

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.

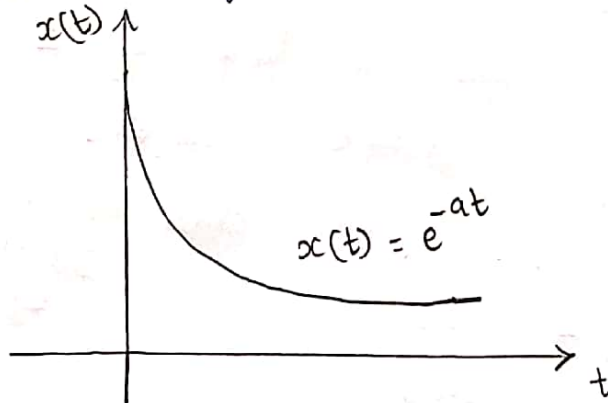
classification of a signal :-

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

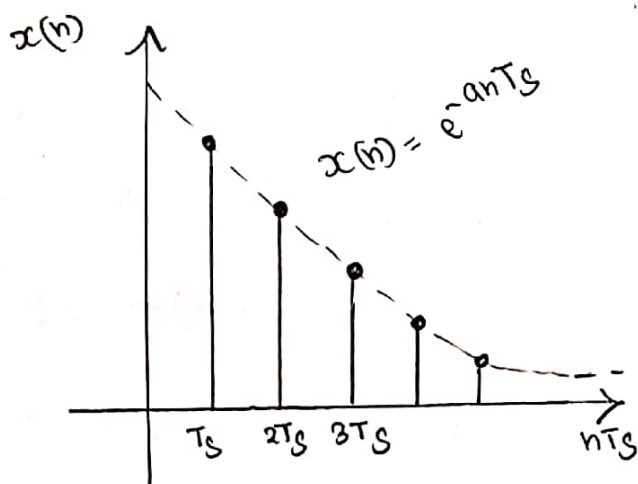


$e^{-at} \rightarrow$ Defined at every time Instant

Discrete time signal :-



It is defined only at specific or regular intervals / time instants.



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

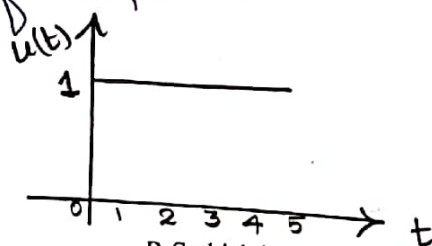
Standard Signals [Elementary signals]

- 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.

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



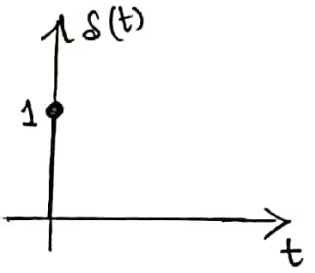
Unit Impulse (or) Delta Function (or) Unit Sample Function :-



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



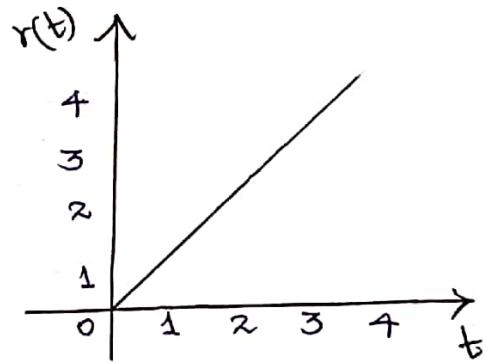
$$S(t) = \begin{cases} 1 & \text{for } t=0 \\ 0 & \text{for } t \neq 0 \end{cases}$$



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 in terms 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 in terms of complex exponential

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

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

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

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

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 :-

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

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

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

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

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

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

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