Signal Energy:-

An energy signal must have→

i) finite energy → $E = 0$ to ∞

ii) zero power → $P = 0$

The area under a certain period is calculated as energy of a signal.

that is→ $E = \int_{-\infty}^{\infty} |x(t)|^2 \, dt$; for continuous time

$E = \sum_{N=-\infty}^{\infty} |x(n)|^2$; for discrete time

Power signal:-

A power signal must have→

i) Finite and non zero power

ii) Energy infinite

$P = W/t$

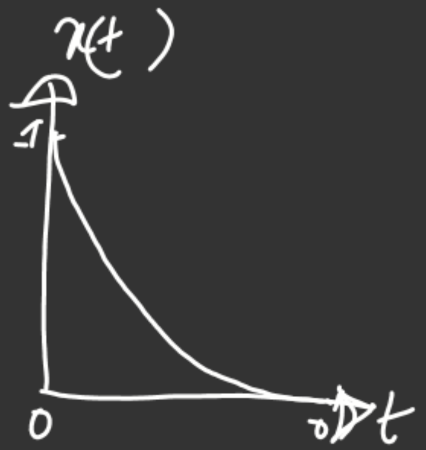
$\Rightarrow P = \frac{\text{Energy}}{\text{time}}$

A power signal is mathematically expressed as→

$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} |x(t)|^2 \, dt$; for continuous time

$P = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{N=-\infty}^{\infty} |x(n)|^2$; for discrete time

Ex-1: $x(t)=e^{-at}u(t)$; $a>0$



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

$$=\int_{0}^{\infty}(e^{-at})^2\,dt=-\frac{1}{2a}\left[e^{-2at}\right]_0^{\infty}$$

$$=-\frac{1}{2a}\left[e^{-2a\infty}-1\right]=\frac{1}{2a}$$

unit function u(t)
t<0 -> u=0
t>=0 -> u=1

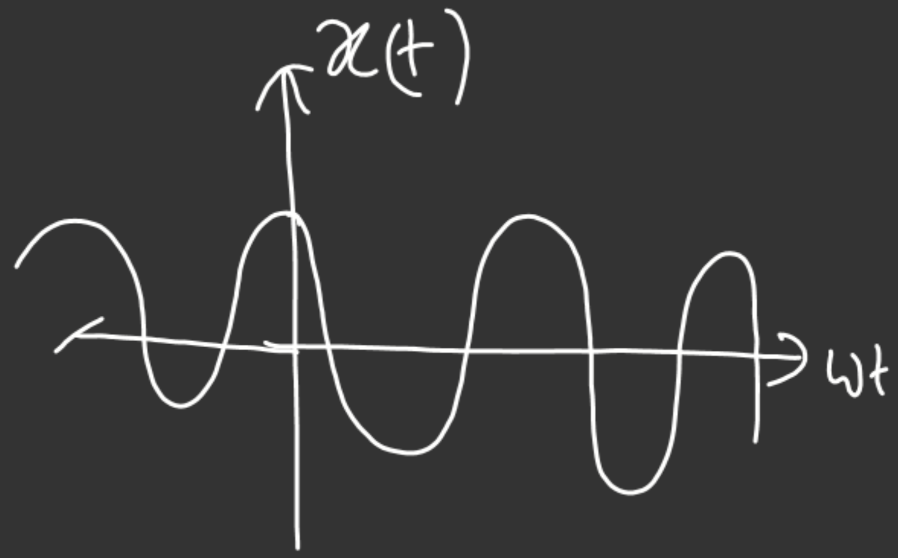
$$P=\lim_{T\to\infty}\frac{1}{2T}\int_{0}^{\infty}e^{-2at}\,dt$$

$$=\lim_{T\to\infty}\left[-\frac{1}{4aT}\left[e^{-2at}\right]_0^{\infty}\right]$$

$$=\lim_{T\to\infty}\left[-\frac{1}{4aT}(-1)\right]\approx 0$$

Ex-2

$x(t) = A\cos(\omega t)$



$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} \{A\cos(\omega t)\}^2 \, d(\omega t)$$

$$= \lim_{T\to\infty} \frac{1}{2T} \cdot \frac{A^2}{2} \int_{-T}^{T} 2\cos^2(\omega t) \, d(\omega t)$$

$$= \lim_{T\to\infty} \frac{A^2}{4T} \left[\int_{-T}^{T} \{1+\cos(2\omega t)\} \, d(\omega t) \right]$$

$$= \lim_{T\to\infty} \frac{A^2}{4T} \left[[\omega t]_{-T}^{T} + \underbrace{\frac{1}{2}[\sin 2\omega T]_{-T}^{T}} \right] = \lim_{T\to\infty} \left[\frac{A^2}{4T} (2T + 0) \right] = \lim_{T\to\infty} \frac{A^2}{\cancel{4}\, 2}$$

$T-(-T) = 2T$

$$\lim_{T\to+\infty} \frac{\sin 2T}{2T} \dashrightarrow 0$$

$E(t) = ?$

$$E = \int_{-\infty}^{\infty} A^2 \cos^2(\omega t)\, d\omega t$$

$$= \frac{A^2}{2} \int_{-\infty}^{\infty} 2\cos^2(\omega t)\, d\omega t$$

$$= \frac{A^2}{2} \int_{-\infty}^{\infty} \left(1 + \cos(2\omega t)\right) d\omega t$$

$$= \frac{A^2}{2} \left[\left[\omega t\right]_{-\infty}^{\infty} + \frac{1}{2}\left[\sin(2\omega t)\right]_{-\infty}^{\infty} \right]$$

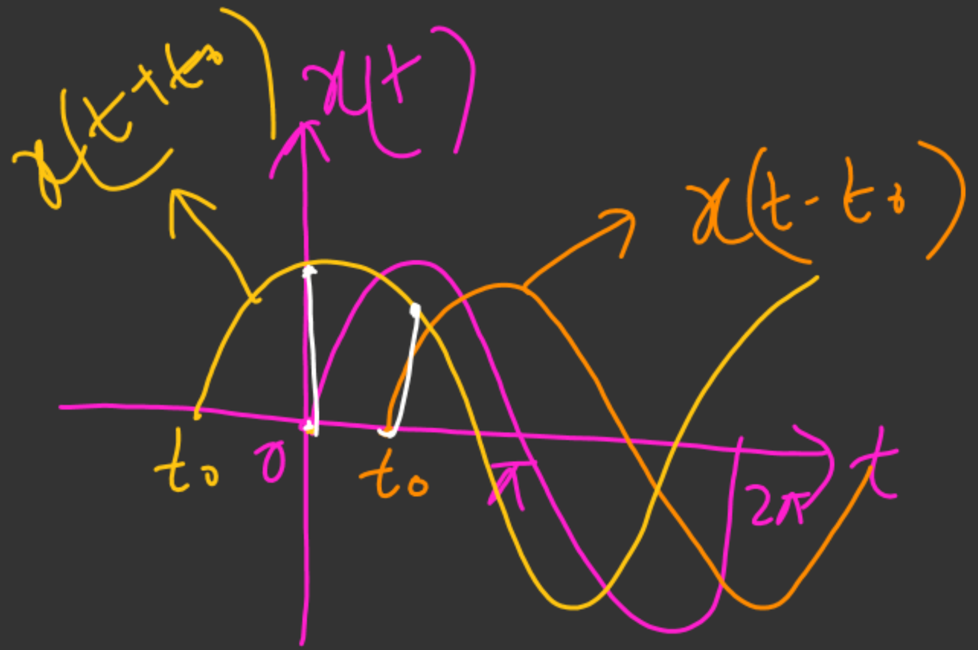
$$\approxeq \infty$$

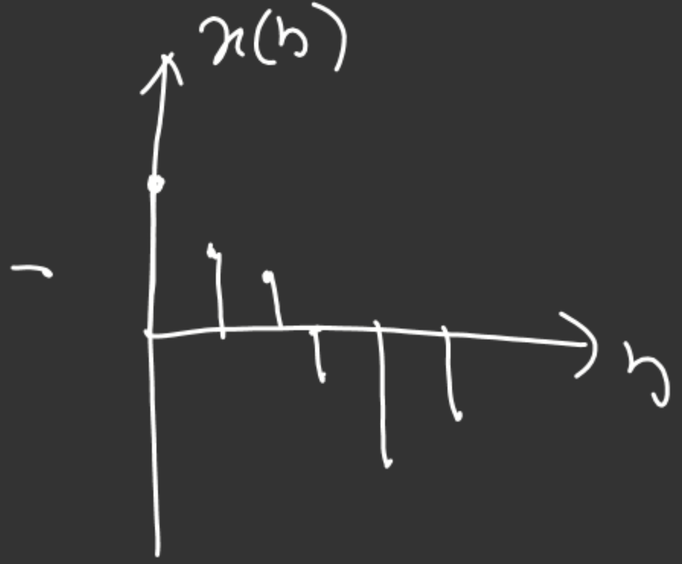
$\therefore$ Power signal

① Time shifting:-

i) Right $\longrightarrow$ Delayed

ii) Left $\longrightarrow$ Advanced





$$\left.\begin{array}{l} x[n-n_0] \\ x[n+n_0] \end{array}\right\} -$$