SIGNALS & SYSTEMS

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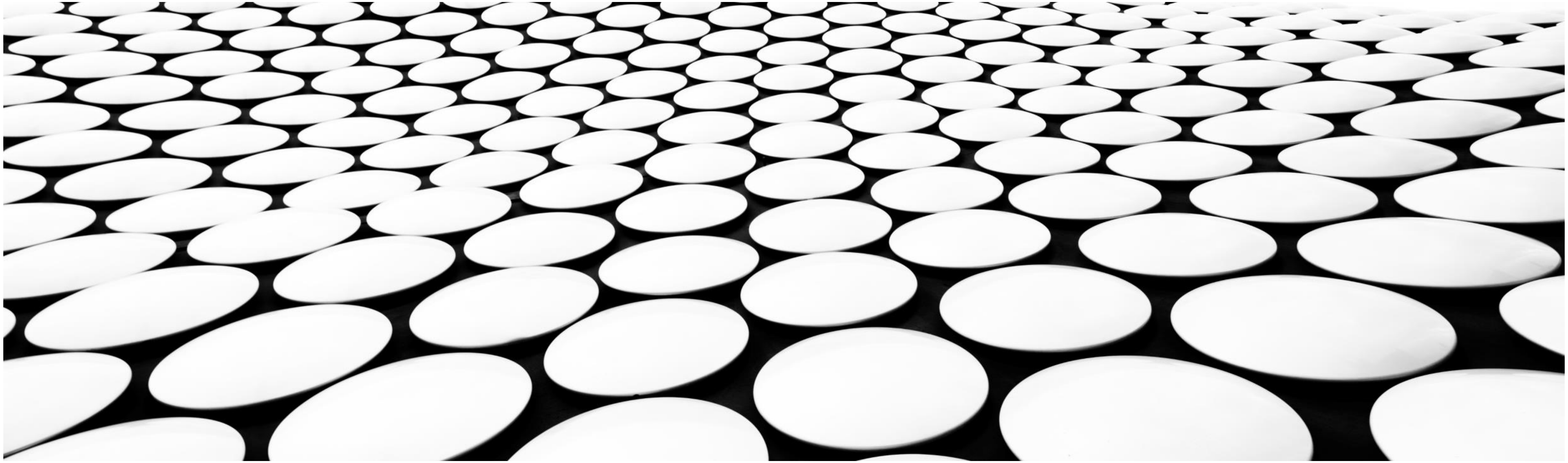

Fourier Series:-

$\downarrow$

periodic signals.

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

Fourier Transform $\rightarrow$ Laplace transform

$\downarrow$

$\boxed{\text{For non-periodic signal}}$

Fourier series is basically used for the expansion of periodic signals in terms of their harmonics which are sinusoidal and orthogonal to one another.

$1 \times 10000 + 2 \times 8000 + 5 \times 5000 + 10 \times 2000$

$$10000 \sum_{n=1} (1) + 8000 \sum_{n=1} (2) + \cdots$$

1 2 5 10

1 $\rightarrow$ 10,000

2 $\rightarrow$ 8,000

5 $\rightarrow$ 5000

10 $\rightarrow$ 2000

Cosine and sine

$\boxed{\text{FS and FT}}$ ⇒ Analysis purpose

$\boxed{\text{LT}}$ ⇒ Design purpose ⇒ continuous time domain

$\boxed{\text{ZT}}$ ⇒ Design purpose ⇒ Discrete time domain

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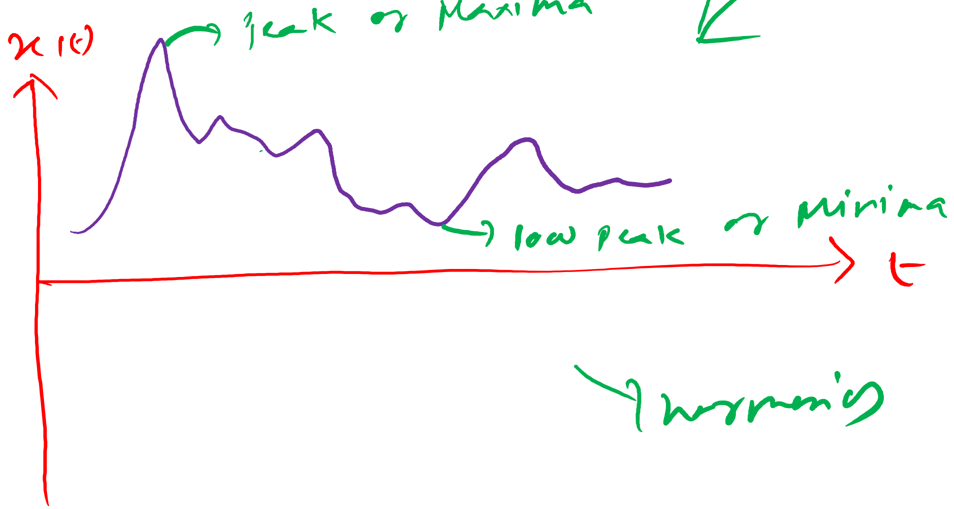
$\boxed{\text{Digital controller}}$

Fourier series Expansion:-

1) Trigonometric F.S

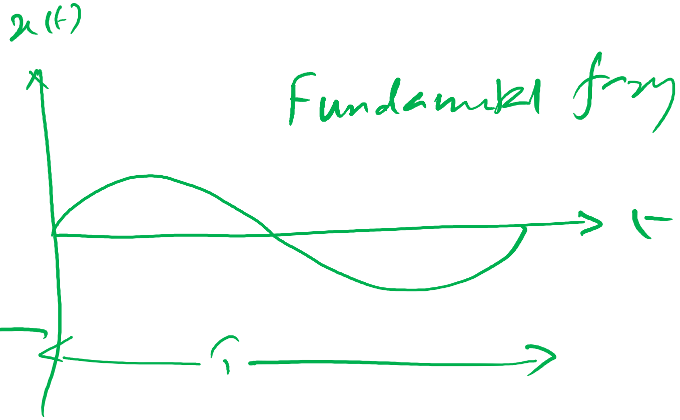
2) Complex Exp. F.S

3) Polar or harmonic F.S



harmonics

$Ae^{j\omega t}$



Fundamental freq.

T sec → 1 cycle

∴ 1 sec → $\frac{1}{T}$ cycle

↓

frequency (Hz)

Real life signal or day to day life signal = fundamental freq + Harmonics.

$p(t) = 5 + \sin \omega_0 t + 2\sin 2\omega_0 t + 3\sin 3\omega_0 t \cdots$

$+ \sin 4\omega_0 t + \cdots$

5 $\rightarrow$ DC value

$\sin 4\omega_0 t \rightarrow$ 4th harm.

$\omega_0 \rightarrow$ fundamental freq $\rightarrow$ 1st har.

$2\omega_0$, $3\omega_0$

$2\omega_0 \rightarrow$ 2nd harmonics

$3\omega_0 \rightarrow$ 3rd harmonic

even $\rightarrow$ 2, 4 . . .

odd $\rightarrow$ 1, 3, 5 . . . .

$x(t) = 5 + \cos \omega_0 t + \cos 2\omega_0 t + \cdots$

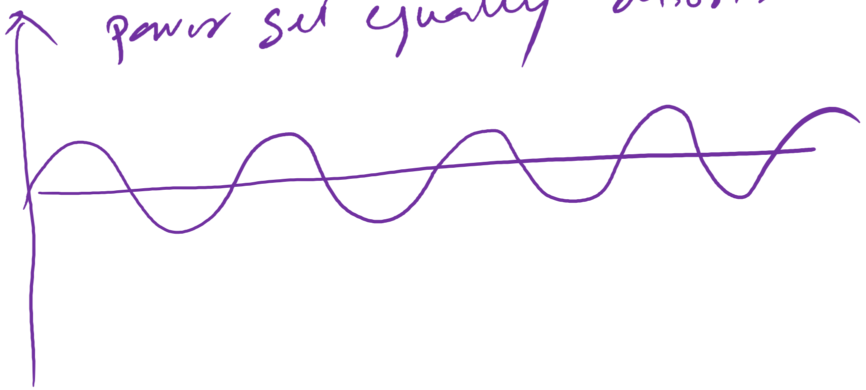
$y(t) = 6 + \sin \omega_0 t + \cos 2\omega_0 t + 7\sin 5\omega_0 t + \cdots$

2 rs → 50,000/- = 1,00,000/-

10 rs → 10,000/- = 10,000/-

FS is also used to calculate → power and phase of a particular harmonic current present in the expansion

→ power set equally distributed over all the harmonics.



: Conditions for existence of FS:-

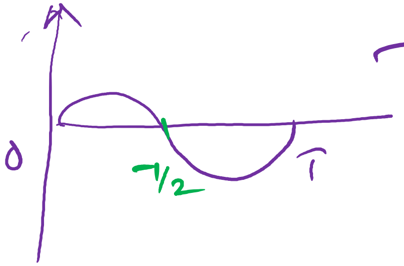
÷ Dirichlet conditions:-

1) Signal should be absolutely integrable over the range of time period.

Energy → Non. p. → Absolutely integrable in nature $\int_{-\infty}^{\infty} |x(t)|^2 dt$

??

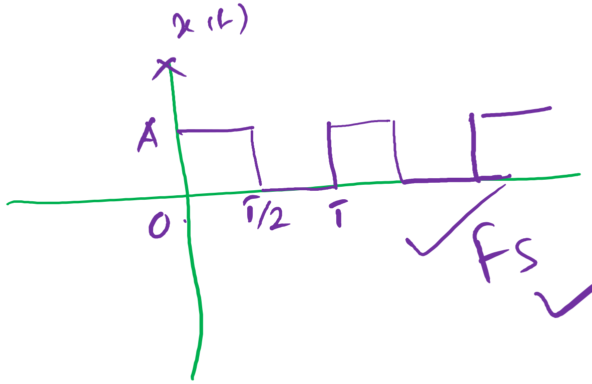
power → periodic



→ $\int_0^T \sin t\,dt$ or $\int_0^T \cos t\,dt = 0$

time value

$$\int_{-\infty}^{\infty} x(t)\,dt < \infty$$



FS ✓

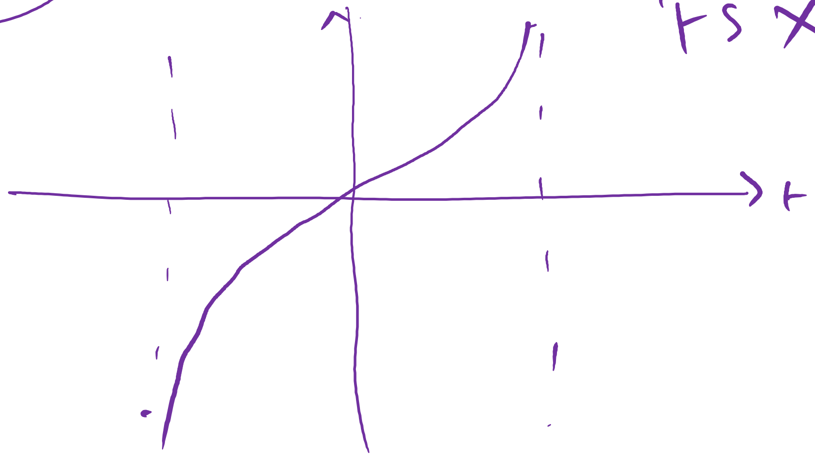
Integration = Area under curve

$$= \int_0^{T/2} x(t)\,dt + \int_{T/2}^{T} x(t)\,dt$$

$$A \times \frac{T}{2} + 0 = \frac{AT}{2}$$

tan t

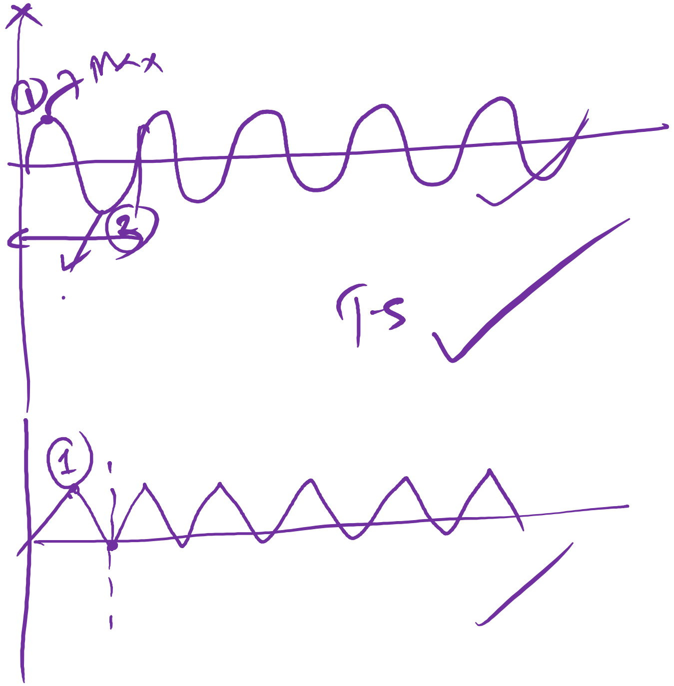
$x(t) = \tan t$



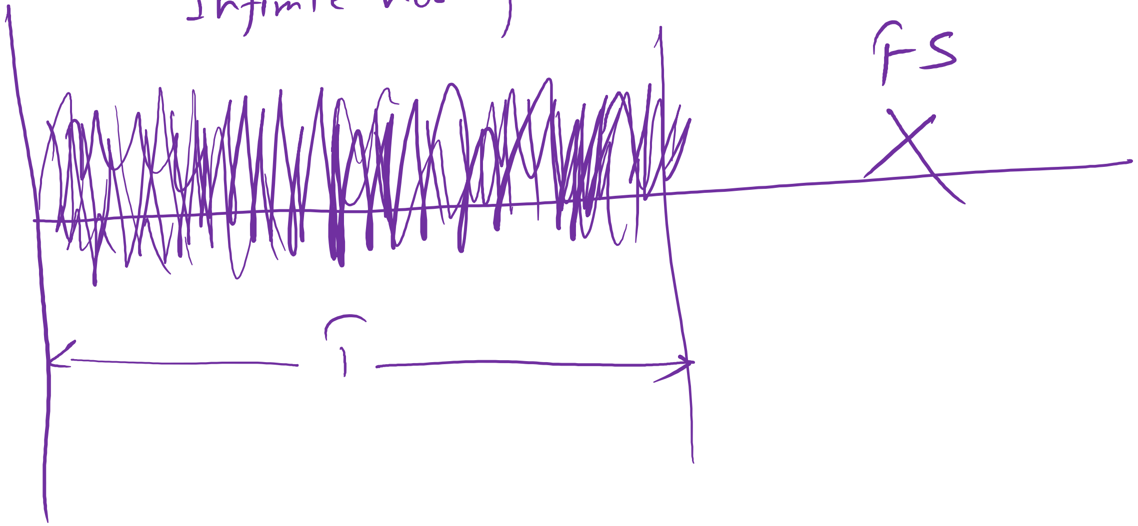
FS ✗

Area under tan t → ∞.

2) Signal should have ~~no~~ proper no. of finite max^m and minima ~~&~~ over ~~an~~ time period.



Infinite nos of max and minimas.



3) should have finite discontinuity over time period.

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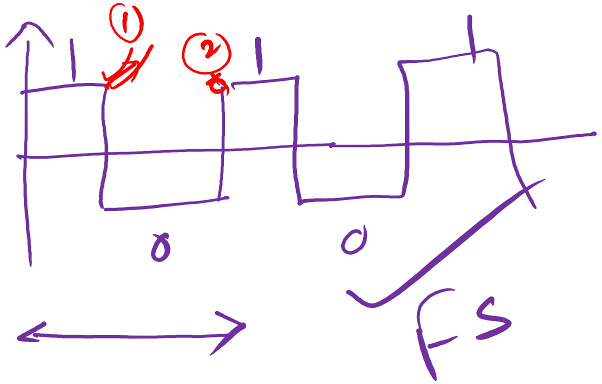
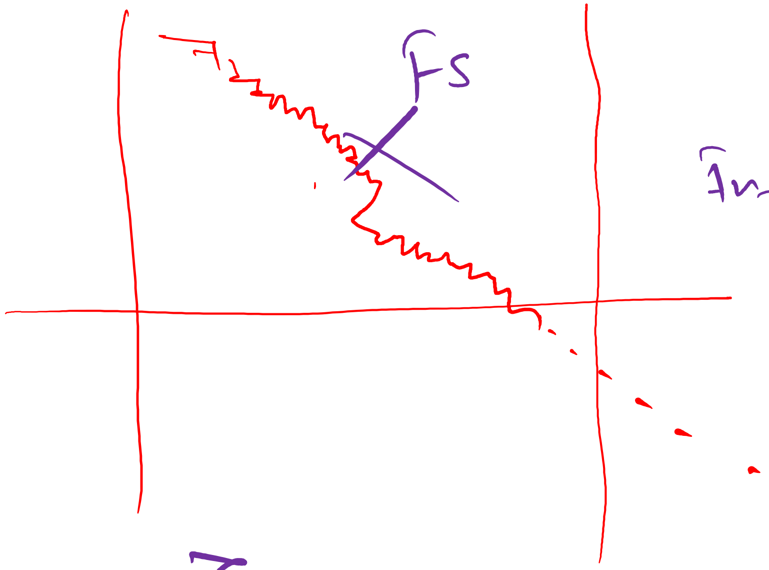
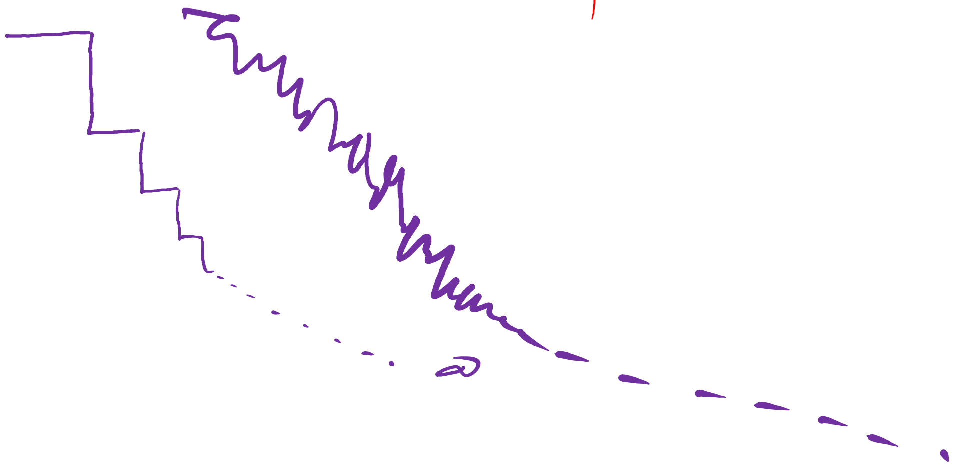
transition





Infinite nos of discont. over a time period



$$x(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos n\omega_0 t + \sum_{n=1}^{\infty} b_n \sin n\omega_0 t$$

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