UNIT-1

Representation of signals:

Signal:- Any physical phenomena that conveys (or) carries some information is called a signal

(or)

⇒ A signal can be considered as a function that carries the information depending on one (or) more independent variable.

Ex:- $f(t)$ t: independent variable
f: dependent variable

$f(t) \rightarrow$ 1D signal $\rightarrow$ Ex: planar surface

$f(x,y) \rightarrow$ 2D signal $\rightarrow$ Ex: image

$f(x,y,3) \rightarrow$ 3D signal $\rightarrow$ Ex: video

System:- System can be defined as a combination of components / elements / blocks / sub systems in a meaningful way such that it generates the required output / response w.r.t the applied input / excitation / driving function.

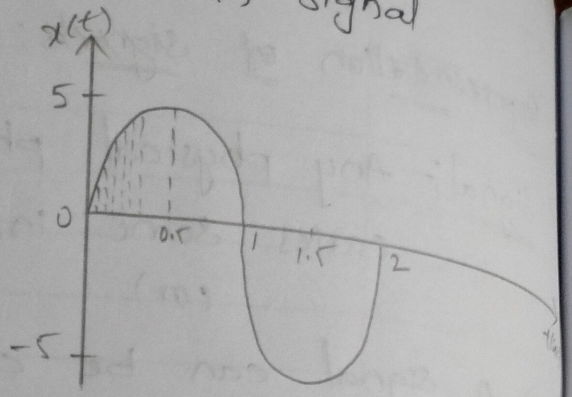
Basic classification of signals (Based on Domain):-

1. Analog / continuous time domain signal
2. Discrete time domain signal
3. Digital signal.

1. Analog / continuous time domain signal

Time → continuous

Amp → continuous



2. Discrete time domain signal

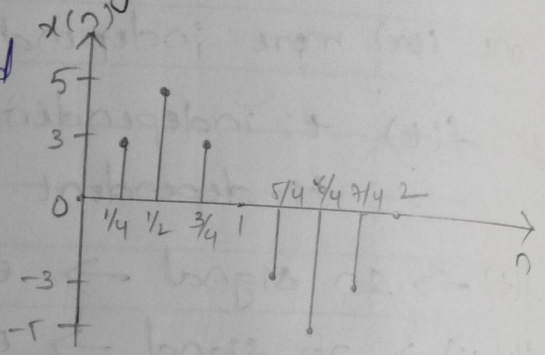
Time → discreatized

Amp → continuous

$t = n.T$

for fixed T

$\boxed{t = n}$



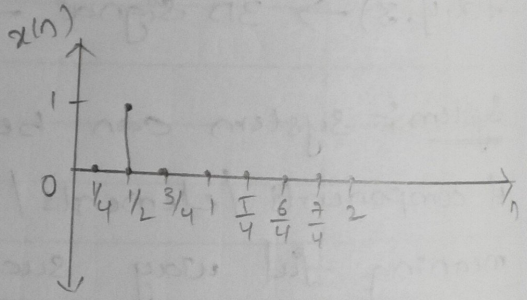
3 Digital signal

Time — discretized

Amp - Quantized

TTL 0 - 0 to 0.8

1 - 3.5 to 5



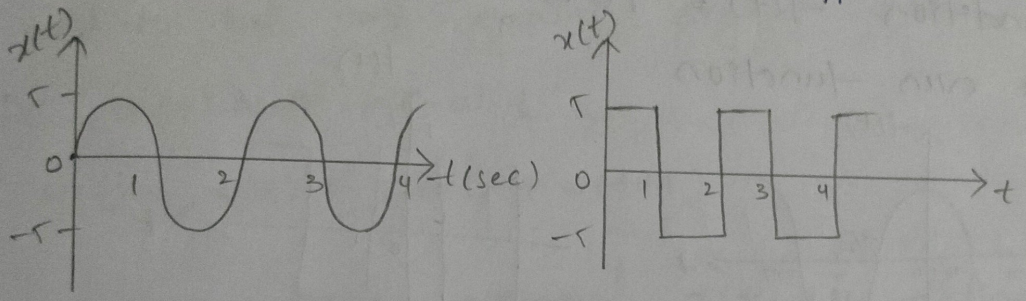
Classification of signal :-

1. Deterministic & Random signals
2. periodic & non periodic / Aperiodic signal
3. Even & odd signals
4. causal & Non causal signal
5. Energy & power signal.

1. Deterministic & Random signal :-

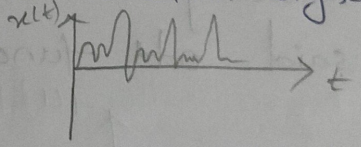
Deterministic signal :-

⇒ A signal is said to be deterministic if it is possible to predict the amplitude at different time instant(or) time instance at different amplitudes



Random signal

⇒ If the amplitude varies randomly w.r.t time t then such signal is known as random signal that can not be predicted.



2. periodic & non periodic signal :-

⇒ If a signal repeats itself at regular time intervals then such signal is known as periodic signal

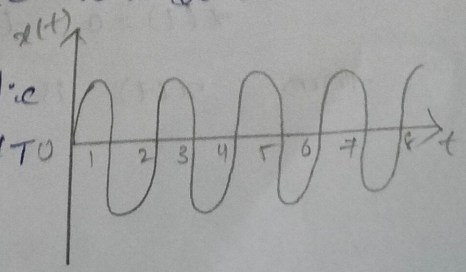
(or)

⇒ If any signal satisfies the following relation then such signal is known as periodic signal

$$x(t) = x(t+T)$$

where T is known as time period which is smallest possible +ve non zero value

ie x(t) is called a periodic signal with time period of T0



⇒ If any signal does not satisfy the above relation i.e $x(t) \neq x(t+T)$ then $x(t)$ is known as non periodic / Aperiodic

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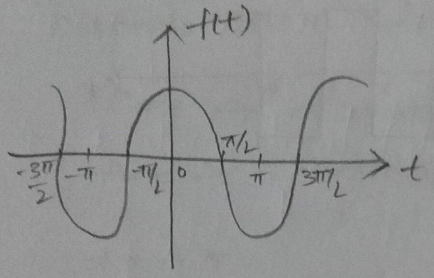
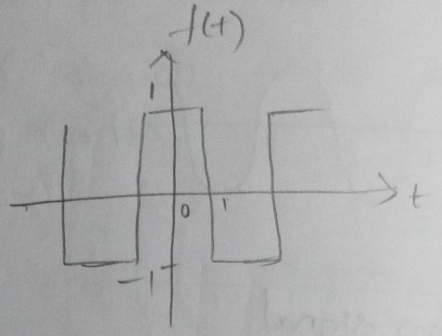
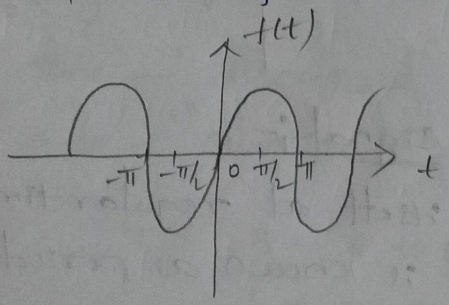
3. Even and odd

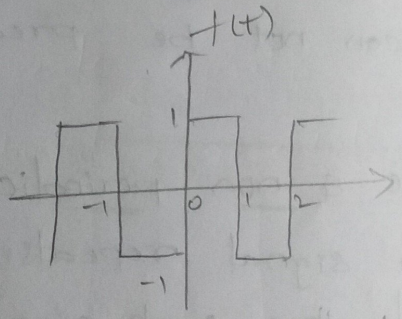
⇒ If any orbitary signal $f(t)$ satisfy the following condition $f(t) = f(-t)$ then $f(t)$ is said to be even function





⇒ If any orbitary signal $f(t)$ satisfy the following condition $f(t) = -f(t)$ then $f(t)$ is said odd function





4. causal and non causal

⇒ If any orbitary signal $x(t)$ is defined for +ve values of t only i.e

i.e $x(t) \neq 0 \quad t \geq 0$

$x(t) = 0 \quad t < 0$

then $x(t)$ is said to be causal signal

⇒ If any

Ex: $y(t) = 3 \cdot x(t)$

$y(t) = 3x(t) + x(t-1)$

⇒ If any orbitary $x(t)$ is defined for both the +ve & -ve values of t then $x(t)$ is said to be non causal signal

i.e $x(t) \neq 0$ for all t

Ex: $y(t) = x(t) + x(t-1) + x(t+1)$

⇒ If any orbitary signal $x(t)$ is defined for only -ve values of t then $x(t)$ is said to be anti causal signal

$y(t) = 2x^2(t+1)$

5. Energy and power signal

⇒ The energy associated with any orbitary signal $x(t)$ can be evaluated using the following formula.

$$E = \int_{-\infty}^{\infty} |x(t)|^2 dt$$

⇒ Then energy associated with periodic signal will generally be ∞, so for such periodic signals average power will be evaluated instead of energy

$$P_{avg} = P = \frac{1}{T} \int_{-T/2}^{T/2} |x(t)|^2 dt$$

⇒ In General all non periodic signal are Energy signal. the power energy signal is "zero".

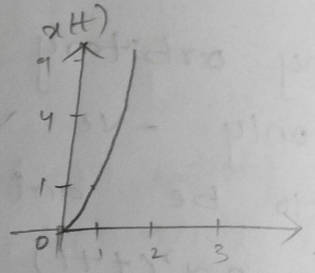
⇒ In General all periodic signal are power signal. The Energy for power signal is "∞".

Representation of Analog signal:-

There are two types to represent Analog signal.

1. Mathematical / functional representation.
2. Graphical representation.

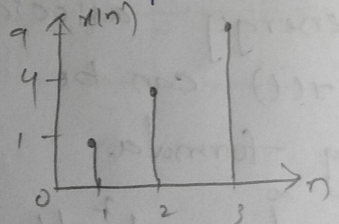
$x(t) = t^2 \; ; t \geq 0$



Representation of discreate signal:-

1. Mathematical / functional representation

Eg: $x(n) = n^2$ for $n \geq 0$



2. Graphical :-

3. Tabular Representation

n	0	1	2	3	4	----
x(n)	0	1	4	9	16	----

4. Sequential

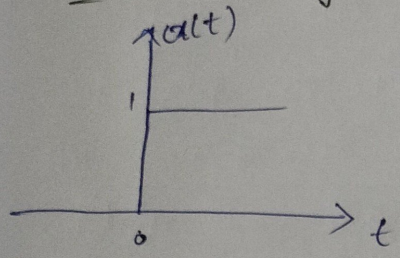
$x(n) = \{0, 1, 4, 9, 16, 25 \text{----}\}$
$\uparrow$ n=1
n=0

$x(n) = \{0, 1, 4, 9, 16\}$
n=-4 n=-3 n=-2 n=-1 $\uparrow$

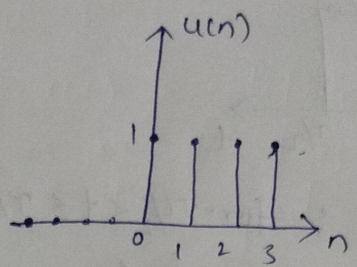
$x(n) = \{0, 1, 4, 9, 16\}$
n=-2 n=-1 $\uparrow$ n=0 n=1 n=2
n=0

Basic signal (or) standard signal

1. unit step signal :-



$u(t) = 1$ for $t \geq 0$
$= 0$ for $t < 0$

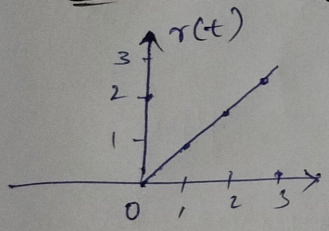


$u(n) = 1$ for $n \geq 0$
$= 0$ for $n < 0$

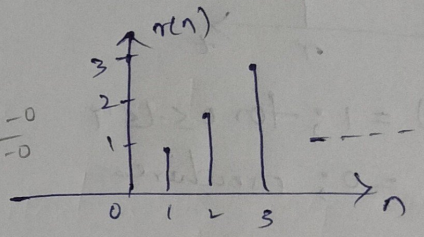
n	-3	-2	-1	0	1	2	3
u(n)	0	0	0	1	1	1	1

$u(n) = \{1, 1, 1, 1, \ldots\}$
↑

2. unit Ramp signal :-



slope = 1
$\frac{r(t)}{t} = \frac{1-0}{1-0}$



$r(t) = t$ for $t \geq 0$
$= 0$ for $t < 0$

$r(n) = n$; for $n \geq 0$
$= 0$; for $n < 0$

$r(n) = \{0, 1, 2, 3, 4, \ldots\}$

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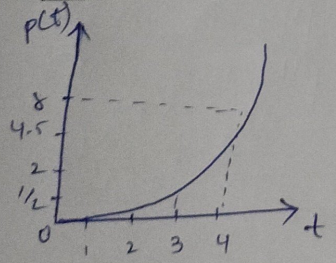
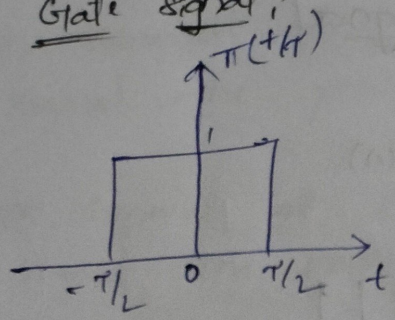
3 parabolic function :-



$p(t) = \frac{1}{2} t^2$; for $t \geq 0$
$= 0$; for $t < 0$

$\Rightarrow \int u(t) = r(t)$
$\Rightarrow \int r(t) = p(t)$

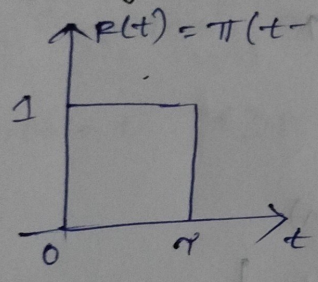
4. Gate signal :-



$\Pi(t/\tau) = 1$; for $-\tau/2 \le t \le \tau/2$

$= 0$; Elsewhere

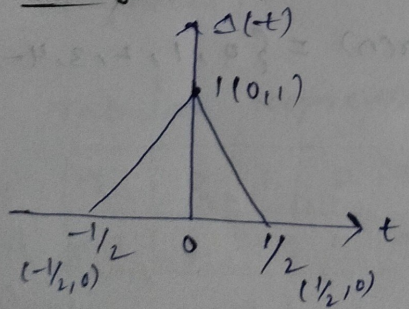
5. Rectangular signal :-



$R(t) = 1$; for $0 \le t \le \tau$

$= 0$; Elsewhere

6. Triangle signal :-



Line Eq

$$\frac{y-y_1}{x-x_1} = \frac{y_2-y_1}{x_2-x_1}$$

$$\frac{\Delta(t)-0}{t+1/2} = \frac{1-0}{0+1/2}$$

$$\Delta(t) = 2\left[t+1/2\right] \quad = \quad \Delta(t) = 1+2t \; ; -1/2 \le t \le 0$$

Line eq

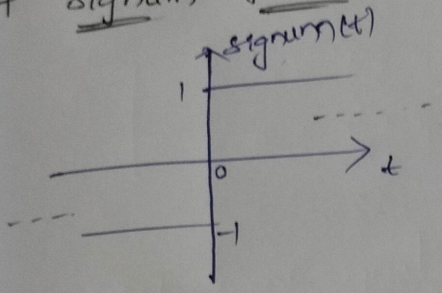
$$\frac{y-y_1}{x-x_1} = \frac{y_2-y_1}{x_2-x_1}$$

$$\frac{\Delta(t)-0}{t-1/2} = \frac{1-0}{1-1/2}$$

$$\Delta(t) = -2[t-1/2]$$

$$\Delta(t) = 1-2t \text{ ; for } 0 \le t \le 1/2$$

7 Signum function :-



$$\text{sign}(t) = -1 \text{ ; } t<0$$
$$= 0 \text{ ; at } t=0$$
$$= 1 \text{ ; for } t>0$$

$$\text{Sgn}(t) = u(t) - u(-t)$$
$$= 2 \cdot u(t) - 1$$

8. Sampling (or) sinc function :-

$$Sa(t) = \text{sinc}(t) = \frac{\sin(t)}{t} \text{ ; for all 't'}$$