Homework 2: Signal Processing

Version: 2020 Fall

1. (20%) A discrete-time LTI system has a unit impulse response given by

$$h[n] = u[n] - u[n-9]$$

Find and plot the output $y[n]$ given the input:

$$x[n] = u[n-2] - u[n-6]$$

by directly performing their convolution sum.

2. Let

$$x(t) - u(t-3) - u(t-6) \;\; and \;\; h(t) = e^{-2t}u(t)$$

(a) (15%) Compute $y(t)$ for the convolution integral as

$$y(t) = x(t) * h(t)$$

(b) (15%) Compute $g(t)$ for the convolution integral as

$$g(t) = \left(\frac{dx(t)}{dt}\right) * h(t)$$

3. (a) (10%) For the following statements, determine whether it is true or false with your answer justified. (* denotes the convolution operation.)

$$"If \;\; y[n] = x[n] * h[n], then \; y[n-1] = x[n-1] * h[n-1]"$$

(b) (10%) Consider an LTI system with input x(t) and output y(t) related through the following equation:

$$y(t) = \int_{-\infty}^{t} e^{-(t-\tau)} x(\tau - 5) d\tau$$

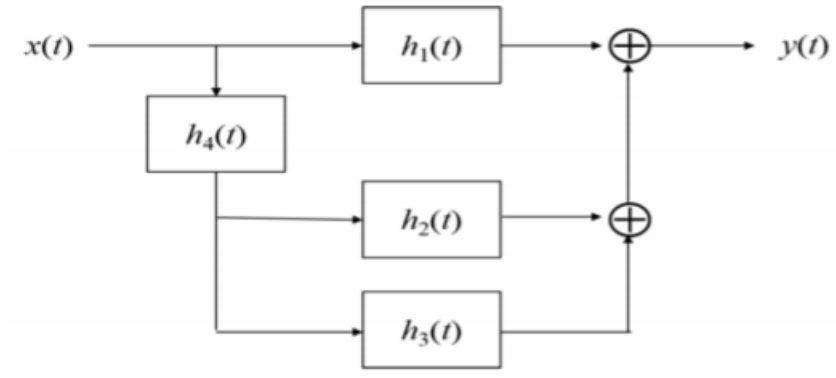
Determine the impulse response *h(t)* for this system.

4. Consider a discrete-time, linear and time-invariant system that has impulse response $h[n] = (\frac{1}{5})^n u[n] \; and \; input \; x[n].$

(a) (10%) Find and plot the output response $y_1[n]$ of the system if $x[n] = x_1[n] = \delta[n-d]$, for integer d = 2.

(b) (10%) Find and plot the output response $y_2[n]$ of the system if $x[n] = x_2[n] = u[n-e]$, for integer e = 3.

5. (10%) Consider an LTI system with the following interconnection configuration:



Suppose the impulse responses of the four LTI subsystems are given by

$$h_1[t] = \frac{1}{2}\delta(t-1) - \frac{1}{2}u(t-1)$$
$$h_2[t] = 2\delta(t)$$
$$h_3[t] = -2u(t)$$
$$h_4[t] = \frac{1}{2}\delta(t) - \frac{1}{4}\delta(t-1)$$

Determine the overall impulse response of the system between $x(t)$ and $y(t)$.

The End of Homework