DSP.

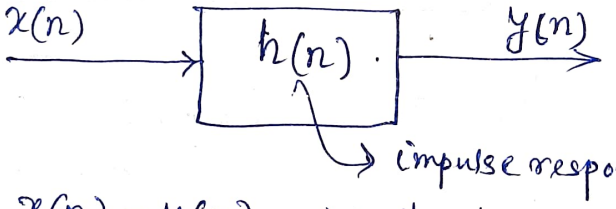
Recap. → • Properties of convolution sum (Linear convolution)

• Methods to compute convolution:
- Graphical method
- Matrix method.

Today's agenda.

- How to compute step-response from impulse response?.
- Causality ~ impulse response of LTI system.
- BIBO Stability ~ impulse response of LTI System.
- Walk through some problems.

Step-response of a discrete-time LTI System.



$x(n) = u(n)$ → unit-step sequence,

$y(n) = s(n)$ → step-response.

$$s(n) = \sum_{k=0}^{\infty} h[k]$$

$$s(n) = \sum_{k=0}^{\infty} h(n-k)$$

$$h(n) = s(n) - s(n-1)$$

$$s(n) = \sum_{n=-\infty}^{n} h(n)$$

Causality Condition for a discrete-time LTI System.

For a causal system,

$$h(n) = 0 \quad , n < 0$$

Stability Condition

A discrete-time LTI System is BIBO stable if its impulse response is absolutely summable. i.e.

$$\sum_{K=-\infty}^{\infty} |h(K)| < \infty$$

→ This is a sufficient condition for stability.

Classification of LTI system based on impulse response.

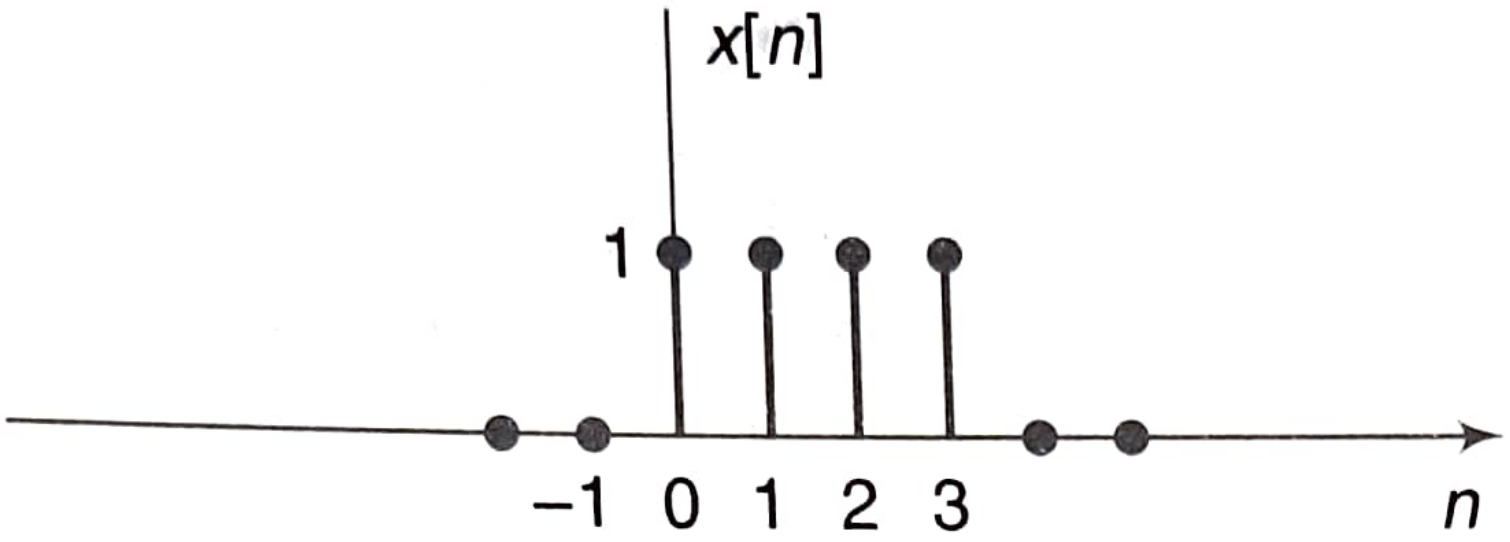
- Finite Impulse Response system. (FIR)
  e.g. $h(n) = \{1, 6, 2, 3\}$ (↑ at 1)
- Infinite Impulse Response System. (IIR).
  $h(n) = a^n u(n)$.

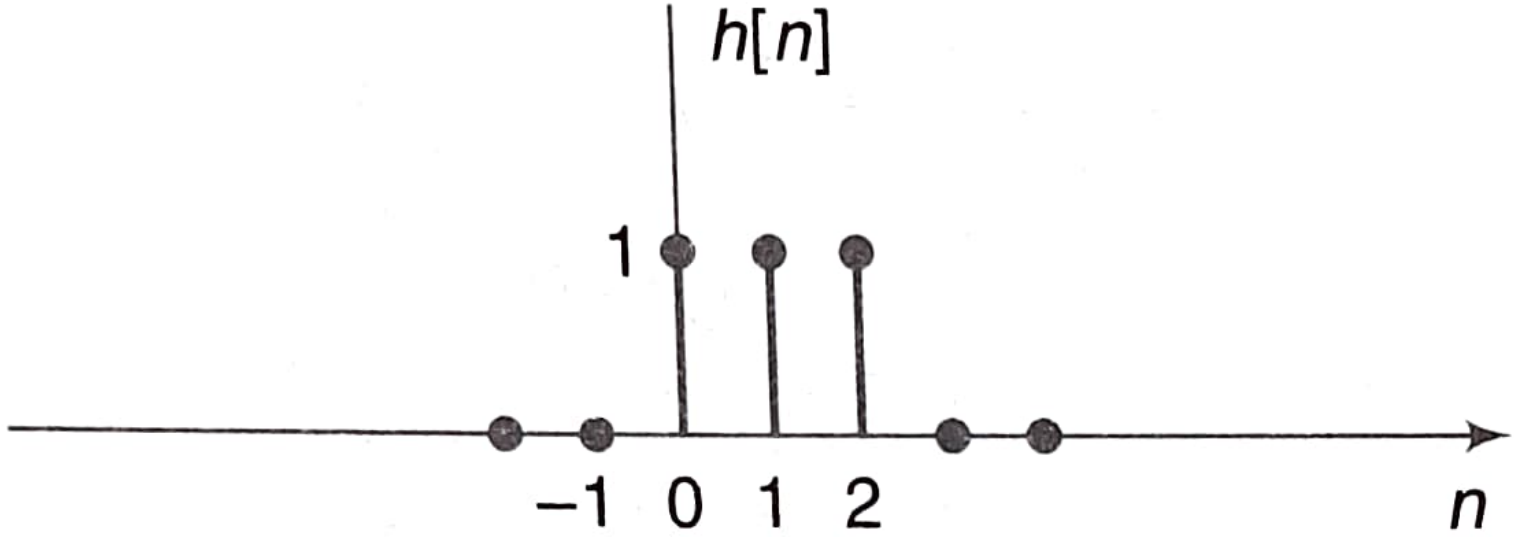
Problems

1. Evaluate $y(n) = x(n) * h(n)$, where $x(n)$ and $h(n)$ are shown in fig. below.

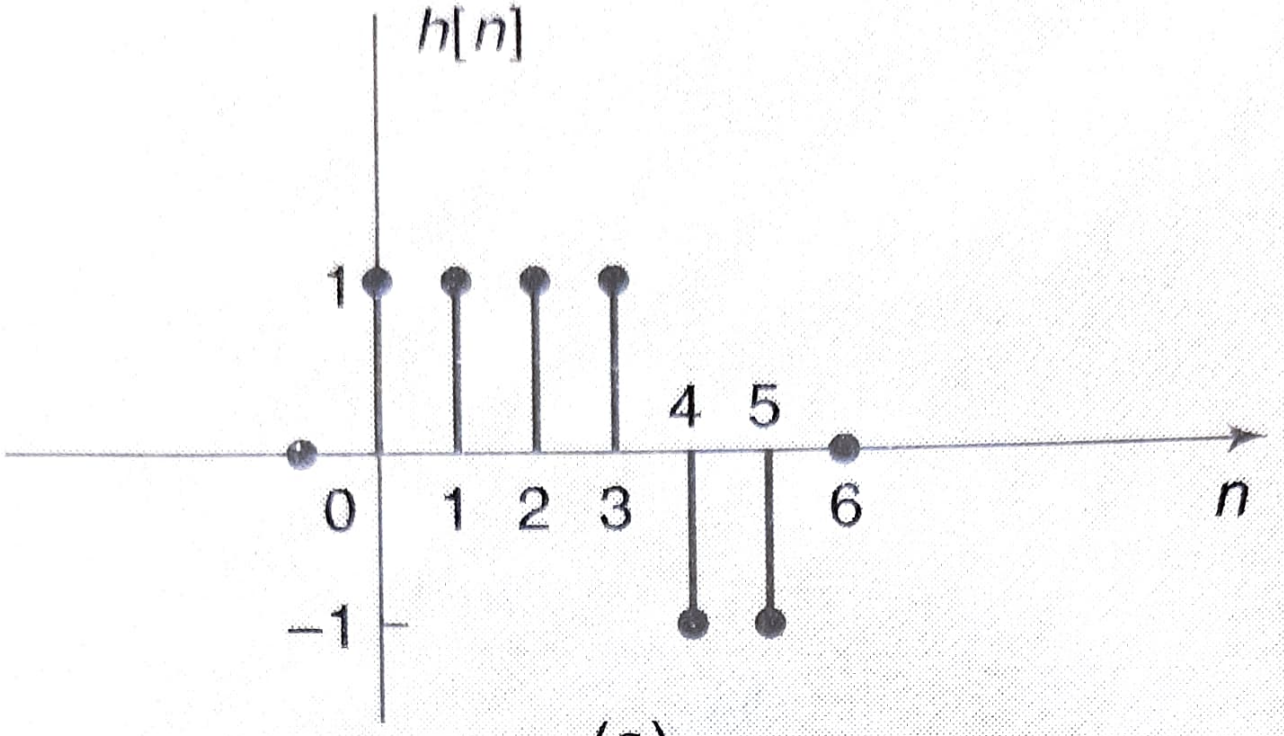
(a) Compute $y(n)$ using Graphical method.

(b) What would be the type of LTI system? (FIR or IIR)?

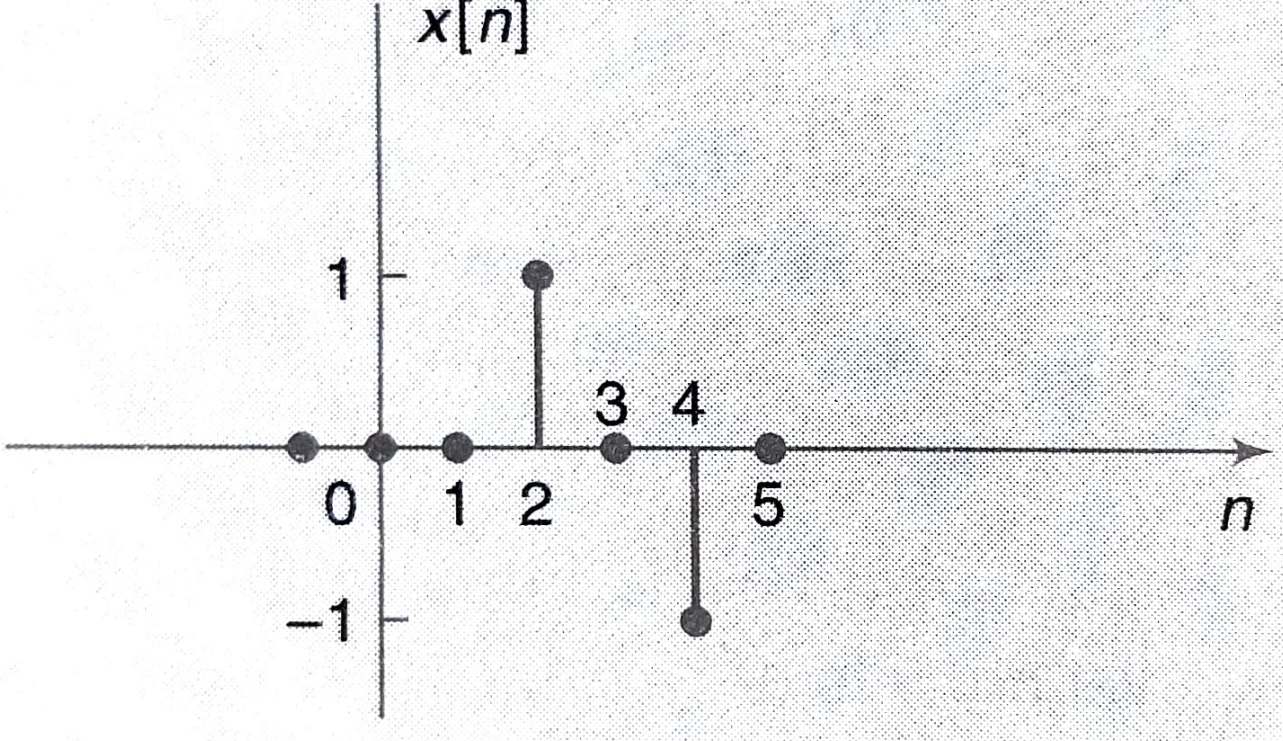

x[n]
1
−1 0 1 2 3
n


h[n]
1
−1 0 1 2
n

2. The impulse response $h[n]$ of a discrete-time LTI System is shown in Fig. Determine and Sketch the output $y[n]$ of this system to the input $x(n)$ shown in the figure (below). [Do this without using the Convolution technique].



(a)



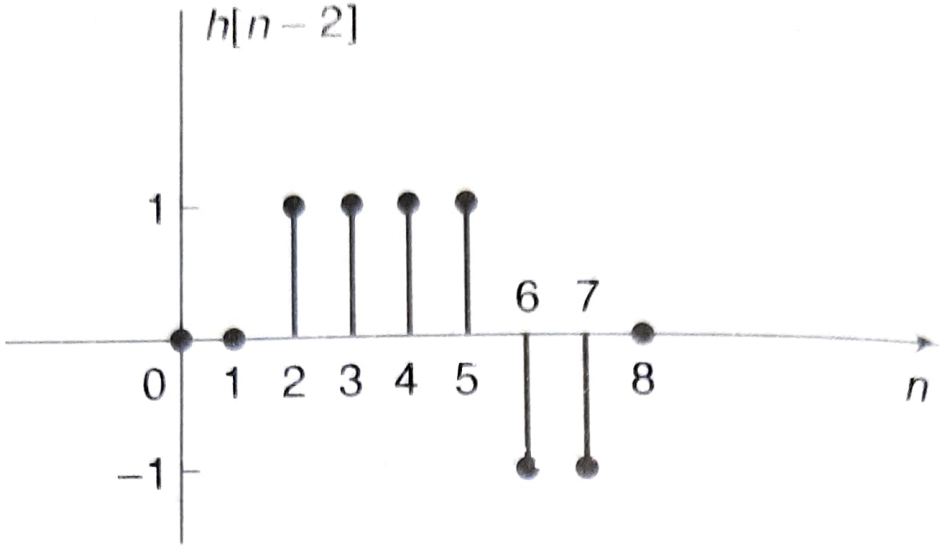
(b)

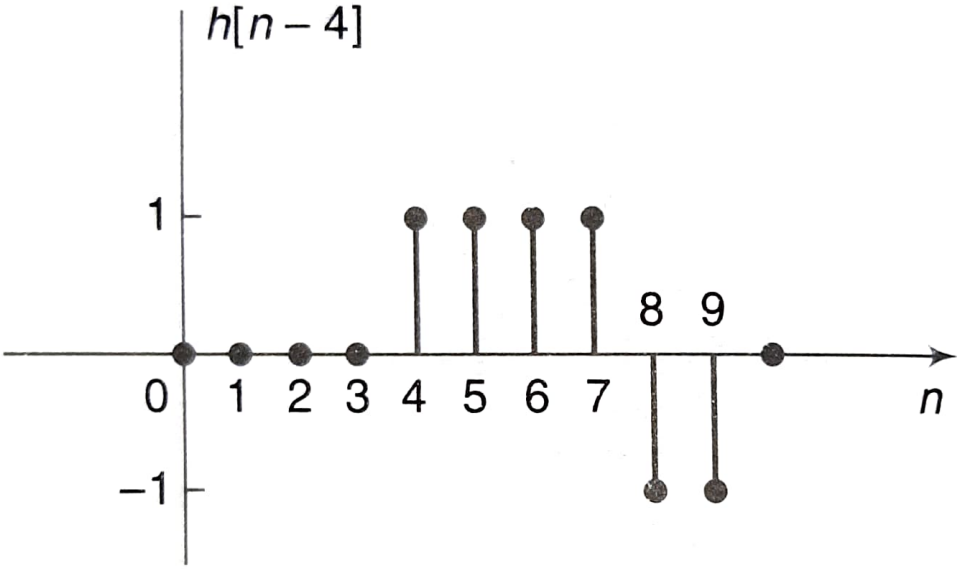
3. Consider a discrete-time LTI system with impulse response $h[n]$ given by.

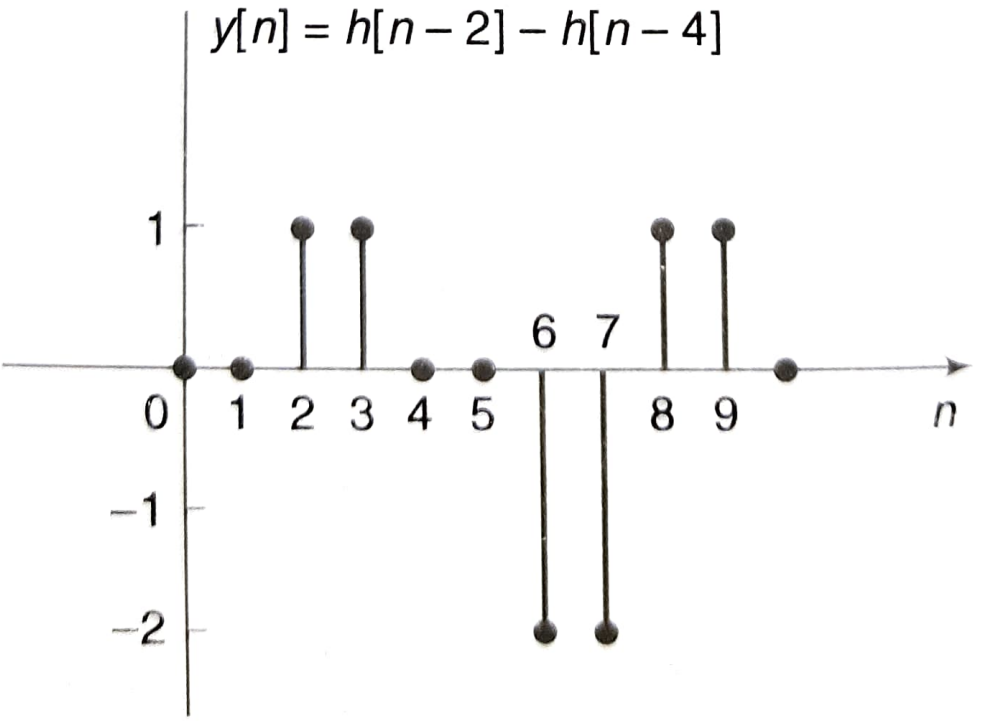
$$h[n] = \alpha^n u[n].$$

(a) Is this system causal?

(b) Is this system BIBO stable?


h[n − 2]
1
0
1 2 3 4 5
6 7
8
n
−1


h[n − 4]
1
0
1 2 3 4 5 6 7
8 9
n
−1


y[n] = h[n − 2] − h[n − 4]
1
0
1 2 3 4 5
6 7
8 9
n
−1
−2