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Chapter 2

1. Let $x[n]=\delta[n]+2\delta[n-1]-\delta[n-3]$ and $h[n]=2\delta[n+1]+2\delta[n-1]$, compute and plot each of the following convolutions:

   (a) $y_1[n]=x[n]*h[n]$ (b) $y_2[n]=x[n+2]*h[n]$ (c) $y_3[n]=x[n]*h[n+2]$

2. Consider an input $x[n]$ and a unit impulse response $h[n]$ given by

$$x[n]=\left(\frac{1}{2}\right)^{n-2}u[n-2],\quad h[n]=u[n+2].$$

   Determine and plot the output $y[n]=x[n]*h[n]$.

3. Compute and plot the convolution $y[n]=x[n]*h[n]$, where

   $x[n]=\left(\frac{1}{3}\right)^{-n}u[-n-1]$ and $h[n]=u[n-1]$.

4. Determine and sketch the convolution of the following two signals:

$$x(t)=\begin{cases} t+1, & 0\le t\le 1 \\ 2-t, & 1<t\le 2 \\ 0, & elsewhere \end{cases},\quad h(t)=\delta(t+2)+2\delta(t+1).$$

5. Let $x(t)=u(t-3)-u(t-5)$ and $h(t)=e^{-3t}u(t)$,

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

   (b) Compute $y(t)=\frac{dx(t)}{dt}*h(t)$

   (c) How is $g(t)$ related to $y(t)$?

6. Which of the following impulse responses correspond to stable LTI system?

   (a) $h_1(t)=e^{-(1-2j)t}u(t)$ (b) $h_2(t)=e^{-t}cos(2t)u(t)$

7. Which of the following impulse responses corresponds to stable LTI system

(a) $h_1[n] = n\cos(\frac{\pi}{4}n)u[n]$ (b) $h_2[n] = 3^n u[-n+10]$

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

(a) $x[n] = \alpha^n u[n]$, $h[n] = \beta^n u[n]$, $\alpha \neq \beta$

(b) $x[n] = (-\frac{1}{2})^n u[n-4]$, $h[n] = 4^n u[2-n]$

(c) $x[n]$ and $h[n]$ are as in Fig. 1

Fig. 1

9. For each of the following pairs of waveforms, use the convolution integral to find the response $y(t)$ of the LTI system with impulse response $h(t)$ to the input $x(t)$. Sketch your results.

(a) $x(t) = e^{-\alpha t}u(t)$, $h(t) = e^{-\beta t}u(t)$, $\alpha \neq \beta$

(b) $x(t) = u(t) - 2u(t-2) + u(t-5)$, $h(t) = e^{2t}u(1-t)$

(c) $x(t)$ and $h(t)$ are in Fig 2.

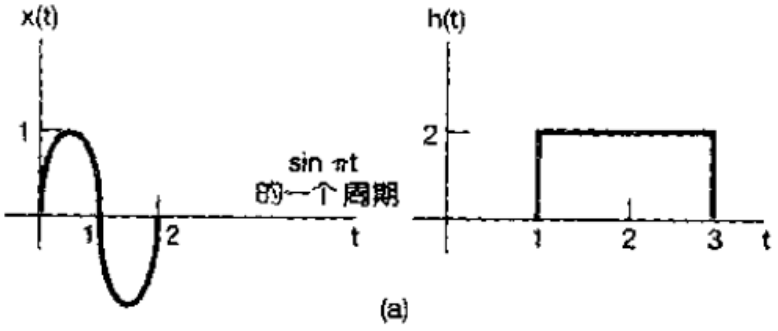


Fig. 2

10. Consider the cascade interconnection of three causal LTI systems, illustrate in Fig. 3(a). The impulse response $h_2[n]$ is

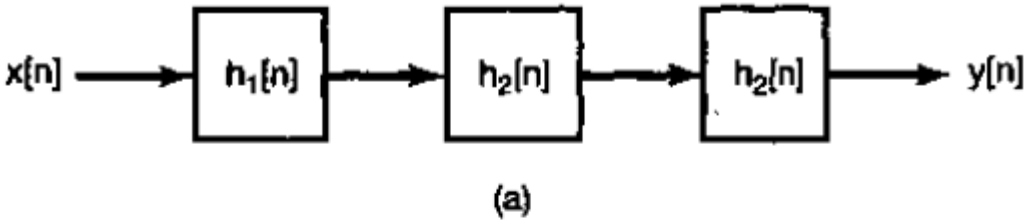
$$h_2[n] = u[n] - u[n-2],$$

And the overall impulse response is as shown in Fig. 3(b).

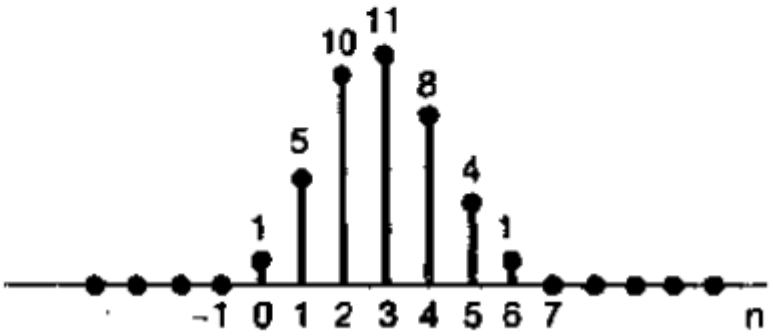
(a) Find the impulse response $h_1[n]$

(b) Find the response of the overall system to the input

$x[n] = \delta[n] - \delta[n-1]$



(a)



(b)

Fig.3

11. The following are the impulse response of discrete-time LTI systems. Determine whether each system is causal and/or stable. Justify your answers.

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

(b) $h[n] = (-\frac{1}{2})^n u[n] + (1.01)^n u[n-1]$

(c) $h[n] = n(\frac{1}{3})^n u[n-1]$

12. The following are the impulse response of continuous-time LTI systems. Determine whether each system is causal and/or stable. Justify your answers.

(a) $h(t) = e^{-4t}u(t-2)$

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

(c) $h(t) = (2e^{-t} - e^{(t-100)/100})u(t)$