SIGNALS AND SYSTEMS

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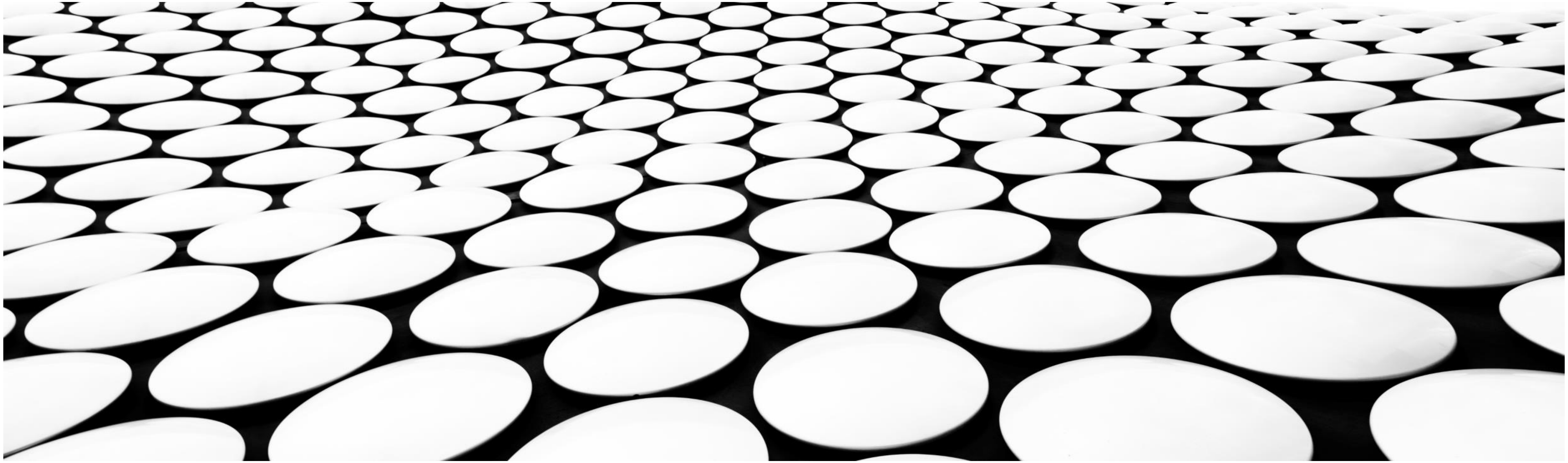


$x(t) = 5\cos 4\pi t + 3\sin 8\pi t$

$x(t)$ is a periodic signal

$5\cos 4\pi t \rightarrow x_1(t) \longrightarrow A\cos\omega_0 t \rightarrow \omega_1 = 4\pi \Rightarrow \frac{2\pi}{T_1} = 4\pi \Rightarrow \boxed{T_1 = \frac{2\pi}{4\pi} = \frac{1}{2}}$

$3\sin 8\pi t \rightarrow x_2(t) \longrightarrow A\sin\omega_0 t \rightarrow \omega_2 = 8\pi \Rightarrow \frac{2\pi}{T_2} = 8\pi \Rightarrow \boxed{T_2 = \frac{2\pi}{8\pi} = \frac{1}{4}}$

$\frac{T_1}{T_2} = \frac{1}{\cancel{2}} \times \cancel{4} = 2$

Time period, $T = \frac{1}{2}$

Symmetric and Antisymmetric :-

(Even) (Odd)

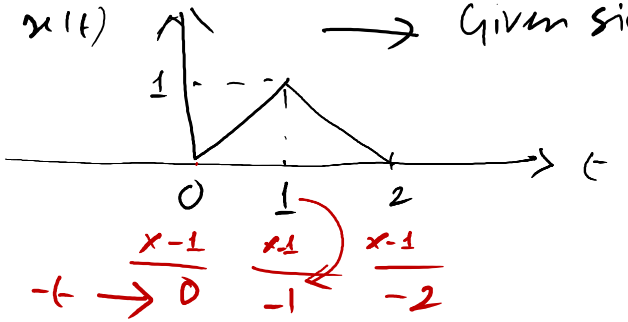
$x(t)$ is given signal

$x(t)$ is said to be even or symmetric

if $x(t) = x(-t)$

$x(t)$ is said to be odd or antisymmetric

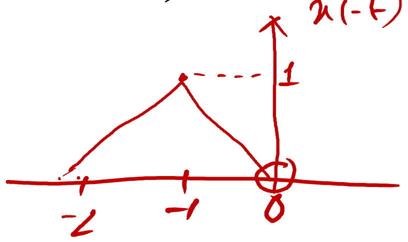
if $x(t) = -x(-t)$ or, $-x(t) = x(-t)$



→ Given signal $x(-t)$

$t \times -1 = -t$

$x(-t)$



Time Reversal or flipping of a signal

⇓

The amplitude of the signal doesn't get changed

Let us consider a signal $x(t)$ → This is neither odd nor even

$\sin(-\theta) = -\sin\theta \Rightarrow \boxed{x(-t) = -x(t)}$ → odd

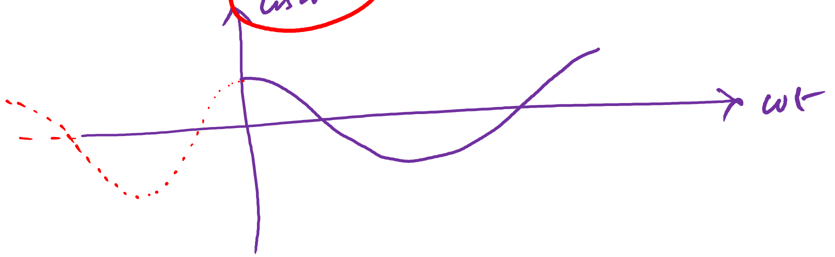
$\cos(-\theta) = \cos\theta \rightarrow x(-t) = x(t)$

⇓

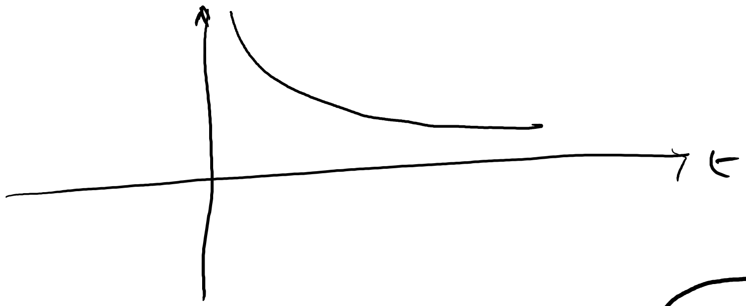
Even.

$\sin\omega t$ odd → even comp = 0

$\cos\omega t$ even → odd comp = 0 even → y axis



$x(t) = e^{-t}$ $\quad e^{-t}$



NONE → Both even components and odd components.

$x(t) \rightarrow$ NIXIE

$t \rightarrow -t$

Time reversal or flipping

$\Rightarrow x(t) = x_e(t) + x_o(t)$ — (1)

$\Rightarrow x(-t) = x_e(-t) + x_o(-t)$ — (2)

If $x_e(t)$ is even; $x_e(t) = x_e(-t)$

if $x_o(t)$ is odd; $x_o(-t) = -x_o(t)$

Any doubt??

(2) $\Rightarrow x(-t) = x_e(t) - x_o(t)$ — (3)

(1) + (3) $\Rightarrow x(t) + x(-t) = 2x_e(t) \Rightarrow x_e(t) = \dfrac{x(t)+x(-t)}{2} \Rightarrow$ even comp.

Similarly (1) − (3) $\Rightarrow$ $x_o(t) = \dfrac{x(t)-x(-t)}{2} \Rightarrow$ odd comp

$$x(t) = \cancel{3} + 2t + 5t^2$$

$$x(-t) = 3 + 2(-t) + 5(-t)^2$$

NONE

$$\Rightarrow x(-t) = \cancel{3} - 2t + 5t^2$$

$$x_e(t) = \frac{x(t) + x(-t)}{2} = \frac{6 + 10t^2}{2} = 3 + 5t^2$$

$$x_o(t) = \frac{x(t) - x(-t)}{2} = \frac{4t}{2} = 2t$$

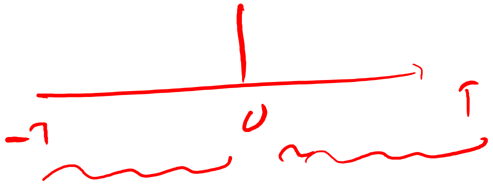
Energy and power signals: -

$x(t) \rightarrow$ Energy $\rightarrow$ finite $\rightarrow$ Non-periodic

$\rightarrow$ power $\rightarrow$ finite / Av. power $\rightarrow$ periodic signals.

$$\text{power} = \frac{\text{Work done}}{\text{Time}} = \frac{\text{Energy}}{\text{Time}}$$

$$\text{Energy}, \; E = \lim_{T \to \infty} \int_{-T}^{T} |x(t)|^2 \, dt \rightarrow \text{in joules.}$$



$$\text{power}, \; P = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2 \, dt \rightarrow \text{in watt.}$$

$$P = \frac{1}{T} \int_{0}^{T} |x(t)|^2 \, dt$$

For energy signals $\Rightarrow$ E is finite but $P = 0$ ✓

$0 < E < \infty$

For power signals $\Rightarrow$ P is finite but $E = \infty$ ✓

$0 < P < \infty$

$E = h\nu$

X

signal → wave → wavelengths, frequency.

AEDCL

APDCL

Assam

power

H/W :-

i) prove that when a signal has finite energy its power will be zero.

ii) power is finite then energy is infinite.

$$\frac{\int_{-T}^{T} |x(t)|^2 \, dt}{\quad}$$

$$x(t) = 3\cos 5\omega_0 t$$

$$2\cos^2\theta = 1 + \cos 2\theta$$

$$\Rightarrow \cos^2\theta = \frac{1 + \cos 2\theta}{2}$$

$$\int_{-T}^{T} (3\cos 5\omega_0 t)^2 \, dt = \int_{-T}^{T} 9\cos^2 5\omega_0 t \, dt$$

$$= 9\int_{-T}^{T} \left(\frac{1 + \cos 10\omega_0 t}{2}\right) dt = \frac{9}{2}\int_{-T}^{T} (1 + \cos 10\omega_0 t) \, dt$$

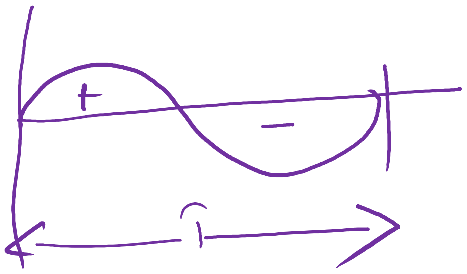
$$\frac{9}{2}\int_{-T}^{T}\left(1+\cancel{\cos 10\omega_0 t}\right)dt \quad 0$$

$$= \frac{9}{2}\left[\int_{-T}^{T} dt + \int_{-T}^{T}\cancel{\cos 10\omega_0 t}\, dt\right] \quad 0$$

$$= \frac{9}{2}\left[\left[t\right]_{-T}^{T} + \cancel{\left[\frac{\sin 10\omega_0 t}{10\omega_0}\right]_{-T}^{T}}\right] \quad 0$$

$$= \frac{9}{2}\times 2T$$

$$= 9T.$$



Av. value of sinusoidal signal over time period = 0

$$\left[\sin 10\omega_0 t\right]_{-T}^{T}$$

$$= \sin 10\omega_0 T - \sin 10\omega_0(-T) \to 0$$

$$\sin 10\times\frac{2\pi}{T}\times T$$

$$\sin(10\times 2\pi)$$

$\sin n\pi + \sin n(-$

$\sin \pi$

$\sin(\ldots\ldots)(-$

$$\int_0^T (\text{Sinusoidal of time})\,dt \to 0$$

$$E = \lim_{T \to \infty} \int_{-T}^{T} |x(t)|^2 \, dt = \lim_{T \to \infty} 9T = \infty$$

$$P = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2 \, dt = \lim_{T \to \infty} \frac{1}{2\cancel{T}} \times 9\cancel{T} = \frac{9}{2} \text{ watt}$$

$\therefore$ $x(t) = 3\cos 5\omega_0 t$ is power signal.