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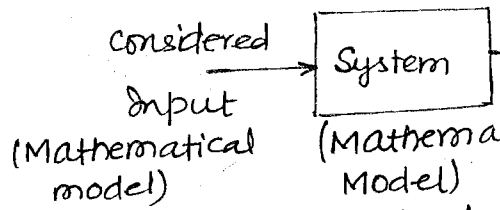
## *WHY SIGNALS AND SYSTEMS:.

* To ensure suitable working of the system to be designed before its actual designing. This is done by providing a Signal to ensure the response.
* And by mathematical tool these can be done.
* Considering the system as mathematical Model and also considering the input as mathematical. The desired System can be designed.

* To find the expression of the Response we study Signal & System.




* Mathematical tools used for find the Response of the System in more efficient way with less effort are:.
  - i) Fourier Series.
  - ii) Fourier Transforms.
  - iii) Laplace Transforms.
  - iv) Z Transforms.

  } used to minimize the effort in designing of the system.

Note:.

* Information (Signal) can exist in only two ways:.
  - i) Continuous Time signal.
  - ii) Discrete Time Signal. (if samples are taken at very close intervals then only information can be Retrieved back).

* Sampling Theorem provides guidelines to convert Continuous Time signals into Equivalent Discrete Time Signals.

## SIGNALS :-

* Any entity having associated information with it is defined as SIGNAL.
* Signal here means voltage and current signals where both are functions of time.

$v(t)$ or $i(t)$ $\Big\}$ $f(t)$ ← 1 DIMENSIONAL SIGNAL

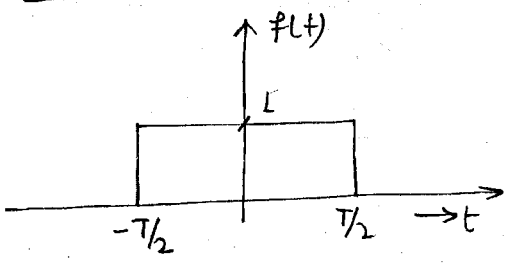
* Signals need not always be function of time.
* Signals also can be function of space having different intensity level.

Photo Picture → $f(x, y)$. ← 2 DIMENSIONAL SIGNALS (signal independent of time)

* Also the moving picture (Video signal) which is made up of various still frame is also a signal which is funcⁿ of space & time.

Hence Video = $f(x, y, t)$. ← 3 DIMENSIONAL SIGNAL (space, time)

* A signal may be function of n variable. These signals are called as N DIMENSIONAL SIGNALS. ↘ need not always be time always.
* Signals can be represented mathematically or graphically. Analysis of signals can be done easily when graphical format is considered.
* RECTANGULAR PULSE :-

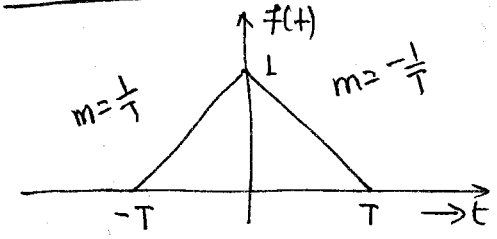



$f(t) = 1 \; ; \; -T/2 \le t \le T/2$

$0 \; ;$ otherwise.

* Any signal having short duration or existing for short duration is called a Pulse.

* TRIANGULAR PULSE :-




$f(t) = f_1(t) = m_1 t + c_1$

$f_1(t) = \frac{1}{T} t + 1 \; ; \; -T \le t \le 0$

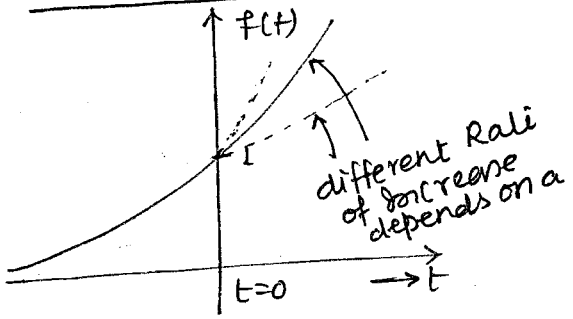
$f(t) = f_2(t) = m_2(t) + c_2$

$f_2(t) = \frac{-1}{T} t + 1 \quad 0 \le t \le T$

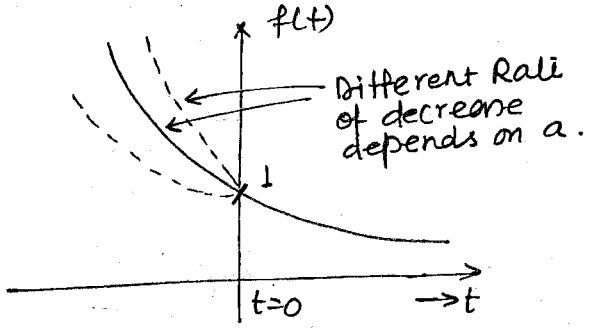
So, for Triangular Pulse:-

$$f(t) = \begin{cases} f_1(t) = \frac{1}{T}t + 1 & ; -T \le t \le 0 \\ f_2(t) = -\frac{1}{T}t + 1 & ; 0 \le t \le T \\ 0 & ; \text{otherwise.} \end{cases}$$

* EXPONENTIAL SIGNALS:-




$f(t) = e^{at}$

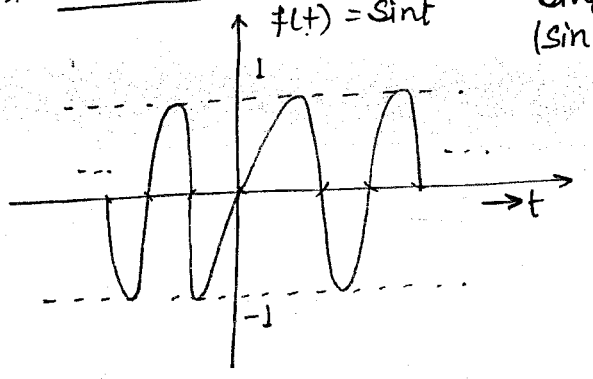



$f(t) = e^{-at}$

a = Scaling factor (deciding Rate of Increase or Decrease).

* a is also called as the Time Const as they decide Rate of Rise and decrease.

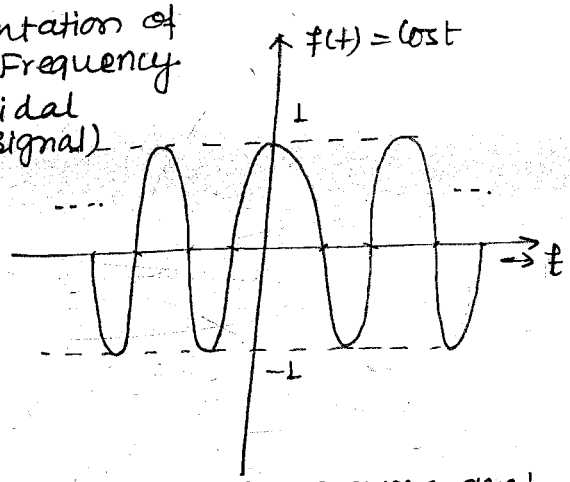
* SINUSOIDAL SIGNALS:-




* Zero cross over are:-

$t = \pm n\pi$

* Representation of Single Frequency (sinusoidal signal)

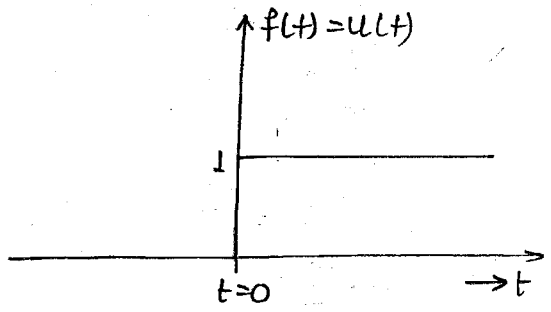



* Zero cross overs are:-

$t = \pm (2n+1)\pi/2$

* The instance of time where signals oscillating b/w +ve and -ve values cross 0 value are defined as ZERO CROSS OVER of such oscillating signals.

## * UNIT STEP SIGNAL:.



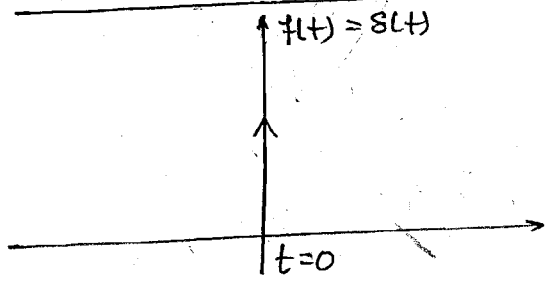

$$f(t) = 1 \; ; \; t > 0$$
$$0 \; ; \; t < 0.$$

$$f(t) = u(t) = 1 \; ; \; t \geq 0.$$
$$0 \; ; \; t < 0.$$

COMPROMISED DEFINITION

$u(t) = 1 \; ; \; t = 0.$

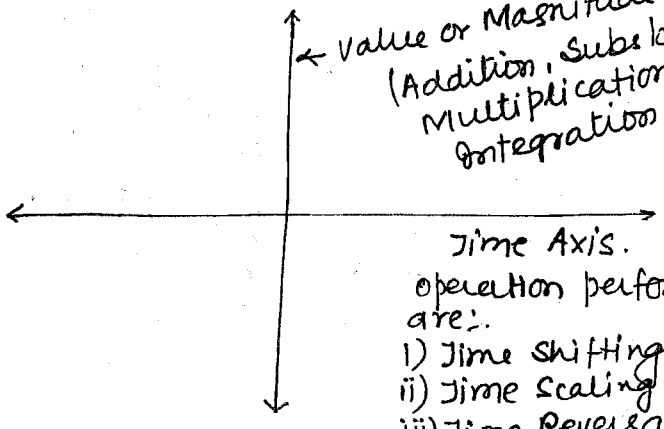
## * IMPULSE FUNCTION:.




$$f(t) = \delta(t) = 0 \; ; \; t \neq 0$$
$$\neq 0 \; ; \; t = 0$$
$$\int_{-\infty}^{\infty} \delta(t)\,dt = 1$$

* Impulse Impacts can be measurable or unmeasurable. Analysis is done only for measurable Impacts.
* Hence to analyse the Impulse signal it has to be measurable and for that its Area should be equal to Unity.
* The magnitude of $\delta(t)$ is $\infty$ at $t=0$ and hence unmanageable so to manage them indirectly its Area is made equal to 1.

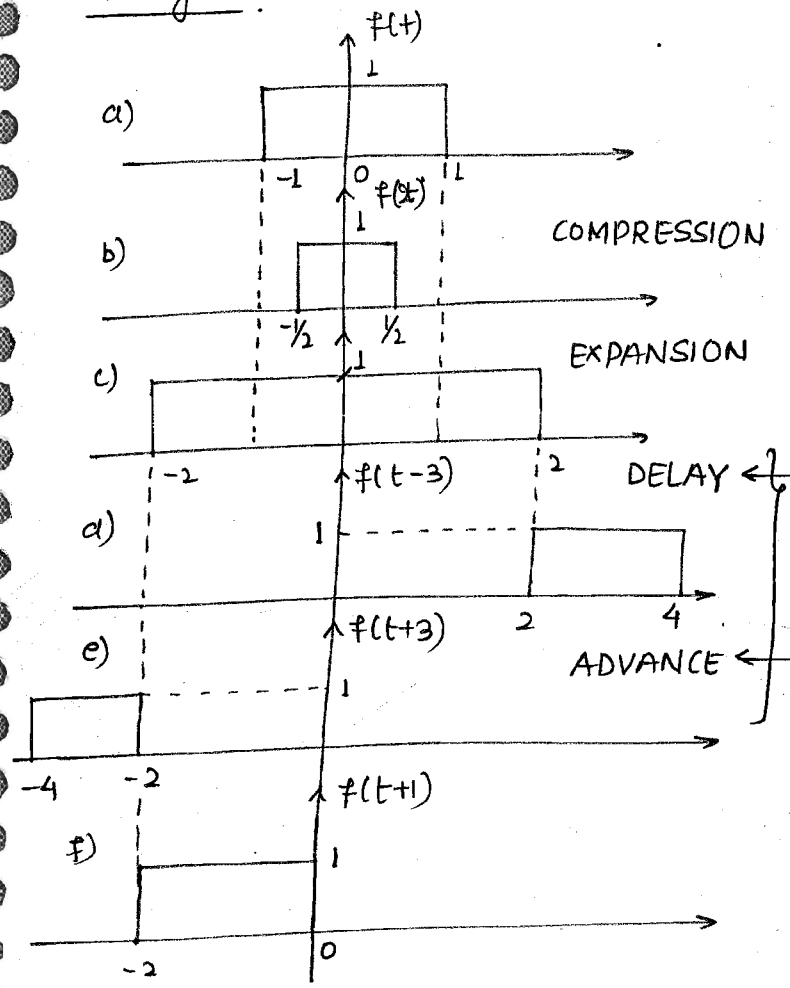
Note :.




operation performed on Time Axis are:.

i) Time Shifting.
ii) Time Scaling.
iii) Time Reversal.

*Analysis :-




*Note :-

* Scaling operation is also known as DIVIDE By "a" operation.
* Delay operation is also known as ADD "to" operation.
* Advance operation is also known as SUBTRACT "to" operation.

a) $f(t) = 1 \; ; \; -1 \le t \le 1$
$\quad\quad 0 \; ; \; \text{otherwise}$

b) $f(2t) = 1 \; ; \; -1 \le 2t \le 1$
$\quad\quad 0 \; ; \; \text{otherwise}$

$f(2t) = 1 \; ; \; -\frac{1}{2} \le t \le \frac{1}{2}$
$\quad\quad 0 \; ; \; \text{otherwise.}$

c) $f(\frac{1}{2}t) = 1 \; ; \; -1 \le t/2 \le 1$
$\quad\quad 0 \; ; \; \text{otherwise}$

$f(t/2) = 1 \; ; \; -2 \le t \le 2$
$\quad\quad 0 \; ; \; \text{otherwise.}$

Note :-

$t \rightarrow at$

$f(t) \xrightarrow{t \rightarrow at} f(at)$

$a > 1 \rightarrow$ COMPRESSION
$a < 1 \rightarrow$ EXPANSION

a = SCALING FACTOR.

d) $f(t-3) = 1 \; ; \; -1 \le t-3 \le 1$
$= 0 \; ;$ otherwise

$f(t-3) = 1 \; ; \; 2 \le t \le 4$
$0 \; ;$ otherwise

e) $f(t+3) = 1 \; ; \; -1 \le t+3 \le 1$
$0 \; ;$ otherwise

$f(t+3) = 1 \; ; \; -4 \le t \le -2$
$0 \; ;$ otherwise

f) $f(t+1) = 1 \; ; \; -1 \le t+1 \le 1$
$= 0 \; ;$ otherwise

$f(t+1) = 1 \; ; \; -2 \le t \le 0$
$0 \; ;$ otherwise

*Note :-

i) $t \rightarrow t - t_0 \rightarrow$ delay or Right shift

ii) $t \rightarrow t + t_0 \rightarrow$ Advance or left shift.