$$E_s = \lim_{T \to \infty} \int_{-T/2}^{T/2} |s(t)|^2 dt = \int_{-\infty}^{+\infty} |s(t)|^2 dt$$

$$P_s(T) = \frac{1}{T} \int_{-T/2}^{T/2} |s(t)|^2 dt$$

Pot. media finita se $\exists$ finito e $\neq 0$

$$P_s = \lim_{T \to \infty} \frac{1}{T} \int_{-T/2}^{T/2} |s(t)|^2 dt$$

segnale periodico $\quad E_s = +\infty$

$$s(t) = s(t + T_0) \quad \forall t$$

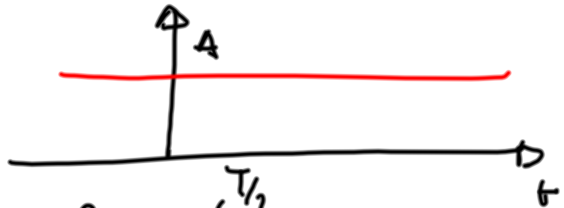
$$P_s = \frac{1}{T_0} \int_{[T_0]} |s(t)|^2 dt$$

DIM $\quad P_s = \lim_{N \to \infty} \frac{1}{NT_0} \int_{-\frac{NT_0}{2}}^{+\frac{NT_0}{2}} |s(t)|^2 dt =$

$$= \lim_{N \to \infty} \frac{1}{\cancel{N}T_0} \cancel{N} \int_{-T_0/2}^{T_0/2} |s(t)|^2 dt$$

<u>segnale costante</u>

$$s(t) = A$$



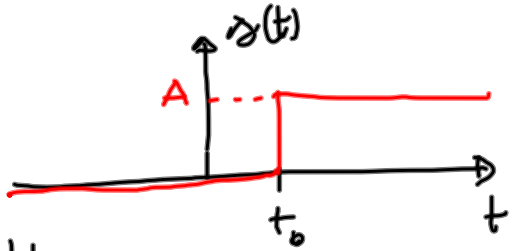
$$E_s = \lim_{T\to\infty} \int_{-T/2}^{T/2} |s(t)|^2 dt = \lim_{T\to\infty} \int_{-T/2}^{T/2} A^2 dt =$$

$$= \lim_{T\to\infty} A^2 T = +\infty$$

$$P_s = \lim_{T\to\infty} \frac{1}{T} A^2 T = A^2$$

<u>segnale a gradino</u>

$$s(t) = A\, u(t - t_0)$$

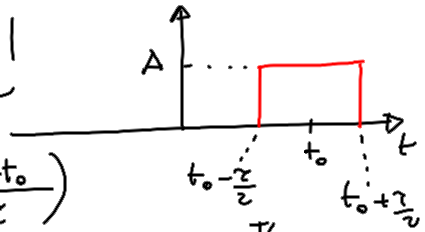


$$P_s = \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} |s(t)|^2 dt =$$

$$= \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} A^2\, u^2(t-t_0)\, dt = \lim_{T\to\infty} \frac{1}{T} \int_{t_0}^{T/2} A^2 dt =$$

$$= \lim_{T\to\infty} \frac{1}{T} A^2 \left(\frac{T}{2} - t_0\right) = \frac{A^2}{2}$$

$$\boxed{\text{rect}\left(\frac{t}{\tau}\right) \triangleq G_\tau(t)}$$



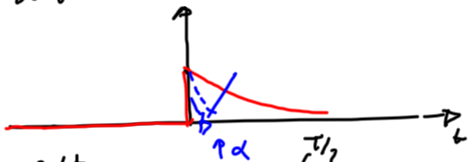
$$s(t) = A\,\text{rect}\left(\frac{t-t_0}{\tau}\right)$$

$$E_s = \lim_{T\to\infty}\int_{-T/2}^{T/2}|s(t)|^2\,dt = \lim_{T\to\infty}\int_{-T/2}^{T/2} A^2\,\text{rect}^2\left(\frac{t-t_0}{\tau}\right)dt =$$

$$= \lim_{T\to\infty}\int_{t_0-\frac{\tau}{2}}^{t_0+\frac{\tau}{2}} A^2\,dt = A^2\left(t_0+\frac{\tau}{2}-t_0+\frac{\tau}{2}\right) = A^2\tau$$

$$P_s = \lim_{T\to\infty}\frac{1}{T}A^2\tau = \emptyset$$

$$- \; s(t) = A\,e^{-\alpha t}u(t) \qquad \alpha>0 \in \mathbb{R}$$



$$E_s = \lim_{T\to\infty}\int_{-T/2}^{T/2} A^2 e^{-2\alpha t}u^2(t)\,dt = \lim_{T\to\infty}\int_{0}^{T/2} A^2 e^{-2\alpha t}\,dt =$$

$$= \lim_{T\to\infty} A^2\frac{1}{-2\alpha}\left(e^{-2\alpha t}\right)\Big|_0^{T/2} = \lim_{T\to\infty}\frac{A^2}{2\alpha}\left(1-e^{-2\alpha\frac{T}{2}}\right) =$$

$$= \lim_{T\to\infty}\frac{A^2}{2\alpha}\left(1-\underbrace{e^{-\alpha T}}_{\to\emptyset}\right) = \frac{A^2}{2\alpha}$$

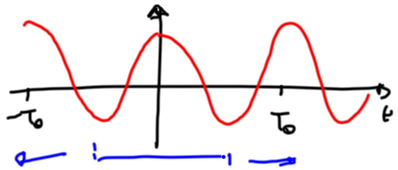
$$P_s = \emptyset$$

$$- \;\boxed{es}\quad s(t) = e^{-\alpha t} \qquad \alpha>0,\ \alpha\in\mathbb{R}$$

$$s(t) = A\cos \omega t = A\cos\left(2\pi \frac{1}{T_0} t\right) = A\cos(2\pi f_0 t)$$

$$T_0 = \frac{2\pi}{\omega}$$

$$f_0 = 1/T_0$$



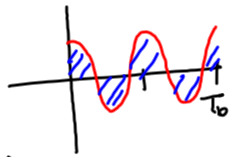
$$E_s = +\infty$$

$$P_s = \frac{1}{T_0}\int_0^{T_0} A^2\cos^2\omega t\, dt =$$

$$\cos^2\alpha = \frac{1+\cos 2\alpha}{2}$$

$$= \frac{1}{T_0}\int_0^{T_0} A^2\left(\frac{1+\cos 2\omega t}{2}\right)dt =$$

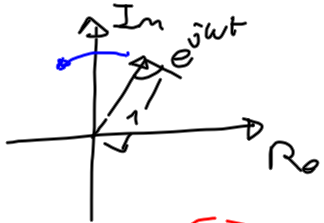
$$= \frac{1}{T_0}\int_0^{T_0}\frac{A^2}{2}\,dt + \frac{1}{T_0}\frac{A^2}{2}\int_0^{T_0}\cos 2\omega t\, dt =$$



$$= \frac{1}{T_0}\frac{A^2}{2}T_0 = \frac{A^2}{2}$$

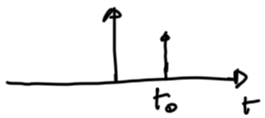
$$- \quad s(t) = A e^{j\omega t} = A(\cos\omega t + j\sin\omega t)$$

$$P_s = \frac{1}{T_0}\int_{-T_0/2}^{T_0/2} |A e^{j\omega t}|^2 dt =$$

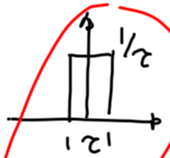


$$= \frac{1}{T_0}\int_{-T_0/2}^{T_0/2} A^2\, dt = A^2$$

$-$



$$s(t) = \delta(t - t_0)$$



$$\lim_{\tau \to 0}$$

$$E_s = +\infty$$

$$P_s = 1$$

$$\int_{-\infty}^{\infty} f(t)\,\delta(t - t_0) = f(t_0)$$

tempo discreto

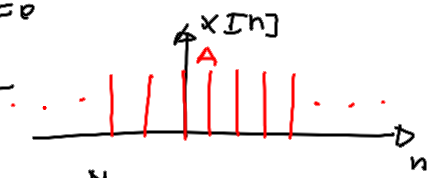
$$E_x \triangleq \sum_{n=-\infty}^{+\infty} |x[n]|^2$$

$$P_x \triangleq \lim_{N \to \infty} \frac{1}{2N+1} \sum_{n=-N}^{N} |x[n]|^2$$

Seq. periodica $x[n] = x[n+N_0] \quad \forall n$

$$P_x = \frac{1}{N_0} \sum_{n=0}^{N_0-1} |x[n]|^2$$

Segnale costante



$x[n] = A$

$$E_x = +\infty$$

$$P_x = \lim_{N \to \infty} \frac{1}{2N+1} \sum_{n=-N}^{N} A^2 = A^2$$

segnale esponenziale

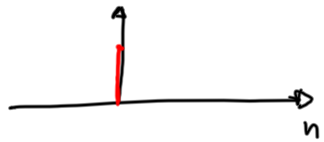
$$x[n] = \begin{cases} e^{-n} & n \geq 0 \\ 0 & n < 0 \end{cases}$$

$$E_x = \sum_{n=-\infty}^{+\infty} |x[n]|^2 = \sum_{n=0}^{+\infty} e^{-2n} =$$

$$\sum_{n=0}^{\infty} a^n = \frac{1}{1-a}$$

$$= \frac{1}{1-e^{-2}}$$

segnale impulsivo



$\delta[n]$

$$E_x = 1$$

Approccio Assiomatico

Ω

1	2	3
4	5	6

S

$S_1 = \{1, 3, 5\}$

$S_2 = \{1, 2, 3, 4\}$

Disposizioni con ripetizione

$D^{(r)}_{n,k} = n^k$

$\{1, 2, 3\}$ $n = 3$ $k = 2$

1,1 1,2 1,3
2,1 2,2 2,3
3,1 3,2 3,3

$3^2 = 9$

Disposizioni semplici

$D_{n,k} = \frac{n!}{(n-k)!}$

1,1 (1,2 (1,3
(2,1 2,2 (2,3
(3,1 (3,2 3,3

$\frac{3!}{(3-2)!} = 6$

$k = n$

$D_{n,n} = P_n = n!$

$\{1, 2, 3\}$

1,2,3 1,3,2, 2,1,3 2,3,1
3,1,2 3,2,1

Combinazioni

$C_{n,k} = \frac{n!}{(n-k)!\,k!} = \binom{n}{k}$

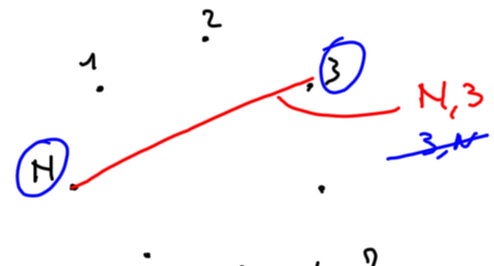
1,1 1,2 1,3
(2,1 2,2 2,3)
(3,1 (3,2 3,3

Combinazioni con ripetizione

$C^{(r)}_{n,k} = \binom{n+k-1}{k} = \frac{(n+k-1)!}{k!\,(n-1)!}$

$C^{(r)}_{3,2} = \binom{4}{2} = \frac{4!}{2!\,2!} = 6$

(1,1 1,2 1,3
(2,1 (2,2 2,3
(3,1 (3,2 (3,2



quante diagonali possiede?

$$C_{N,2} = \frac{N!}{2!\,(N-2)!} = \frac{N\cdot(N-1)}{2}$$

$$\text{Num diag} = C_{N,2} - N = \frac{N(N-1)}{2} - N =$$

$$= \frac{N^2 - N - 2N}{2} = \frac{N(N-3)}{2}$$

- Valigia con sicurezza a 6 cifre
  Quante combinazioni ha?

0, 1, ..., 9

0 0 0 0 0 0
0 0 0 0 0 1
1 0 0 0 0 0
0 1 0 0 0 0

$$D^{(r)}_{10,6} = 10^6$$

- parole di 4 lettere si possono formare a partire da "albergo"

$$D_{7,4} = \frac{7!}{3!} = 7\cdot 6\cdot 5\cdot 4$$

- ANAGRAMMI vocali

$$D_{5,5} = P_5 = 5!$$

— mietere

quante parole si possono formare con le lettere di "mietere"?

P_7

$m\, i\, e_1\, t\, e_2\, r\, e_3$ —

$m\, i\, e_2\, t\, e_1\, r\, e_3$ —

$m\, i\, e_3\, t\, e_2\, r\, e_1$ —

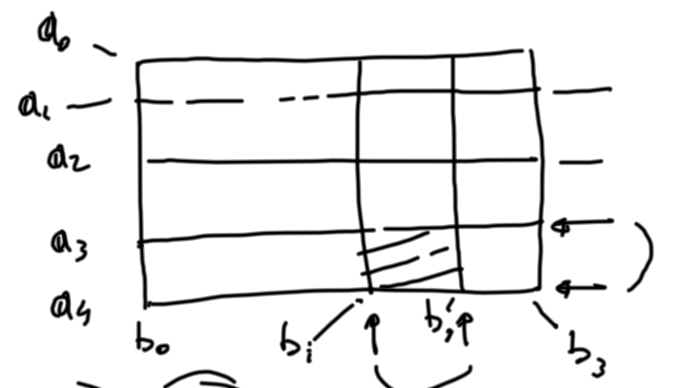
⋮

$$\frac{P_7}{P_3}$$

— tratteggiare

a 2	r 2
g 2	e 2
t 3	

$$\frac{P_{12}}{P_2\, P_2\, P_2\, P_2\, P_3} = \frac{12!}{2!\,2!\,2!\,2!\,3!}$$



$a_i \; a_k$ $\quad$ $b_j \; b_h$

$$C_{5,3} * C_{4,2} = \frac{5!}{2!\,3!} \cdot \frac{4!}{2!\,2!}$$