دانشگاه صنعتی امیرکبیر
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Signals and Systems

Assignment 2

Fall 2019 - Group 1

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Question 1

(a) The impulse response of a CTLTI system is

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

Determine and sketch the response of this system to the triangular waveform shown in Figure 1.

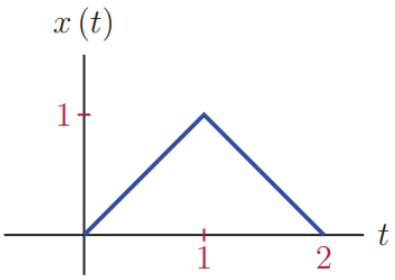

Figure 1: $x(t)$ for question $1(a)$

(b) A CTLTI system has the impulse response

$$h(t) = \delta(t) + 0.5\delta(t-1) + 0.3\delta(t-2)$$

Determine and sketch the response of this system to the exponential input signal

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

Question 2

For each pair of signals $x(t)$ and $h(t)$ given below, find the convolution $y(t) = x(t) * h(t)$

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

(b) $x(t) = \Pi(t - \frac{1}{2}) - \Pi(t - \frac{3}{2})$, $h(t) = u(t) - u(t-1)$

$$\Pi(t) = \begin{cases} 1 & |t| < \frac{1}{2} \\ 0 & otherwise \end{cases}$$

(c) Figure 2

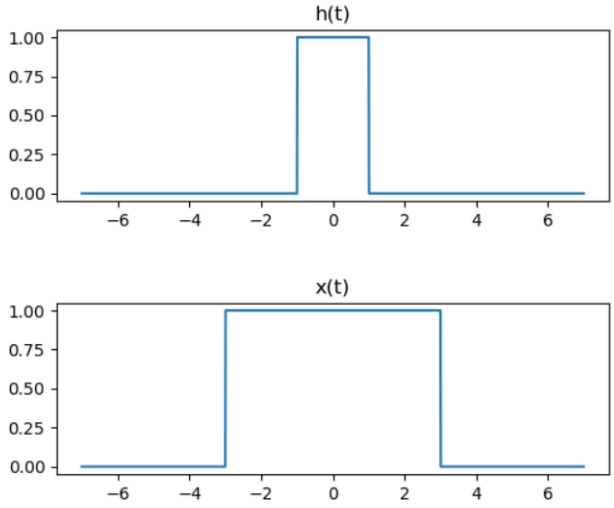

Figure 2: This type of convolution is widely used in the upcoming chapters

Question 3

(a) Consider a system with the impulse response

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

Determine the output if the input is defined as follows:

$$x[n] = u[n] - u[n-5]$$

(b) Convolve:

$$h[n] = \left(\frac{1}{2}\right)^n (u[n] - u[n-4])$$
$$x[n] = u[n] - u[n-7]$$

Question 4

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

(a) $h(t) = u(t) - u(t-3)$

(b) $h(t) = \Pi(t)$

(c) $h(t) = e^{-3|t|}$

(d) $h(t) = sin(2\pi t)u(t)$

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

(f) $h[n] = 5^n u[3-n]$

(g) $h[n] = cos(n\pi)u[n+5]$

Question 5

Find the step response for systems with following impulse responses:

(a) $h(t) = \delta(t) - \delta(t-5)$

(b) $h(t) = \delta(t) + \delta(t-5)$

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

(d) $h[n] = (\frac{1}{5})^n u[n]$

Question 6

Consider the CTLTI system shown in Figure 3

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

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

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

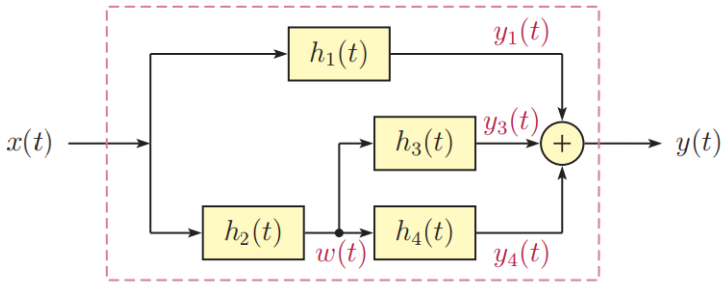

Figure 3: An integrated system

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

(b) Let the input signal be a unit-step, that is, $x(t) = u(t)$. Determine and sketch the signals $w(t), y_1(t), y_3(t)$ and $y_4(t)$.

Matlab Question 1

Use Matlab *conv*() function to convolve following signals:

(a) $h[n] = \{4, 3, 2, 1\}$ and $x[n] = \{-3, 7, 4\}$ (starting from $n = 0$)

(b) $h[n] = (0.8)^n(u[n] - 2u[n-5]$ and $x[n] = u[n] - 2u[n-6]$

Modify matlab *heaviside*() function to match it with the heaviside you know :)

$$u[n] = \begin{cases} 1 & n \geq 0 \\ 0 & n < 0 \end{cases}$$

Matlab Question 2

Load the *signal.mat* file into your matlab workspace.

(a) Plot the signal.

(b) Convolve the signal with the following impulse response and plot the result:

$$h[n] = \{\frac{1}{5}, \frac{1}{5}, \frac{1}{5}, \frac{1}{5}, \frac{1}{5}\}$$

(starting from $n = -2$)

(c) Convolve the signal with the following impulse response and plot the result:

$$h[n] = \{0.06136, 0.24477, 0.38774, 0.24477, 0.06136\}$$

(starting from $n = -2$) (Gaussian 1D kernel with $\sigma = 1$)

(d) Explain the effect of convolving the input signal with kernels (impulse responses) mentioned above.