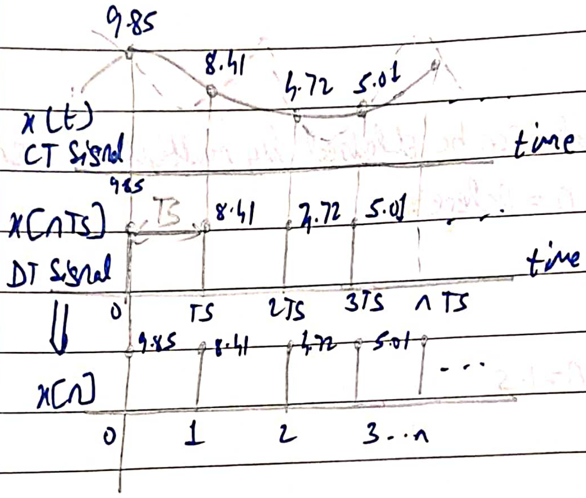
Discrete Time Signal

* Graphically Representation :-



→ Ts : Sampling Time.

→ $x[n] = \{\underset{\uparrow n=0}{9.85}, 8.41, 4.72, 5.01\}$ (Arrow indicates time at n=0. Arrow is

→ CT. Signal = Continuous Time Signal ($x(t)$)

→ DT. Signal = Discrete Time Signal ($x[nT_s] = x[n]$)

∵ Ts is constant thus $x[n]$ is a simplified notation of DT signal.

* Discrete Time Signal is obtained by sampling Continuous Time Signal at regular intervals of Time.

* Mathematically

$$\underbrace{x(t)}_{\text{CT Signal}}\Big|_{t=nT_s} = \underbrace{x[nT_s] = x[n]}_{\text{DT Signal}}$$

⇒ Why do we need to sample CT Signal :-

Ans Since Devices cannot work on CT signal we need to sample them to DT signal.

* NOTE :-

→ Some Discrete Time Signal can be obtained by multiple C.T Signal.

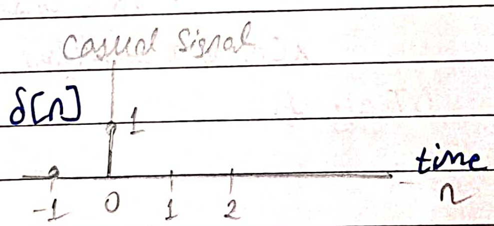
→ DT Signal is only for n = integers.

Q) Value of ~~DT~~ $x(n)$ at $n = 1.5$

Ans NOT defined.

* Standard Discrete Time Signal :-

1) Delta Signal / Impulse Signal / Unit Sample Signal :- $[\delta[n]]$

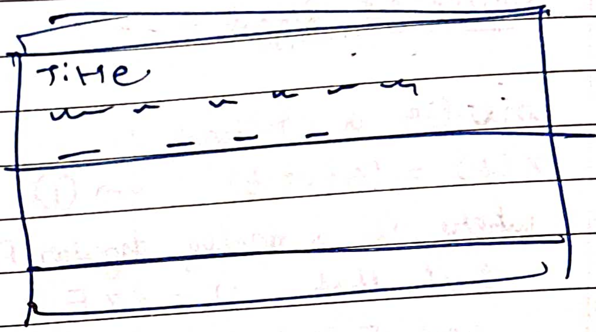


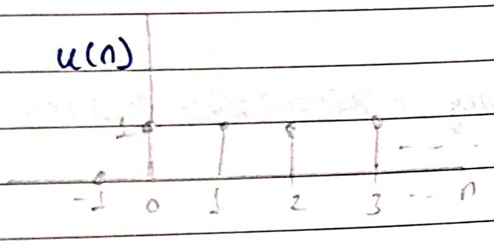
$\delta[n] = \{ \underset{\uparrow}{1}, 0, 0, 0 \ldots \}$

$$\delta[n] = \begin{cases} 1 & n = 0 \\ 0 & \text{otherwise} \end{cases}$$

2) **Unit Step Signal** :- [u(n)]

Casual Signal



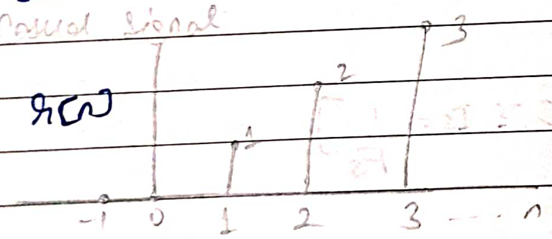


$$u(n) = [\underset{\uparrow}{1}, 1, 1, \ldots n]$$

$$u(n) = \begin{cases} 1 & n \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

3) **Ramp Signal** :- [r(n)]

Casual Signal



$$r(n) = [\underset{\uparrow}{0}, 1, 2, 3 \ldots n]$$

$$r(n) = \begin{cases} n, & n \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

A **NOTE**:- when the -ve side of signal is 0, that signal is called '<u>casual</u>' <u>signal</u>.

classmate

Date

Page

4] <u>Sinusoidal Signal</u> :-

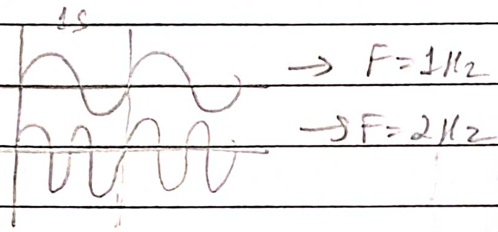
⇒ Consider a CT signal :-

$x(t) = \cos(\Omega t)$ → ①

where Ω is Analog Angular Frequency in ~~Hertz (Hz)~~ <u>rad/sec</u>.

such that $\boxed{\Omega = 2\pi F}$

and F is in Hertz (Hz)



$$\boxed{F = \frac{1}{T}}$$

<u>By sampling</u> :-

We put $t = nT_s = \frac{n}{F_s}$ $\left[\because T_s = \frac{1}{F_s}\right]$

<u>In eq 1</u> :-

$$x[nT_s] = \cos\left[2\pi F \frac{n}{F_s}\right]$$

$$x[n] = \cos\left[2\pi\left(\frac{F}{F_s}\right)n\right]$$

$$x[n] = \cos[2\pi f n] \qquad \left(f = \frac{F}{F_s}\right)$$

$$\boxed{x(n) = \cos(\omega n)}$$

$f = \frac{F \rightarrow Hz}{F_s \rightarrow Hz}$ (Angular Freq in Hz) (Sampling Freq in Hz)

Digital Freq (No unit)

∴ DT sinusoidal signal :-

$$\boxed{x(n) = \cos(\omega n)}$$

where ω is digital ~~a~~ Angular frequency in <u>radian</u>

such that $\omega = 2\pi \underline{f}$, where f is digital frequency with no unit.

* NOTE :-

Ω	rad/sec	F	Hz	→ Analog Frequency
ω	rad	f	No unit	→ Digital Frequency.

→ $f = \frac{F}{F_s}$

Multiply by 2π

$2\pi f = \frac{2\pi F}{F_s}$

$\omega = \frac{\Omega \rightarrow rad/s}{F_s \rightarrow Hz}$

$\omega = \Omega T_s$

$= \frac{rad}{\cancel{s}} \times \cancel{s}$

$\boxed{\omega = rad}$