Signals and Systems (CT 203)

Tutorial Sheet-05 DA-IICT, Gandhinagar.

Problem 1 Consider a linear time-invariant (LTI) system whose response to the signal $x_1(t)$ in Fig. 1a is the signal $y_1(t)$ in Fig. 1b. Determine and sketch carefully response of the system to the input $x_2(t)$ shown in Fig. 1c.

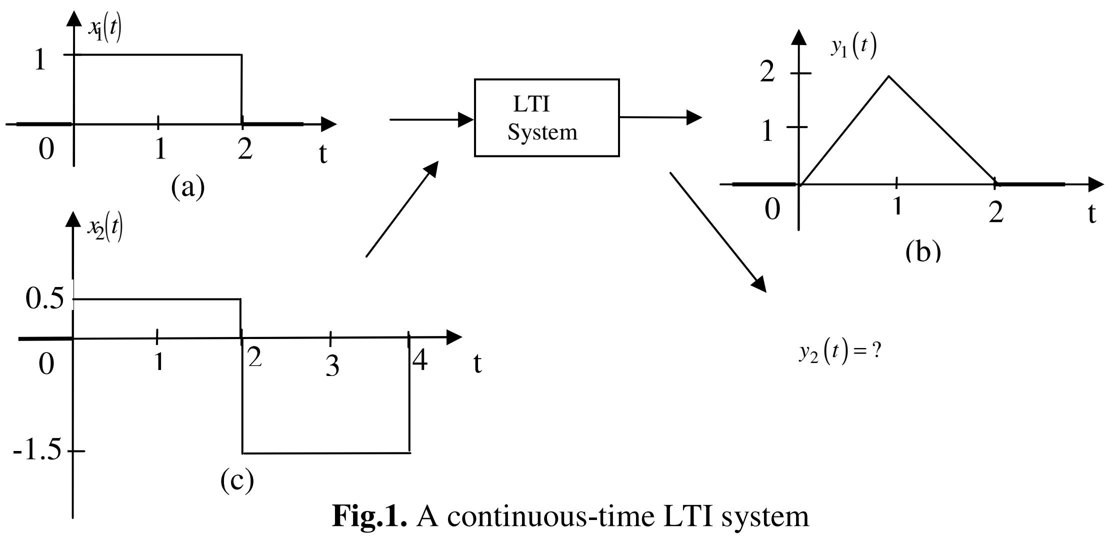


Fig.1. A continuous-time LTI system

Problem 2. Find the impulse response, $h(n)$ of following systems

$$x(n) = \delta(n) \longrightarrow \boxed{\text{System } T\{.\}} \longrightarrow y(n) = T\{x(n) = \delta(n)\} = h(n)$$

Fig.2a. Concept of Impulse Excitation

(a) Ideal Delay System, $y(n) = T\{x(n)\} = x(n - n_d)$

(b) Moving Average System, $y(n) = T\{x(n)\} = \dfrac{1}{N_1 + N_2 - 1} \displaystyle\sum_{k=-N_1}^{N_2} x(n-k)$

(c) Accumulator System, $y(n) = T\{x(n)\} = \displaystyle\sum_{k=-\infty}^{n} x(k)$

(d) Forward Difference system, $y(n) = T\{x(n)\} = x(n+1) - x(n)$

(e) Backward Difference system, $y(n) = T\{x(n)\} = x(n) - x(n-1)$

(f) Linear interpolator system,

$$y(n) = T\{x(n)\} = x(n) + \frac{1}{2}\{x(n-1) - x(n+1)\}$$

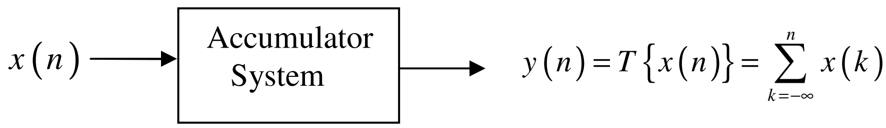


Fig.2b. Ideal Delay System

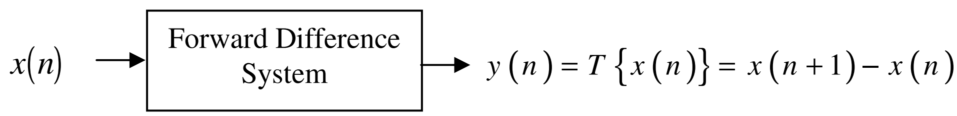


Fig.2c. Moving Average (MA) System

Problem 3 Consider an input $x(n)$ and a unit impulse response $h(n)$ given by,

$$x(n) = \left(\frac{1}{2}\right)^{n-2} u(n-2)$$
$$h(n) = u(n+2)$$

Determine and plot output, $y(n) = x(n) * h(n)$.

Problem 4 Let $x(t) = u(t-3) - u(t-5)$ and $h(t) = e^{-3t}u(t)$, then compute following,

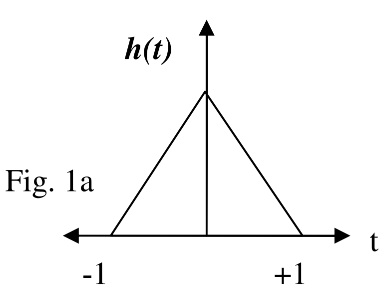
(a) $y(t) = x(t) * h(t)$

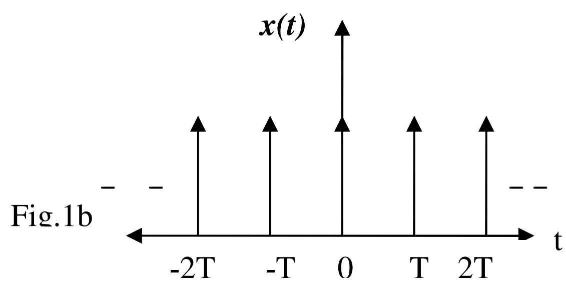
(b) $g(t) = \frac{d}{dt}[x(t)] * h(t)$

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

Problem 5 Consider a causal LTI system whose input $x(n)$ and output $y(n)$ are related by the difference equation. $y(n) = \frac{1}{4}y(n-1) + x(n)$. Determine $y(n)$ if $x(n) = \delta(n-1)$.

Problem 6 Let $h(t)$ be the triangular pulse shown in Fig. 1(a) and let $x(t)$ be the impulse train shown in fig.(b)





Determine and sketch $y(t) = x(t) * h(t)$ for the following values of T.

(a) T=4 **(b)** T=2 **(c)** T=3/2 **(d)** T=1