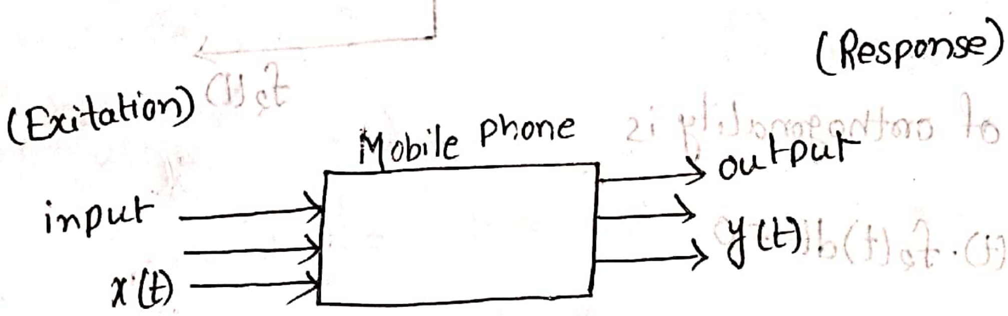
DSP (Digital signal processing)

class-1

#Signal: Any time varying phisical phenomenon that is intended to convey information is called as signal. Singal is a function of time. That is denoted by $f(t)$.

Ex: Human voice, voltage on telephonewires. Noise is also a signal which carries unwanted information.

 # System: System is a device which operates on signals according to it's characteristics.



Ex: Communication system.

Important points about signals-

(*) A signal $f_1(t)$ can be represented in terms of other signal $f_2(t)$ as,

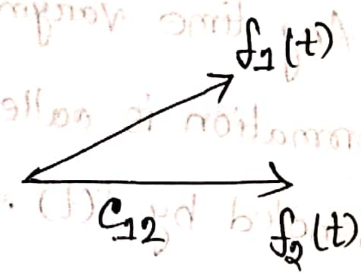
$$f_1(t) = C_{12} f_2(t)$$

Here,

C_{12} = Coefficient of approximation.

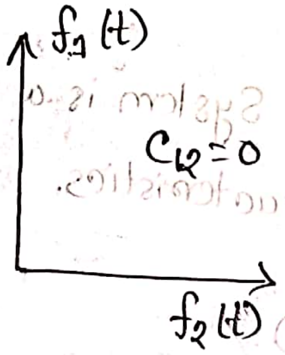
Where,

$$C_{12} = \frac{\int_{t_1}^{t_2} f_1(t) \cdot f_2(t)\,dt}{\int_{t_1}^{t_2} f_2^{\,2}(t)\,dt}$$



$$f_1(t) = C_{12} f_2(t)$$

(*) If two signals are orthogonal, coefficient is zero, $C_{12} = 0$



(*) The condition of orthogonality is

$$\int_{t_1}^{t_2} f_1(t) \cdot f_2(t)\,dt = 0$$

(*) Sin and cos functions are orthogonal to each other.
If $f_1(t)$ is in terms of sin and $f_2(t)$ is in term of cos than we can say this signal are orthogonal to each other.

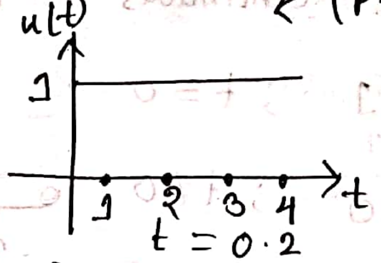
Unit step signal: The area covered by all unit signal is 1
Amplitude is 1

if amplitude is more then one then it is called "step signal".

- It is denoted with $u(t)$ or $u(n)$
Continuous ↑ discreet ↑

(pictorial representation)

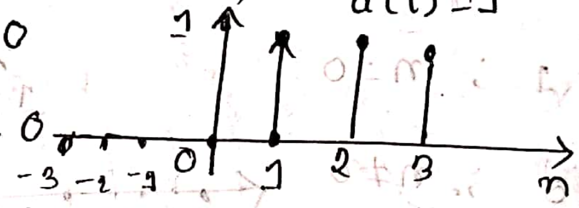
Here, $u(t) = \begin{cases} 1 & ; t \geq 0 \\ 0 & ; t < 0 \end{cases}$



$t = 0.2$
$u(t) = 1$

$u(n) = \begin{cases} 1 & ; n \geq 0 \\ 0 & ; n < 0 \end{cases}$

(mathematical condition)



$n = 0.2$
$u(n) =$ can't be determined.

Property:

(I) $[u(t)]^n = u(t)$

$\Rightarrow [u(t-t_0)]^k = u(t-t_0)$

Shift/multiply → output will be 1

(II) $u(at) = u(t)$ [time scaling will not work here)]

$u(at - t_0) = u[a(\underline{t - t_0/a})]$

$= u(t - t_0/a)$ [$\because u(at) = u(t)$]

* unit step signal is the best testing signal to test any system & getting response.

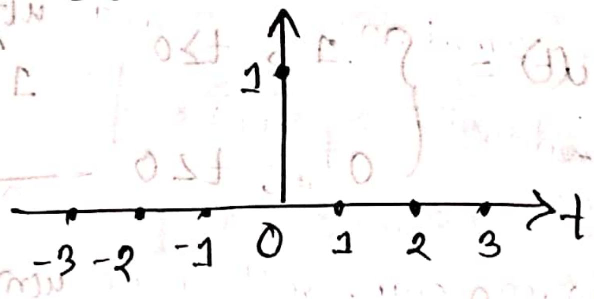
shifting - উপরের left or right এ সরানো।

④ Impulse function :

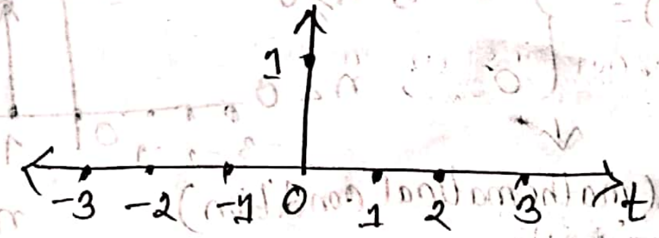
It is denoted by $\delta(t)$ or $\delta(n)$

$\delta(t)$ ↑ Continuous, $\delta(n)$ ↑ discreet

$$\delta(t) = \begin{cases} 1 & ; t = 0 \\ 0 & ; t \neq 0 \end{cases}$$



$$\delta(n) = \begin{cases} 1 & ; n = 0 \\ 0 & ; n \neq 0 \end{cases}$$



Properties :-

(i) $\displaystyle\int_{-\infty}^{\infty} \delta(t)\,dt = 1$

$\Rightarrow \delta(t)\big|_{t=0} = 1$

(ii) $\delta(n-k) = \begin{cases} 1 & ; n = k \\ 0 & ; n \neq k \end{cases}$ [K এর value যত- ততেই একটা output pabo]

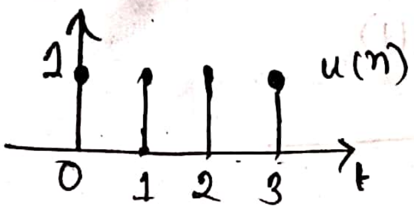
↑ Positive shifting

$n - k = 0$

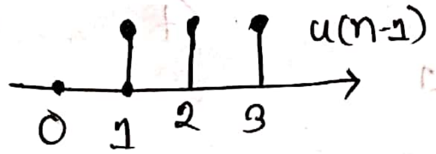
$\therefore n = k$

$\therefore \delta(k) = \begin{cases} 1 & ; k = n \\ 0 & ; k \neq n \end{cases}$

(III) $\delta(n) = u(n) - u(n-1)$



(−)



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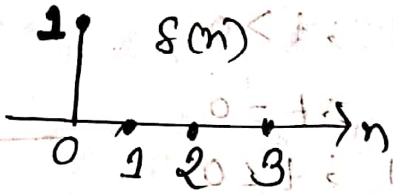
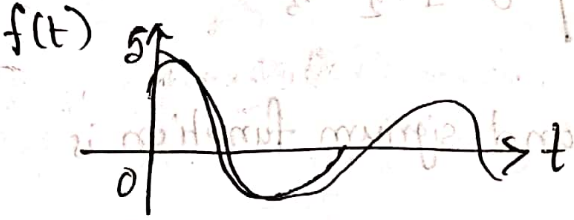
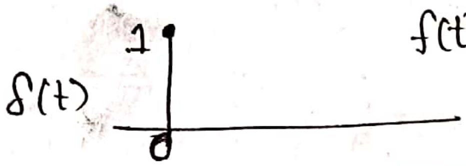
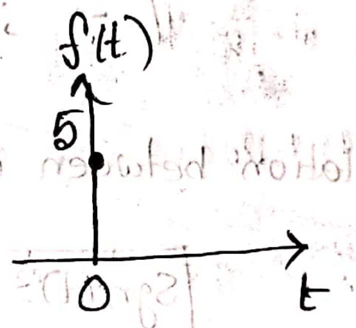


(IV) $f(t) \cdot \delta(t) = f(0)$

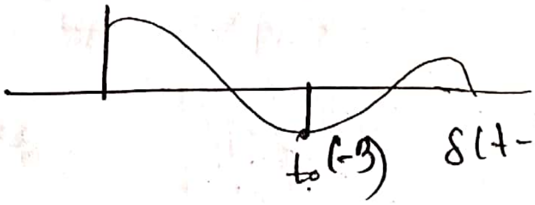




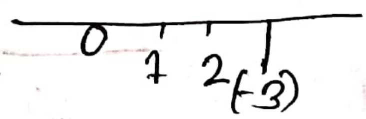
$f(t) \times \delta(t) = 5$ (X) =

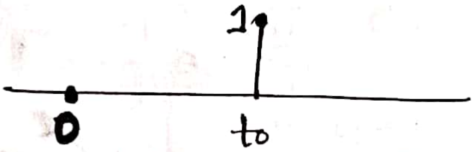


(V) $\delta(t - t_0) \cdot f(t) = f(t_0)$



$\delta(t - t_0) \cdot f(t) = f(t_0)$ =





(VI) $\delta(Kt) = \frac{1}{|K|}\delta(t)$

$\therefore \delta(2t) = \frac{1}{2}\delta(t)$

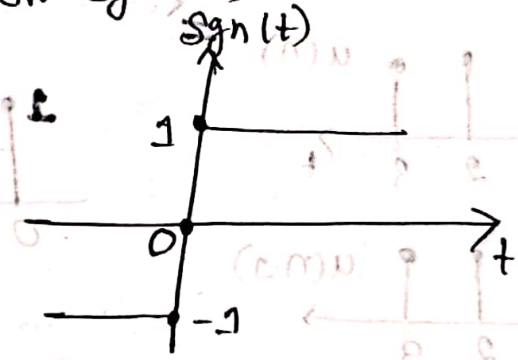
(VII) $\delta(-t) = \delta(t)$ * *

↳ It indicates that it is an even function.

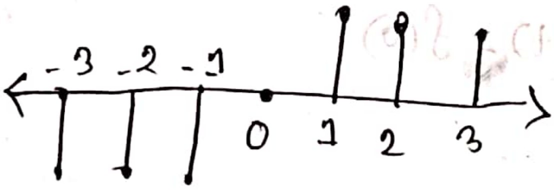
Signum function :

It is denoted by sgn(t) or sgn(n)

$$sgn(t) = \begin{cases} 1 & ; t > 0 \\ 0 & ; t = 0 \\ -1 & ; t < 0 \end{cases}$$

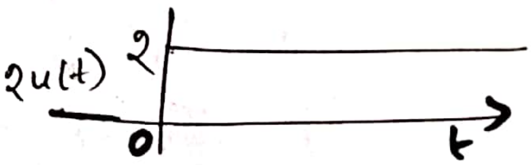


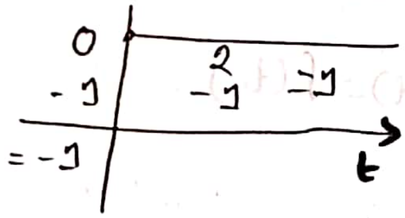
$$sgn(n) = \begin{cases} 1 & ; n > 0 \\ 0 & ; n = 0 \\ -1 & ; n < 0 \end{cases}$$

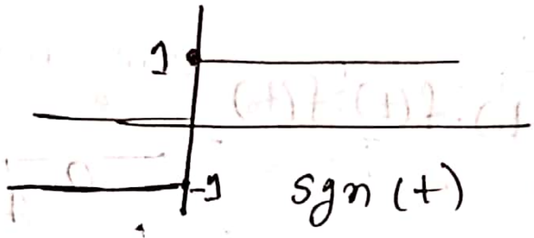


Relation between unit step signal and signum function is

$$\boxed{sgn(t) = 2u(t) - 1}$$







** Exponential Signal :

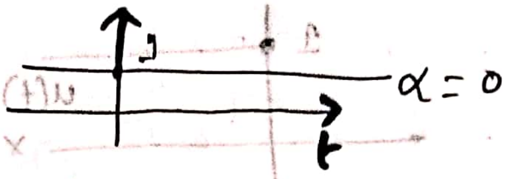
This signal is in the form $x(t) = Ae^{\alpha t}$ [A is the amplitude]

$\therefore x(t) = e^{\alpha t}$ If $A = 1$; then it is called unit exponential signal

(ues) - unit exponential

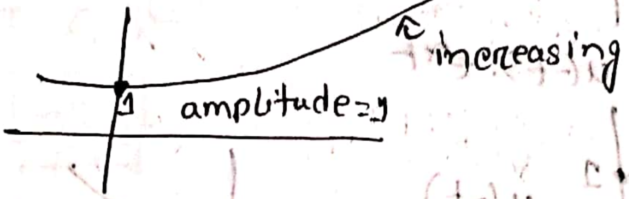
(*) The Shape of exponential depends on α :

Case 1: $\alpha = 0 \Rightarrow x(t) = e^{0 \cdot t} = 1$



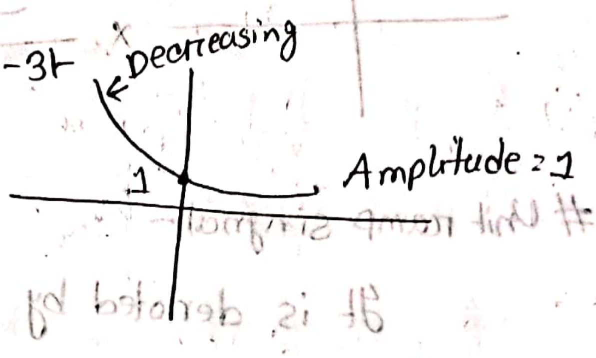
Case 2: $\alpha > 0$ $\Rightarrow x(t) = e^{3t}$

Let $\alpha = 3$



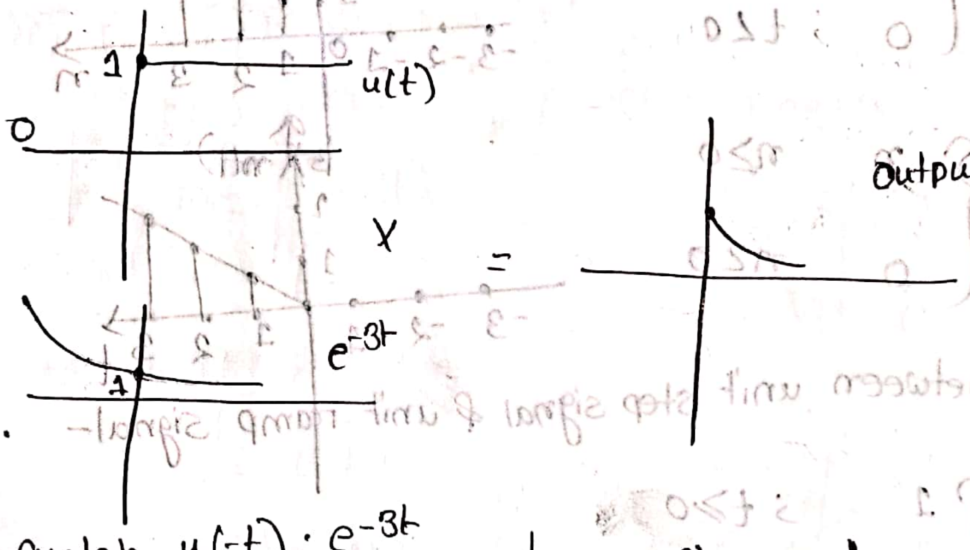
Case 3: $\alpha < 0$

Let $\alpha = -3$ $\Rightarrow x(t) = e^{-3t}$

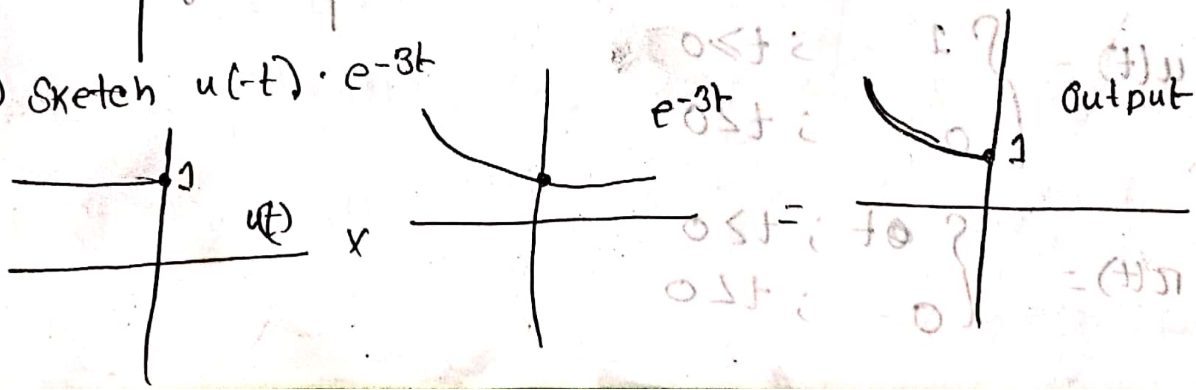


class-2

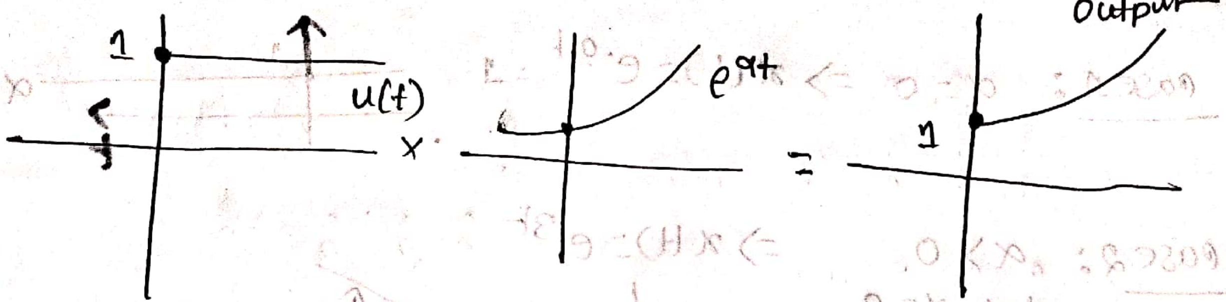
(i) Sketch $u(t) \cdot e^{-3t}$



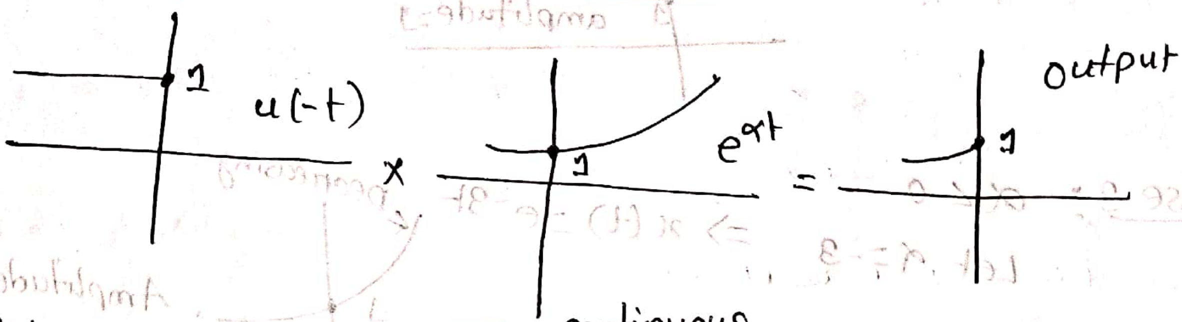
(ii) Sketch $u(-t) \cdot e^{-3t}$



(iii) Sketch $u(t).e^{\alpha t}$



(iv) Sketch $u(-t).e^{\alpha t}$

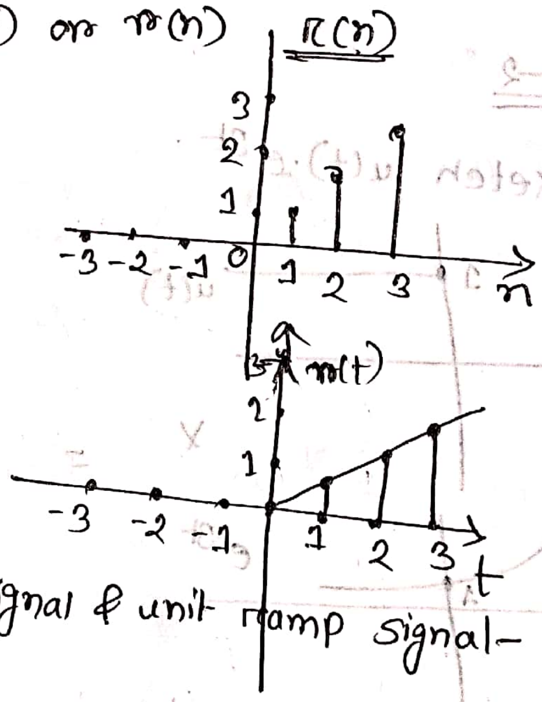


Unit ramp singnal –

It is denoted by $r(t)$ or $r(n)$ — continuous

$$r(t) = \begin{cases} t & ; t \geq 0 \\ 0 & ; t < 0 \end{cases}$$

$$r(n) = \begin{cases} n & n \geq 0 \\ 0 & n < 0 \end{cases}$$



Relation between unit step signal & unit ramp signal –

$$u(t) = \begin{cases} 1 & ; t \geq 0 \\ 0 & ; t < 0 \end{cases}$$

$$r(t) = \begin{cases} t & ; t \geq 0 \\ 0 & ; t < 0 \end{cases}$$