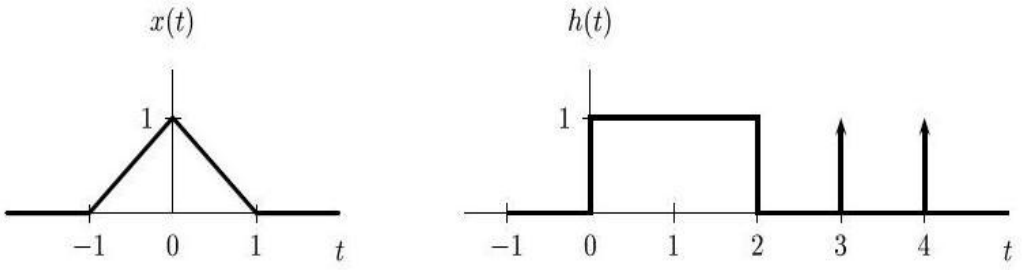
(b). $x[n] = u[n+4] - u[n-1]$, $h[n] = 2^n u[2-n]$.

Problem 3

Compute the convolution $y(t) = x(t) * h(t)$ for each of the following pairs of signals:

(a). $x(t) = e^{-t}u(t+1)$, $h(t) = e^{2t}u(-t)$

(b). $x(t)$ and $h(t)$ are depicted below:



Problem 4

The following are impulse responses of either discrete-time or continuous-time LTI systems. Determine whether each system is causal and/or stable. Justify your answer:

(a). $h[n] = 2^n u[3-n]$

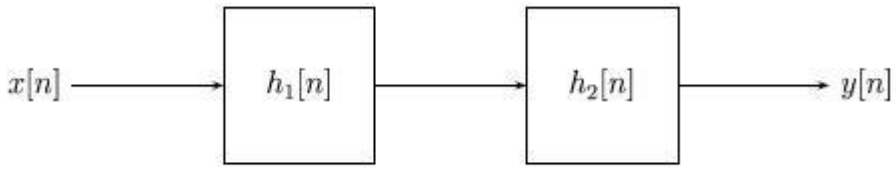
(b). $h(t) = u(1-t) - \frac{1}{2}e^{-t}u(t)$

(c). $h[n] = [1-(0.99)^n]u[n]$

(d). $h(t) = e^{15t}[u(t-1) - u(t-100)]$

Problem 5

Consider the cascade of LTI systems with unit sample responses $h_1[n]$ and $h_2[n]$ depicted below:

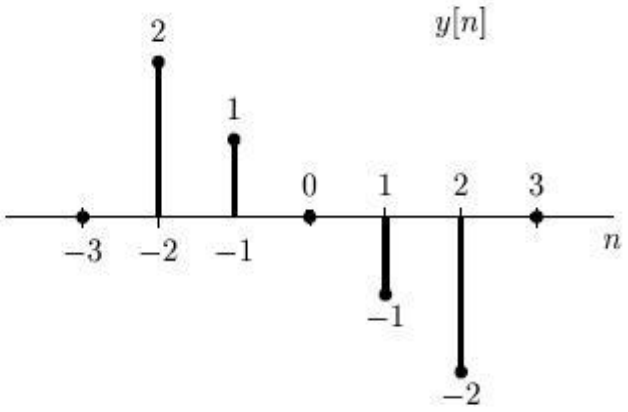


Suppose we are given the following information:

- $h_2[n] = \delta[n] - \delta[n-1]$
- If the input is

$$x[n] = u[n] - u[n-2]$$

then the output is as depicted below



Find $h_1[n]$.

Problem 6

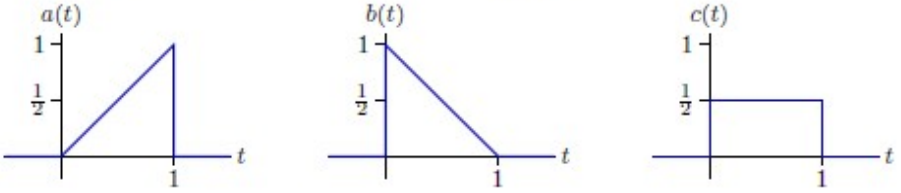
OWN 2.66, with the following corrections:

- In part (a), replace (ii) with
  (ii) $x_1(t) = 0$ for $t < 0$ and $t > 4$
- In part (a), the correct statement of (iv) is
  (iv) $y_1(t) = x_1(t) * h_1(t)$ is as large as possible at $t = 4$

After working this problem, make sure to read the brief paragraph on the top of p. **170**

Problem 7

Consider the convolution of two of the following signals.



Determine if each of the following signals can be constructed by convolving (a or b or c) with (a or b or c). If it can, indicate which signals should be convolved. If it cannot, put an X in both boxes.

Notice that there are ten possible answers: $(a * a)$, $(a * b)$, $(a * c)$, $(b * a)$, $(b * b)$, $(b * c)$, $(c * a)$, $(c * b)$, $(c * c)$, or (X,X). Notice also that the answer may not be unique.