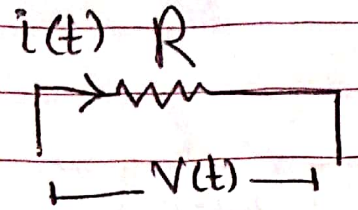
Energy & Power Signals



Instantaneous $P(t) = V(t)\, i(t) = i(t)^2 R = \frac{V^2(t)}{R}$

if $R = 1$ $\quad P_w = V^2(t) = i^2(t) = x^2(t)$

(average) $P_{avg} = \frac{1}{T} \int_0^T x^2(t)\, dt$

$T_1 \rightarrow T_2$ $\quad P_{avg} = \frac{1}{T_2 - T_1} \int_{T_1}^{T_2} x^2(t)\, dt$ Watts

$\downarrow$

energy in Joules

$$\text{Eneregy}_{total} = \int_{-\infty}^{\infty} x^2(t)\, dt$$

$$P_{avg} = \lim_{T \to \infty} \int_{-T}^{T} x^2(t)\, dt * \frac{1}{2T}$$

Continuous signals

$$E = \lim_{T\to\infty} \int_{-T}^{T} X^2(t)\,dt \quad (J)$$

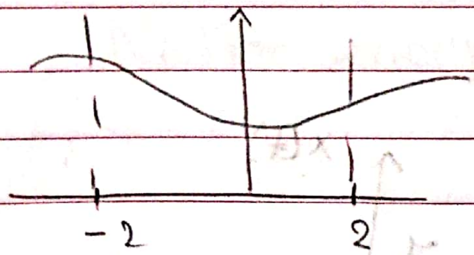
$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} X^2(t)\,dt \quad (W)$$

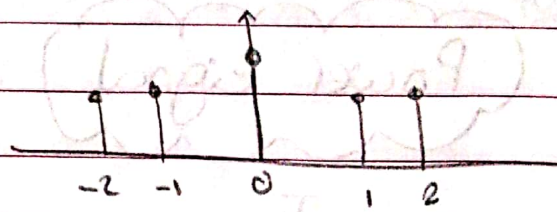
Discrete signals

$$E = \lim_{N\to\infty} \sum_{n=-N}^{N} X^2[n]$$

$$P = \lim_{N\to\infty} \frac{1}{2N+1} \sum_{n=-N}^{N} X^2[n]$$

$(2N+1)$





$$P = \frac{1}{4} \int_{-2}^{2} X^2(t)\,dt$$

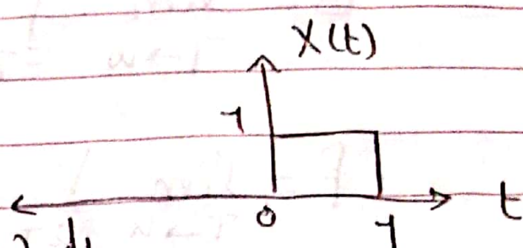
adding units (5 units)

$$P = \frac{1}{5} \sum_{-2}^{2} X^2[n]$$

بيقول سيف معلم و He is teaching only Maria in class :')

DATE: SUBJECT:

Energy Signal



E & P

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

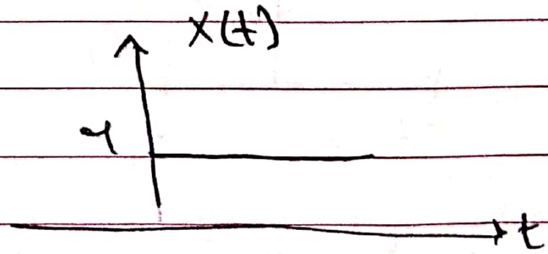
$$= \int_{0}^{1} dt = \boxed{1}\ J$$

$$P = \lim_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} x^2(t)\,dt = \frac{1}{\infty}\cdot 1 = \boxed{\text{Zero}}$$

Finite energy and Zero average Power

→ energy signal

Power Signal



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

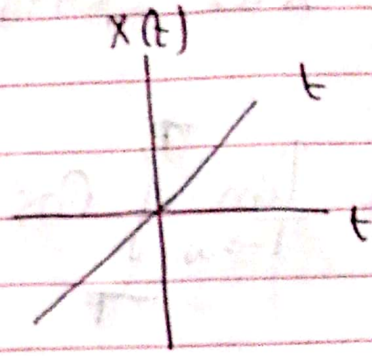
$$= \lim_{T\to\infty} \int_{0}^{T} dt = \lim_{T\to\infty} T = \boxed{\infty}\ J$$

$$P = \lim_{T\to\infty} \frac{1}{2T} E = \lim_{T\to\infty} \frac{1}{2\cancel{T}} (\cancel{T}) = \boxed{\frac{1}{2}}\ W$$

When we have infinite energy and Finite Power.

DATE: SUBJECT:

$x(t) = t$, find E & P



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

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

$$= \lim_{T\to\infty}\int_{-T}^{T} t^2\,dt = \lim_{T\to\infty} \cdot \left[\frac{t^3}{3}\right]_{-\infty}^{\infty} = \lim_{T\to\infty}\frac{2T^3}{3} = \boxed{\infty}\,J$$

$$\text{Power} = \lim_{T\to\infty}\frac{1}{2T}\int_{-\infty}^{\infty} x^2(t)\,dt$$

$$= \lim \frac{1}{2T}\cdot E = \lim_{T\to\infty}\frac{1}{2T}\left(\frac{2T^3}{3}\right) = \lim_{T\to\infty}\frac{T^2}{3}$$

$$= \boxed{\infty}\,W$$

Neither energy nor power, it has no name.

DATE: SUBJECT:

$$X(t) = \cos(2\pi t)$$

$$E = \lim_{T\to\infty} \int_{-\infty}^{\infty} \cos^2(2\pi t)\,dt = \lim_{T\to\infty} \int_{-T}^{T} \frac{1}{2} + \frac{1}{2}\cos(4\pi t)$$

$$= \lim_{T\to\infty} \left[\frac{1}{2}T + \frac{1}{8\pi}\sin(4\pi t) \right]_{-T}^{T}$$

$$= \lim_{T\to\infty} \left[\frac{1}{2}T + \frac{1}{8\pi}\sin(4\pi T) + \frac{1}{2}T - \frac{1}{8\pi}\sin(-4\pi T) \right]$$

$$= \lim_{T\to\infty} \left[T + \frac{1}{4\pi}\sin(4\pi T) \right]$$

$$= \boxed{\infty} \; J$$

$$\text{Power} = \lim_{T\to\infty} \frac{1}{2T} E = \lim_{T\to\infty} \frac{1}{2T} \left[T + \frac{1}{2}\int_{-T} \cos() \right]$$

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

$$= \frac{1}{4T} \int_{-T}^{T} \cos(4\pi t)\,dt$$

$$= \frac{1}{4T(4\pi)} \left[\sin(4\pi t) \right]_{-T}^{T} = \sin(4\pi T) - \sin(4\pi(-T))$$

$$= \sin(\infty) =$$

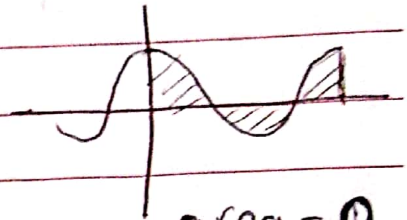
$$= \frac{\text{finite}}{\infty} = \boxed{\text{Zero}}$$

$$\text{Power} = \boxed{\frac{1}{2}}$$

DATE: SUBJECT:

$$P = \lim_{T\to\infty}\left[\frac{1}{2} + \underbrace{\frac{1}{4T}\int_{-T}^{T} \cos\, dt}_{\frac{\text{finit}}{\infty}}\right]$$

$$= \frac{1}{2} + \frac{0+0+0+0 \ldots + \text{finite}}{4(\infty)}$$



area = 0

$$= \frac{1}{2} + \text{zero}$$

$$= \boxed{\frac{1}{2}}$$

So $x(t) = \cos(—)$ is a Power signal

infinite E — $\frac{1}{2}$ W

Any Finite Periodic signals are always Power signal

infinite E — Finite P

trick :)

Power is one Period as it repeats itself.