UNIT - I

SIGNALS AND SYSTEMS

Signal :-

A Function of one or more independent Variables which contain some information is called a signal.

Radio signal, TV signal, Telephone signal - Electrical signals

Sound signal and pressure signal - Non Electrical signals

Noise signal :-

A signal which doesnot contain any information is called Noise signal.

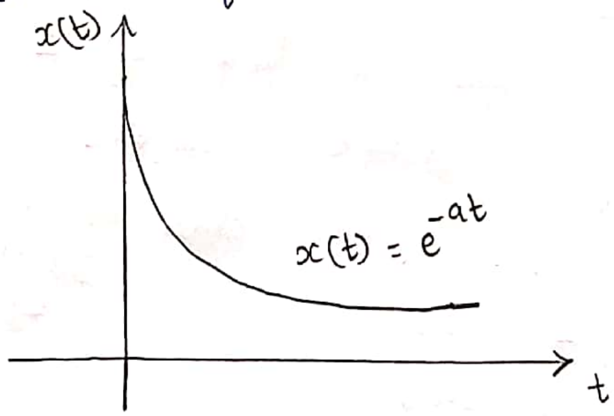
classification of a signal :-

It can be classified into two parts depending upon the independent variable time.

1) continuous time signal
2) Discrete time signal

continuous time signals :-

It is defined continuously with respect to time



e^{-at} → Defined at every time Instant

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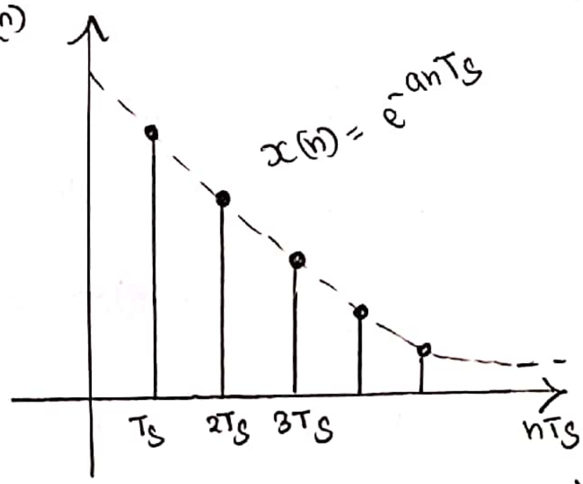
Discrete time Signal :-

It is defined only at specific or regular Intervals / time Instants.



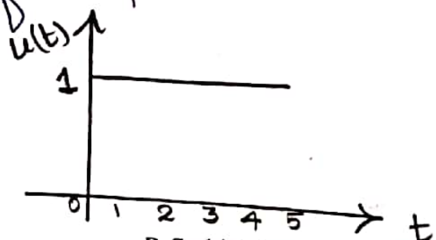
This discrete time signals has values only at $T_s, 2T_s, 3T_s$ it is not defined over continuous time.

Standard Signals [Elementary Signals]

1) Unit step Function
2) Unit Impulse function
3) Unit Ramp Function
4) complex exponential function
5) Sinusoidal Function

Unit step function :- It has amplitude of '1' for all the positive values of independent variables and it has amplitude of '0' for negative values of independent variable.

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



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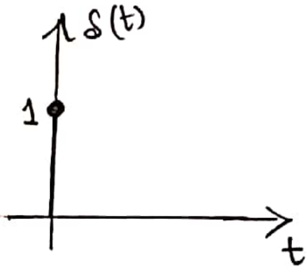
Unit Impulse (or) Delta Function (or) Unit Sample Function :-

It has the amplitude of '1' only at $t=0$ and amplitude of '0' only at $t \neq 0$

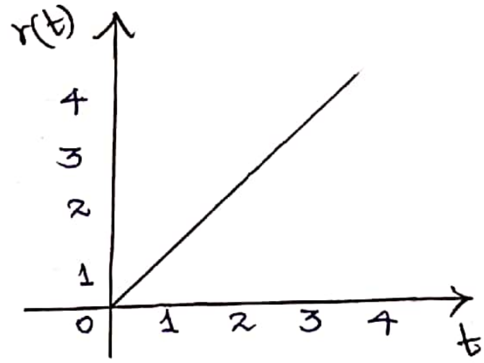
$$\delta(t) = \begin{cases} 1 & \text{for } t=0 \\ 0 & \text{for } t \neq 0 \end{cases}$$



Unit Ramp Function :-

It is linearly growing function for all positive values of independent variables.

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



Exponential Signal :-

When the exponent is purely imaginary then the signal is said to be complex exponential signal.

$$x(t) = e^{j\omega_0 t}$$

complex exponential can be written interms of sinusoidal signals as

$$x(t) = e^{j\omega_0 t} = \cos\omega_0 t + j\sin\omega_0 t$$

Sinusoidal signal can be written interms of complex exponential

$$\cos[\omega_0 t + \phi] = \frac{e^{j[\omega_0 t + \phi]} + e^{-j[\omega_0 t + \phi]}}{2}$$

$$\sin[\omega_0 t + \phi] = \frac{e^{j[\omega_0 t + \phi]} - e^{-j[\omega_0 t + \phi]}}{2j}$$

* $\cos\theta = \dfrac{e^{j\theta} + e^{-j\theta}}{2}$

* $\sin\theta = \dfrac{e^{j\theta} - e^{-j\theta}}{2j}$

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Relationship between unit step and Unit Ramp :-

Unit ramp :-

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

Unit Step :-

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

Diff $r(t)$ w.r to t

$$\frac{d}{dt} r(t) = \begin{cases} 1, & t \geq 0 \\ 0, & t < 0 \end{cases}$$

$$\frac{d}{dt} r(t) = u(t)$$

$$d\, r(t) = u(t)\, dt$$

$$r(t) = \int u(t)\, dt$$

Relationship between Unit step and Unit Impulse :-

Unit step : $u(t) = \begin{cases} 1, & t \geq 0 \\ 0, & t < 0 \end{cases}$

Unit Impulse : $\delta(t) = \begin{cases} 1, & t = 0 \\ 0, & t \neq 0 \end{cases}$

Diff $u(t)$ w.r to t

$$\frac{d}{dt} u(t) = \begin{cases} 1, & t = 0 \\ 0, & t \neq 0 \end{cases}$$

$$\frac{d}{dt} u(t) = \delta(t)$$

$$d\, u(t) = \delta(t)\, dt$$

$$u(t) = \int \delta(t)\, dt$$

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