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MADE EASY
ELECTRONICS ENGINEERING
Signal System
By- Vishnu Sir

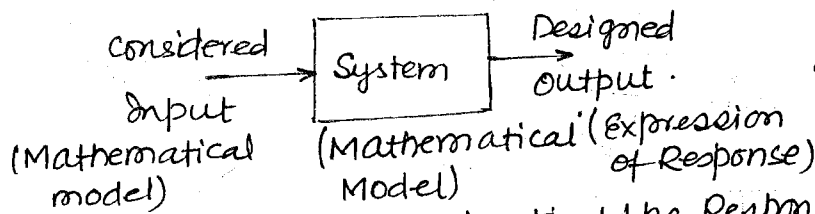
- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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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 to find the response of the system in more efficient way with less effort are:

- Fourier Series.
- Fourier Transforms.
- Laplace Transforms.
- 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.

$$\left. \begin{array}{l} v(t) \\ \text{or} \\ i(t) \end{array} \right\} f(t) \leftarrow \text{1 DIMENSIONAL SIGNAL}$$

* Signals need not always be function of time.

* Signals also can be function of space having different intensity level.
signal independent of time.

$$\text{Photo Picture} \rightarrow f(x, y) \leftarrow \text{2 DIMENSIONAL SIGNALS}$$

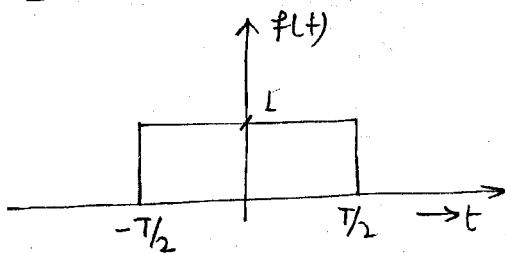
* Also the moving picture (video signal) which is made up of various still frame is also a signal which is funcⁿ of space & time.

$$\text{Hence Video} = f(x, y, t) \leftarrow \text{3 DIMENSIONAL SIGNAL}$$

* 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.

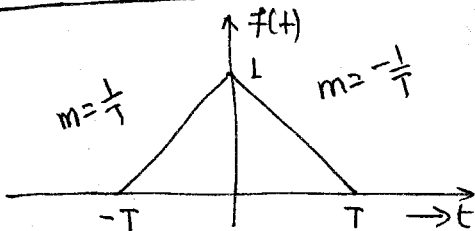
RECTANGULAR PULSE ∴



$$f(t) = \begin{cases} 1 & -T/2 \leq t \leq T/2 \\ 0 & \text{otherwise} \end{cases}$$

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

TRIANGULAR PULSE ∴



$$f(t) = f_1(t) = m_1 t + C_1$$

$$f_1(t) = \frac{1}{T} t + 1 \quad ; \quad 0 \leq t \leq T$$

$$f(t) = f_2(t) = m_2(t) + C_2$$

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

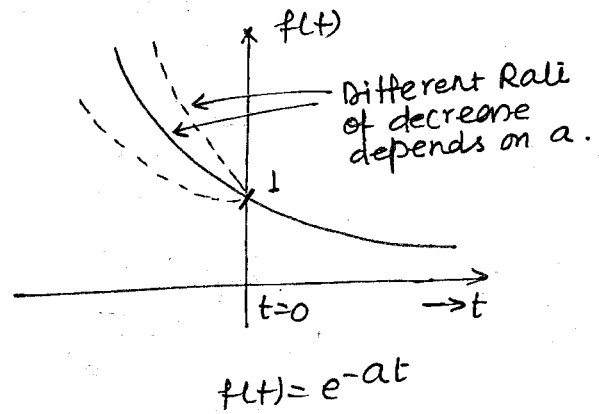
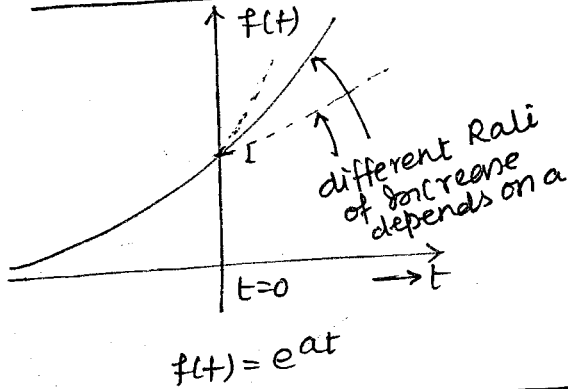
So, for triangular Pulse:

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

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

$$0 \quad ; \quad \text{otherwise.}$$

* EXPONENTIAL SIGNALS!:

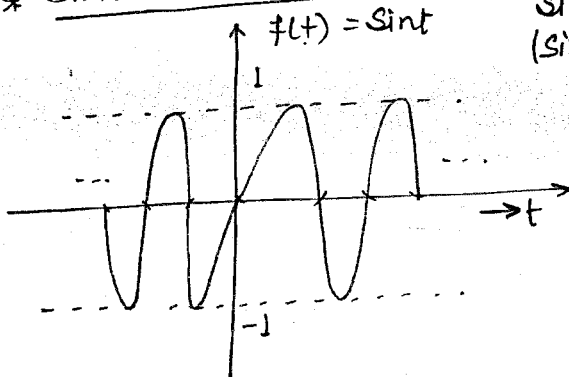


$a = \text{Scaling factor}$

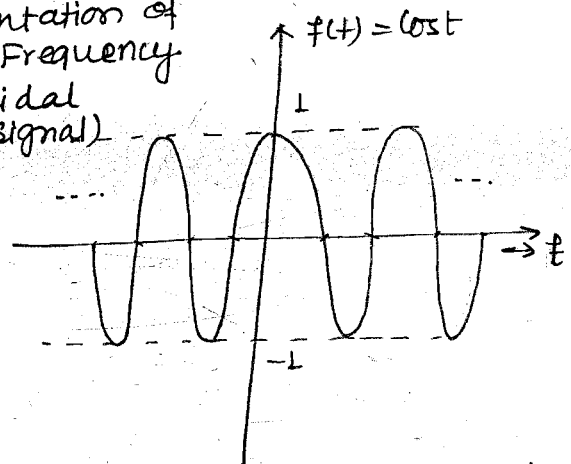
(deciding Rate of increase or decrease).

* a is also called as the time constant as they decide Rate of Rise and decrease.

* SINUSOIDAL SIGNALS!:



* Representation of Single Frequency (sinusoidal signal)



* Zero cross over are!:

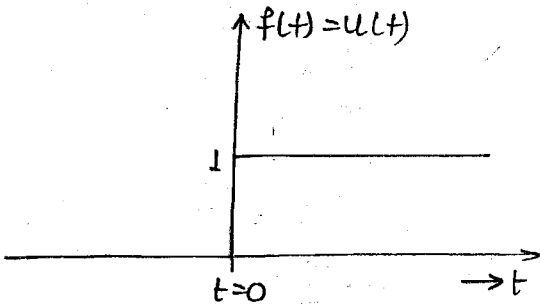
$$t = \pm n\pi$$

* Zero cross overs are!:

$$t = \pm (2n+1)\frac{\pi}{2}$$

* 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:

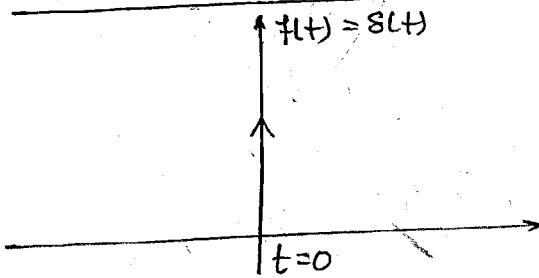


$$f(t) = \begin{cases} 1; & t > 0 \\ 0; & t < 0. \end{cases}$$

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

COMPROMISED DEFINITION
 $u(t) = 1; t = 0.$

* IMPULSE FUNCTION:



$$f(t) = s(t) = \begin{cases} 0; & t \neq 0 \\ \infty; & t = 0 \end{cases}$$

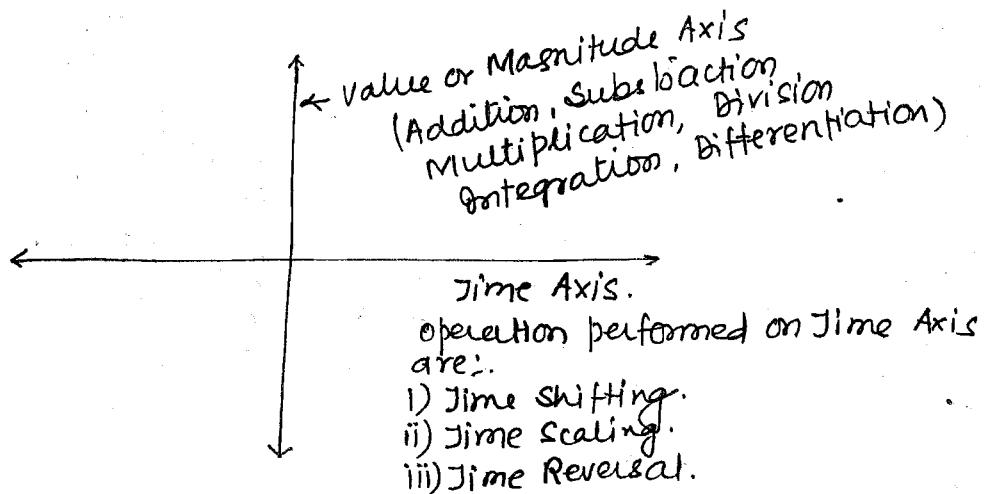
$$\int_{-\infty}^{\infty} s(t) dt = 1$$

* Impulse signals can be measurable or unmeasurable. Analysis is done only for measurable signals.

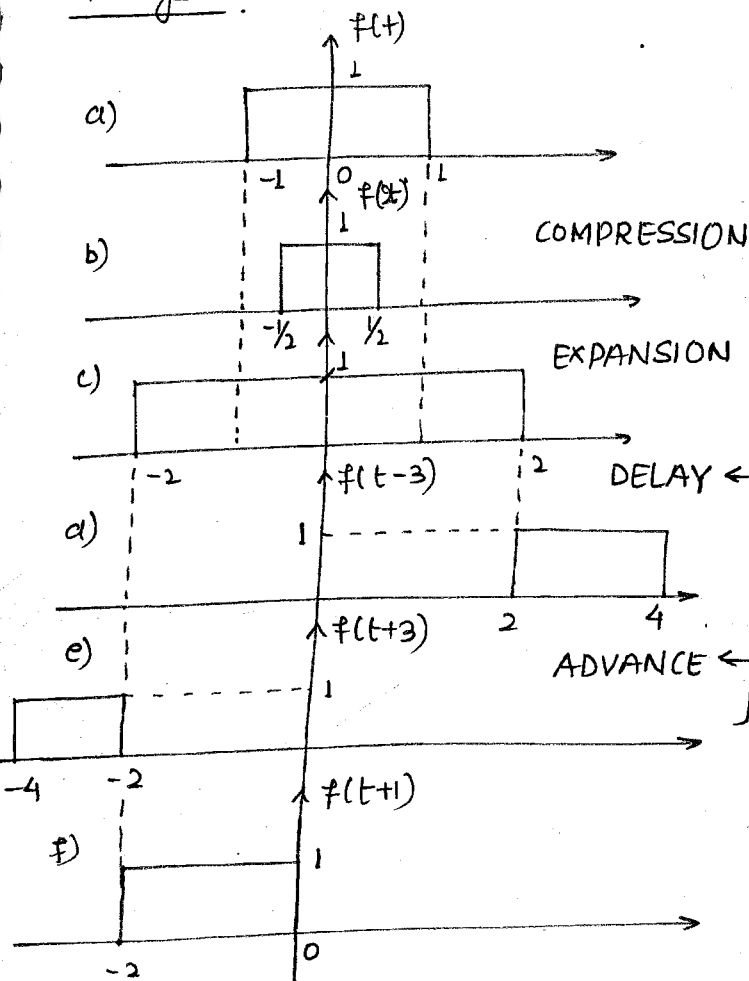
* Hence to analyse the impulse signal it has to be measurable and for that its Area should be equal to unity.

* The magnitude of $s(t)$ is ∞ at $t=0$ and hence unmanageable so to manage them indirectly its Area is made equal to 1.

Note :-



* 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) $f(t) = 1; -1 \leq t \leq 1$
 $0; \text{otherwise}$

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

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

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

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

Note !:

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

$a > 1 \rightarrow \text{COMPRESSION}$
 $a < 1 \rightarrow \text{EXPANSION}$

$a = \text{SCALING FACTOR}$

d) $f(t-3) = 1; -1 \leq t-3 \leq 1$
 $= 0; \text{ otherwise}$

$$f(t-3) = 1; 2 \leq t \leq 4$$
$$0; \text{ otherwise}$$

f) $f(t+1) = 1; -1 \leq t+1 \leq 1$
 $= 0; \text{ otherwise}$

$$f(t+1) = 1; -2 \leq t \leq 0$$
$$0; \text{ otherwise}$$

e) $f(t+3) = 1; -1 \leq t+3 \leq 1$
 $= 0; \text{ otherwise}$

$$f(t+3) = 1; -4 \leq t \leq -2$$
$$0; \text{ otherwise}$$

*Note!:

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

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