



Signals and Systems

Assignment 2

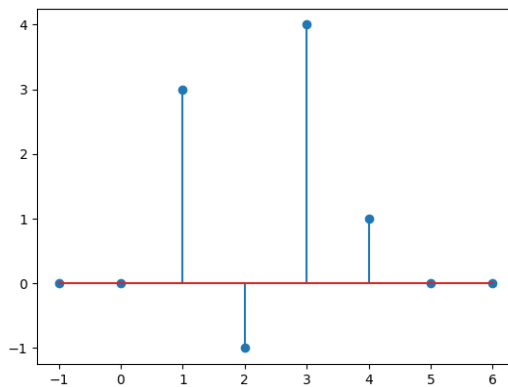
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Question 1

Output of an LTI system given input $x[n] = \delta[n - 2]$ is depicted below:



- (a) Determine system's output $y[n]$ given input $x[n] = e^{j\pi n}(u[n] - u[n - 3])$.
- (b) If system's output is $y[n]$ for input $x[n] = e^{j\pi n}u[n]$, determine $y[1]$.

Question 2

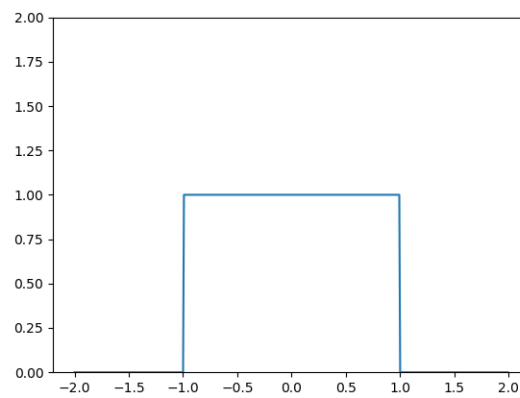
For each pair of impulse response and input given below, determine LTI system's output:

(a) $h(t) = u(t)$, $x(t) = e^t$

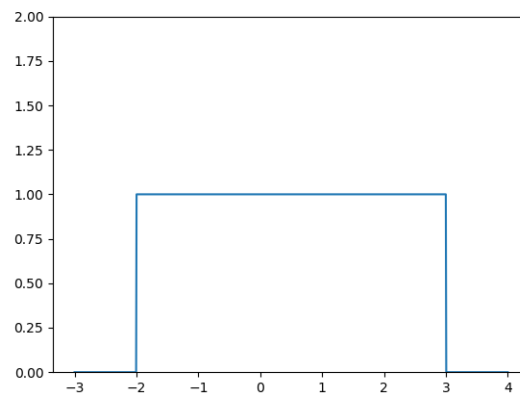
(b) $h(t) = u(t)$, $x(t) = e^t u(t)$

(c)

$h(t)$



$x(t)$

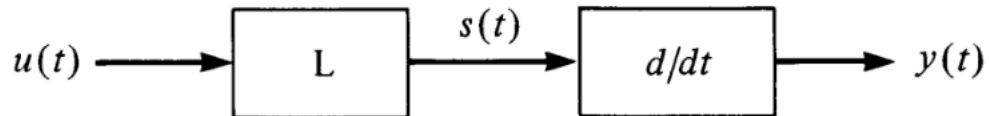


(d)

$$x(t) = \begin{cases} 2t+1 & , -1 \leq t < 1 \\ \ln(t) & , 1 \leq t < 2 \\ e^t & , 2 \leq t < 3 \\ 0 & , O.W. \end{cases} , \quad h(t) = \delta(t + \frac{3}{2}) + 2\delta(t + \frac{5}{2})$$

Question 3

Consider the cascade of two systems shown below:



- (a) The system on the right is called a differentiator. Prove it is an LTI system.
- (b) Assuming the system on the left (L) is also an LTI system with impulse response $h(t)$ and step response $s(t)$, Prove:

$$h(t) = \frac{ds(t)}{dt}$$

note: *step response of a system, is the system's output given unit step as input.*

Question 4

For each of the following impulse responses, determine whether the corresponding LTI system is memoryless, causal and stable. Justify your answers.

(a) $h(t) = e^{-4|t|}$

(b) $h(t) = te^{-t}u(t)$

(c) $h(t) = \cos(2\pi t)u(t+1)$

(d) $h(t) = \frac{\sin(t)}{t}u(t)$

(e) $h[n] = (\frac{1}{2})^n u[-n]$

(f) $h[n] = \delta[2n]$

(g) $h[n] = \cos(\frac{\pi}{2}n)u[n+1]$

(h) $h[n] = e^{2n}u[n]$

Question 5

Using convolution integral, determine the output $y(t)$ of a system where:

$$x(t) = e^{2t}u(1-t)$$

$$h(t) = 2u(t) + 4u(t-2) + 8u(t-4)$$

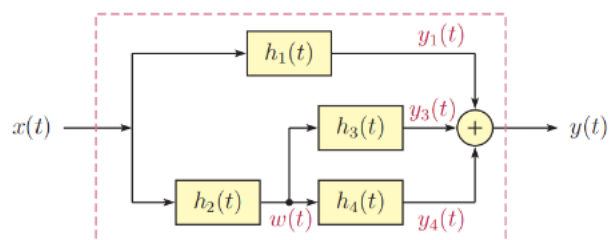
Question 6

Consider cascaded interconnection of LTI systems shown below, where:

$$h_1(t) = e^{-t}u(t)$$

$$h_2(t) = h_3(t) = u(t) - u(t - 1)$$

$$h_4(t) = \delta(t - 1)$$



Determine the impulse response $h_{eq}(t)$ of the equivalent system.

Question 7

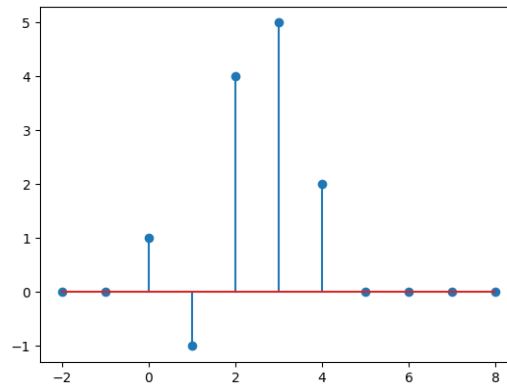
For each pair of impulse responses below, show the corresponding systems are inverses of each other:

(a) $h_1(t) = e^{-t}u(t)$, $h_2(t) = \delta(t) + \delta'(t)$

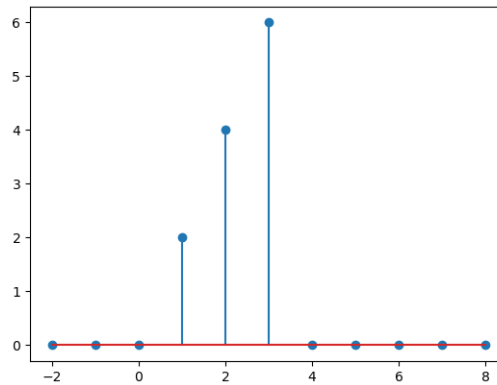
(b) $h_1[n] = \delta[n] - \delta[n-1]$, $h_2[n] = u[n]$

Matlab Question 1

Use Matlab to compute output of a system where input signal is:



and impulse response is:



plot the result.

Matlab Question 2

Use Matlab to compute the output of an LTI system with input:

$$x[n] = u[n + 2] - 2u[n - 12]$$

and impulse response:

$$h[n] = 0.9^n(u[n - 2] - 2u[n - 4])$$