

• Classification of signals

→ Theoretical Summary:-

1) Deterministic or Random:-

Deterministic=predictable; $\cos(t)$ || Random like noise in Electrical circuits.

2) Periodic or Aperiodic:-

CT → periodic if “ $x(t+T_0) = x(t)$ ”, where the smallest T_0 is called the **Fundamental period** ($T_0=2\pi/\omega_0$)
 → Trigonometrics ($\cos(\omega_0 t)$, $\sin(\omega_0 t)$) are **always** periodic for **any** ω_0 .
 → Sum of periodic is **not always** periodic; periodic **only if** T_1/T_2 is a **rational** number (1, 1/5, etc...))
 The new Fundamental period of the sum $T_s = \text{LCM}(T_1, T_2)$

DT → periodic if “ $x(n+N_0) = x(n)$ ”; the smallest N_0 is called the **Fundamental period** ($N_0=2\pi/\omega_0$)
 → Trigonometrics ($\cos(\omega_0 t)$, $\sin(\omega_0 t)$) are **Not always** periodic;
 It's periodic only if $[N = \frac{2\pi \cdot k}{\omega} = \text{Integer}]$ is true for any arbitrary integer k.
 → Sum of periodics is **always** periodic;
 The new Fundamental period of the sum $N_s = (N_1 \cdot N_2) / \text{gcd}(N_1, N_2)$.

3) Even or Odd:-

Even if → $x(t) = x(-t)$ or $x[n] = x[-n]$.

Odd if → $x(t) = -x(-t)$ or $x[-n] = -x[n]$.

* any signal can be represented as a sum of an even and an odd signal where;

$$x_{\text{even}} = \frac{x(t)+x(-t)}{2} \quad || \quad x_{\text{odd}} = \frac{x(t)-x(-t)}{2}$$

4) Energy or power sg. :-

$$\text{CT; } E = \lim_{T \rightarrow \infty} \int_{-T}^T |x(t)|^2 dt \quad \text{DT; } E = \lim_{N \rightarrow \infty} \sum_{n=-N}^N |x[n]|^2$$

for an Energy sg. → $0 < E < \infty$ & $P_{\text{avg}} = 0$.

$$\text{CT; } P_{\text{avg}} = \lim_{T \rightarrow \infty} \frac{1}{2T} \int_{-T}^T |x(t)|^2 dt \quad \text{DT; } P_{\text{avg}} = \lim_{N \rightarrow \infty} \frac{1}{2N+1} \sum_{n=-N}^N |x[n]|^2$$

for a power sg. → $0 < P_{\text{avg}} < \infty$ & $E = \infty$

* Periodic signals are power signals.

• Complex Exponentials:-

In CT; $e^{j\omega_0 t}$ is periodic for any value of ω_0

In DT; $e^{j\omega_0 n}$ is periodic only if $[N = \frac{2\pi}{\omega_0} K = \text{integer}]$ exists for any arbitrary integer k.

Euler's formula:- $e^{j\omega_0 t} = \cos(\omega_0 t) + j \sin(\omega_0 t)$

** magnitude of complex exp → $|e^{j\omega_0 t}| = 1$

Q1) Classify if periodic and find the fundamental period:-

i) $x(t) = \cos(2.32\pi t)$

ii) $x(t) = [\cos(2t + 2\pi/3)]^2$

iii) $x(t) = \cos(2\pi t) + \sin(0.5\pi t) + \sin(\pi t)$

iv) $x[n] = \cos(2n)$

v) $x[n] = \cos(2\pi n) + \exp(j\pi n)$

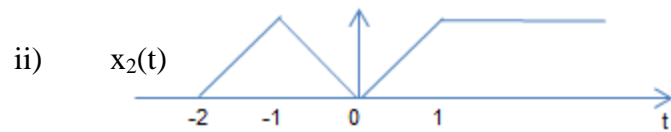
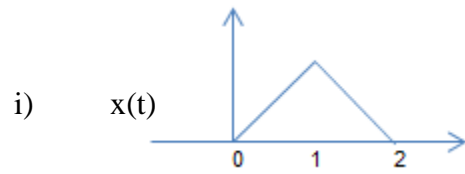
Q2) Calculate the Energy and power of the following, and state whether it's power or energy signal:-

i) $x(t) = e^{-2t} u(t)$

ii) $x(t) = A e^{j(\omega t + \alpha)}$

iii) $x[n] = (0.5)^n u[n]$

Q3) Determine and sketch the even and odd part of the following signals:-



iii) $y[n] = u[n] - u[-n-1]$