e.g

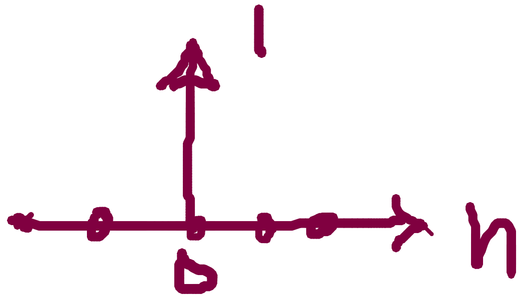
$$x[n] \longrightarrow \boxed{\text{Delay of } n_0} \longrightarrow y[n] = x[n-n_0]$$

$$x[n] = \delta[n] \longrightarrow y[n] = \delta[n-n_0]$$

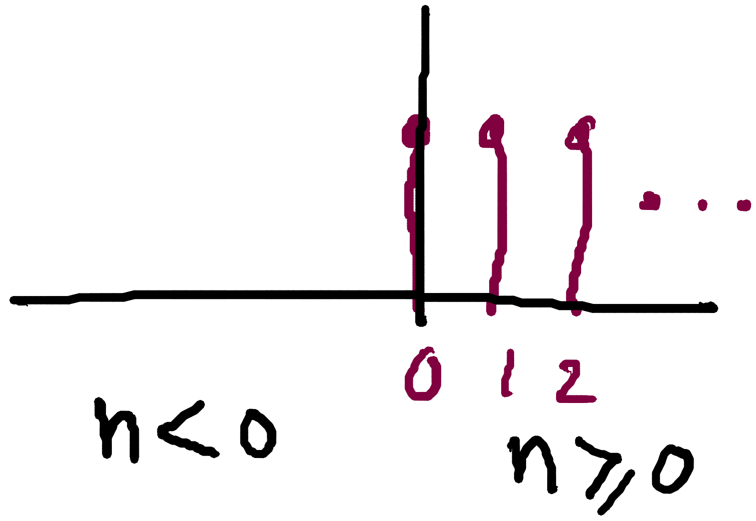
e.g Accumulator

$$x[n] \longrightarrow \boxed{\text{Accumulator}} \longrightarrow y[n] = y[n-1] + x[n]$$

$$y[n] = \sum_{k=-\infty}^{n} x[k]$$



$$\delta[n] \longrightarrow h[n] = \sum_{k=-\infty}^{n} \delta[k]$$



$$\boxed{h[n] = u[n]}$$

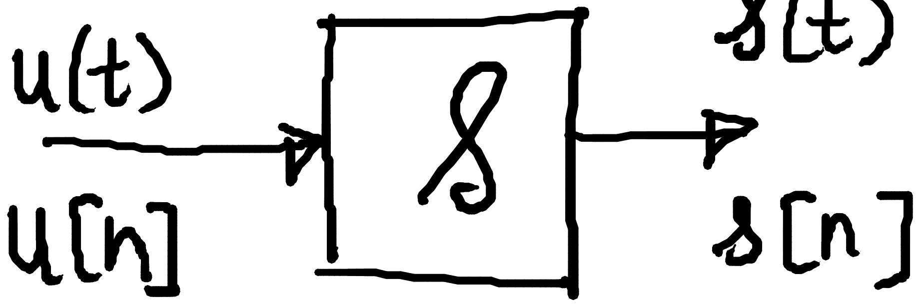
$$y[n] = y[n-1] + x[n]$$

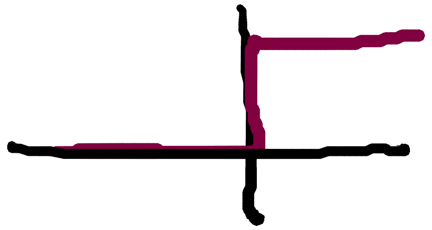
$$y[n] - y[n-1] = x[n]$$

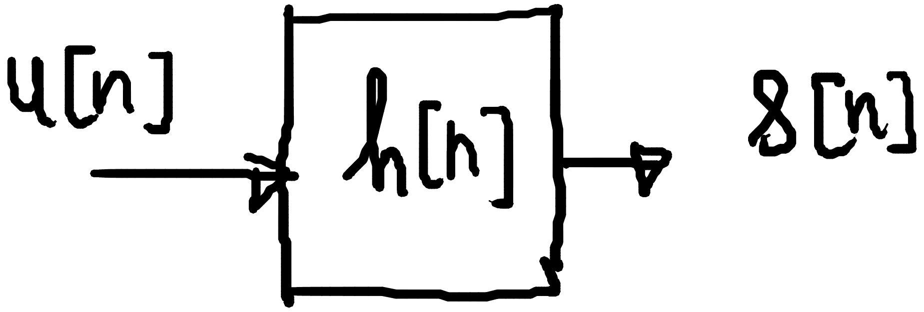
$x[n]$ 1, 2, 3

$y[n]$ 1, 3, 6 ....

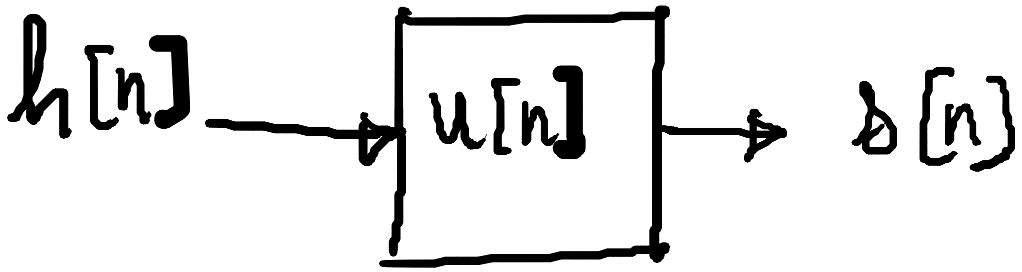
Step Response :







$$s[n] = h[n] * u[n]$$



$$s[n] = \sum_{k=-\infty}^{n} h[k]$$

Step response

x → 1, 2, 3, 4, ...

y → 1, 3, 6, 10, ...

1, 2, 3, 4, ...

$u(t) \rightarrow \boxed{\underset{\text{LSI}}{s}} \rightarrow$

$s(t) = u(t) * h(t)$

$s[n] = u[n] * h[n]$

$= h[n] * u[n]$

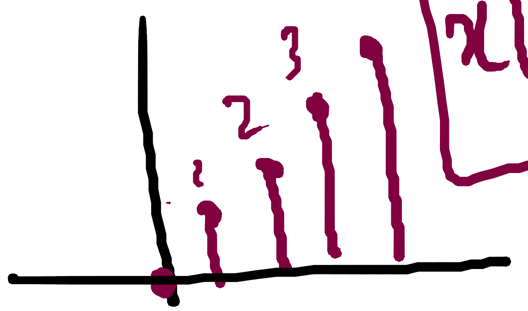
$h[n] \rightarrow \boxed{u[n]} \rightarrow s[n]$

Step response is running sum / result of accumulation of Impulse response

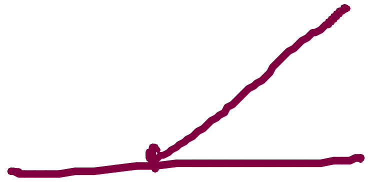
$$s[n] = \sum_{k=-\infty}^{n} h[k]$$

$$h[n] = s[n] - s[n-1]$$

Impulse response can be obtained from step response by simply taking first difference of step response

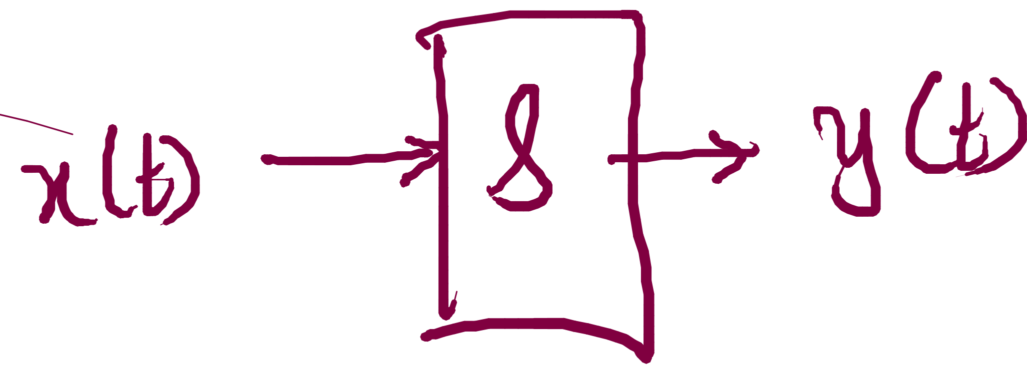


$\boxed{x[n] = n}$

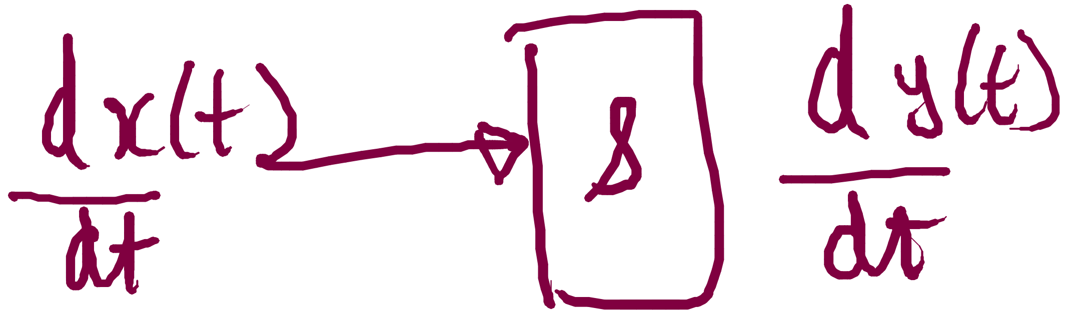


$r[n]$	1	2	3	4
$u[n]$	1	1	1	1
$\delta[n]$	1	0	0	0

n



$$\frac{dx(t)}{dt} = \lim_{t_0 \to 0} \frac{x(t) - x(t - t_0)}{t_0}$$



$$= \lim_{t_0 \to 0} \frac{x(t) - x(t + t_0)}{t_0}$$

$$y[n] = x[n] + x[n-1]$$

$$y[n] = \underline{x[n] + x[n+1]}$$

e.g

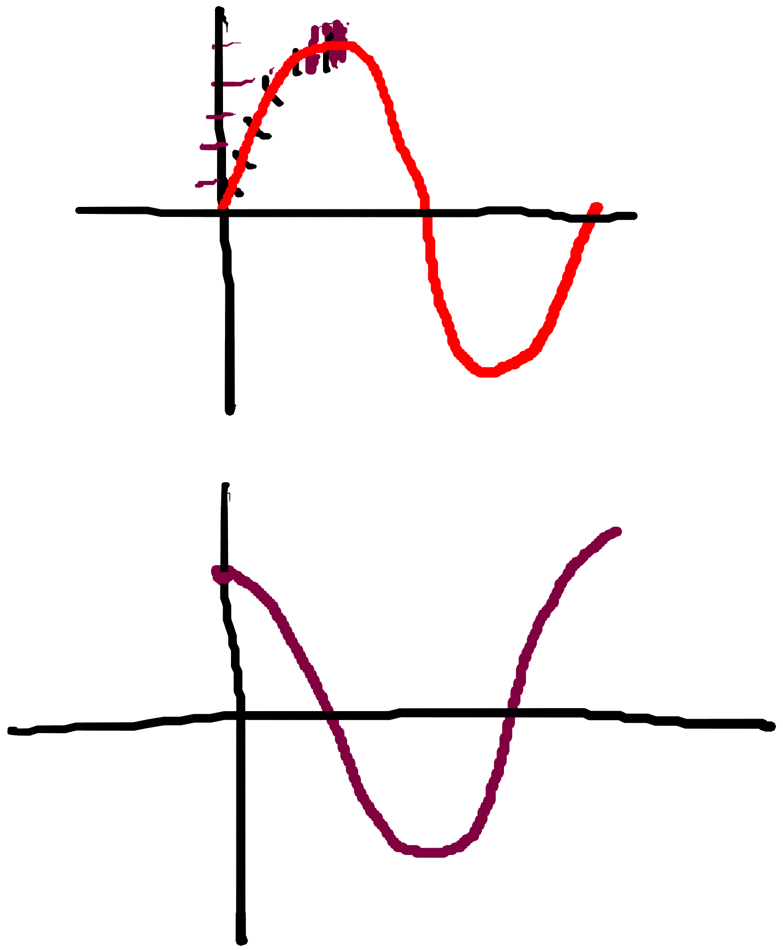
$$s(t) = \sin(2t)$$

$$h(t) = 2\cos(2t)$$

2, 4, 6, 8,

$$\boxed{\begin{aligned} h(t) &= \frac{ds(t)}{dt} \\ s(t) &= \int_{-\infty}^{t} h(\tau)\, d\tau \end{aligned}}$$

$$x[n] \rightarrow \boxed{h[n]} \rightarrow y[n]$$

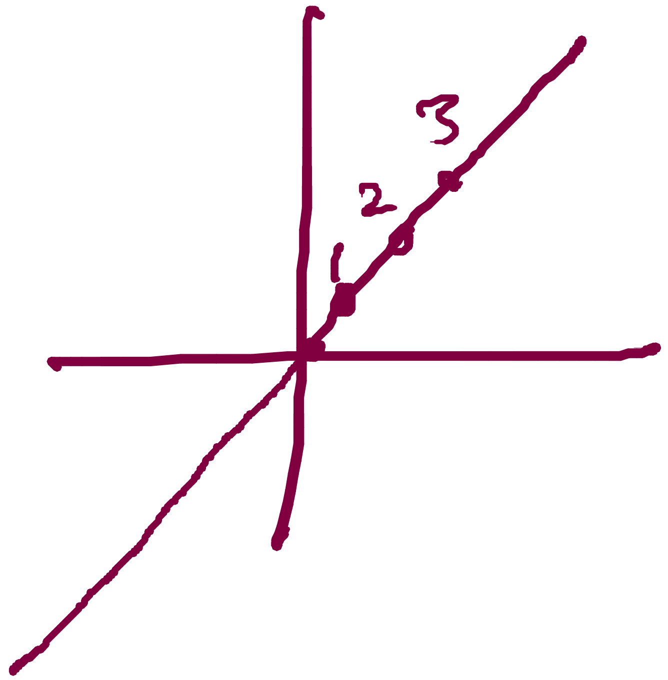


t

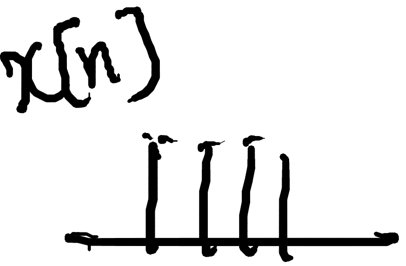
$2t$

$2x$

$x(t) = t$



Stability of LSI System



$$h[n] = \{1, 2, 3\}$$

$$\boxed{\delta}$$

$$\boxed{h[n] = u[n]}$$

$$y[n] = \sum_{k=-\infty}^{\infty} x[k]\, h[n-k] = \sum_{k=-\infty}^{\infty} h[k]\, x[n-k]$$

$$0 < |x[n]| < \infty$$

$$\boxed{|x[n]| < B}$$

$$|y[n]| = \left| \sum_{k=-\infty}^{\infty} h[k]\, x[n-k] \right| \le \sum_{k=-\infty}^{\infty} |h[k]\, x[n-k]|$$

$$= \sum_{k=-\infty}^{\infty} |h[k]|\, |x[n-k]| \le \sum_{k=-\infty}^{\infty} |h[k]|\, B$$

$$\boxed{|y[n]| \le B \sum_{k=-\infty}^{\infty} |h[k]|}$$