Universidad Nacional Autónoma de México

Facultad de Ingeniería

División de Ingeniería Eléctrica

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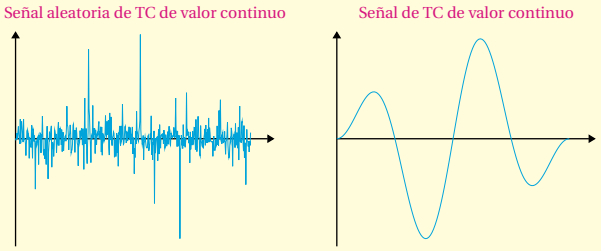
Señal

Es una variable física que contiene información acerca de la naturaleza, del comportamiento de algún fenómeno físico o de un proceso creado por el ser humano. Las señales se pueden representar mediante una función de una o más variables. Las señales se estudian, analizan y transforman a través de modelos matemáticos y de sistemas.

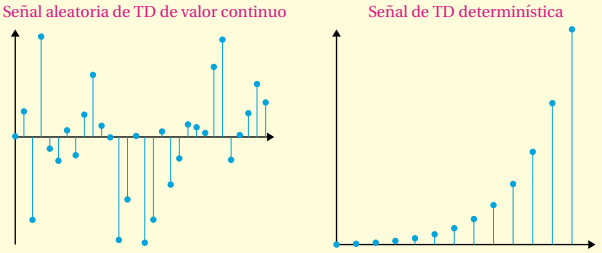
Señales Determinísticas y Aleatorias

Las señales determinísticas pueden describirse completamente de forma analítica en el dominio del tiempo. Las señales aleatorias no pueden ser modeladas analíticamente. Se analizan en términos de sus propiedades estadísticas.

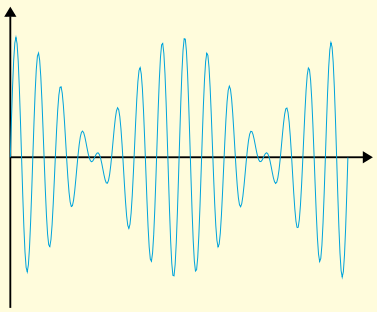
Tiempo continuo $x(t)$



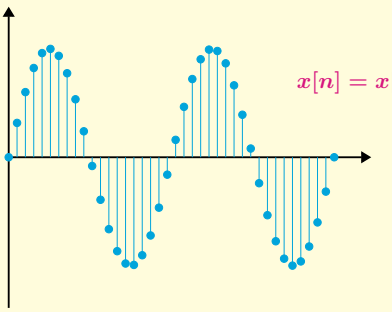
Tiempo discreto $x[n]$



Señales Periódicas

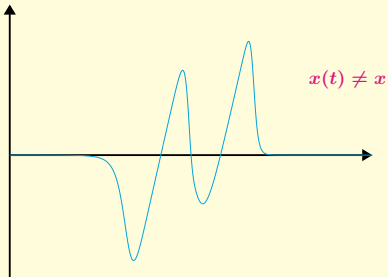


$$x(t) = x(t + mT)$$

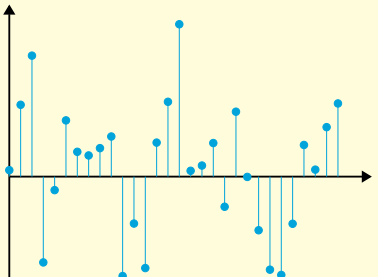


$$x[n] = x[n + mN]$$

Señales Aperiódicas

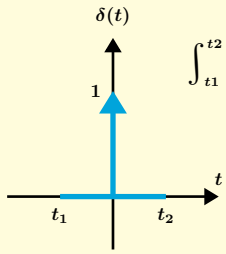


$$x(t) \neq x[t + mT]$$



$$x[n] \neq x[n + mN]$$

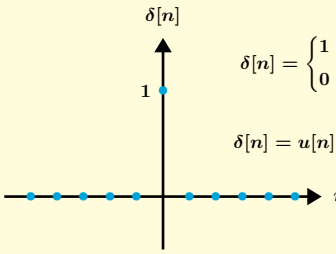
Impulso unitario $\delta(t)$, $u_0(t)$



$$\int_{t1}^{t2} \delta(t)\,dt = \begin{cases} 1 & t_1 < 0 < t_2 \\ 0 & \text{en otro caso} \end{cases}$$

$$\delta(t) = 0 \quad t \neq 0$$

Muestra unitaria o Delta de Kronecker $\delta[n]$



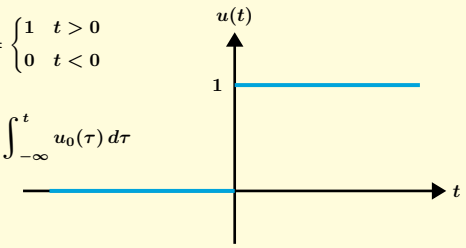
$$\delta[n] = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$$

$$\delta[n] = u[n] - u[n-1]$$

Escalón unitario $u(t)$, $u_{-1}(t)$

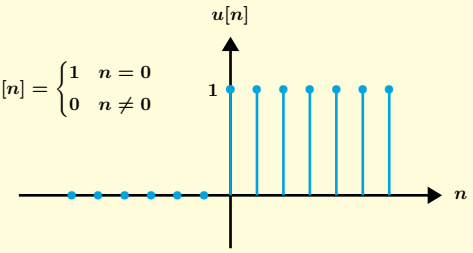
$$u(t) = \begin{cases} 1 & t > 0 \\ 0 & t < 0 \end{cases}$$

$$u_{-1}(t) = \int_{-\infty}^{t} u_0(\tau)\,d\tau$$



Secuencia Unitaria $u[n]$

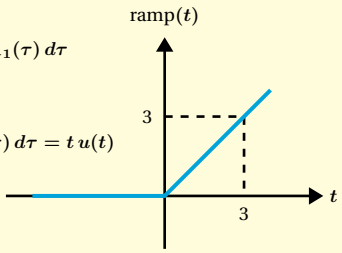
$$\delta[n] = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$$



Función Rampa ramp(t), $r(t)$, $u_{-2}(t)$

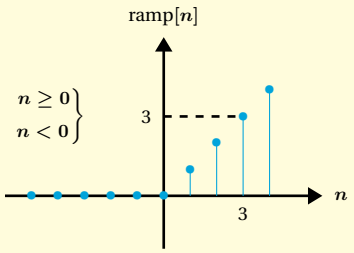
$$u_{-2}(t) = \int_{-\infty}^{t} u_{-1}(\tau)\,d\tau$$

$$\text{ramp}(t) = \begin{cases} t & t \geq 0 \\ 0 & t < 0 \end{cases} = \int_{-\infty}^{t} u(\tau)\,d\tau = t\,u(t)$$

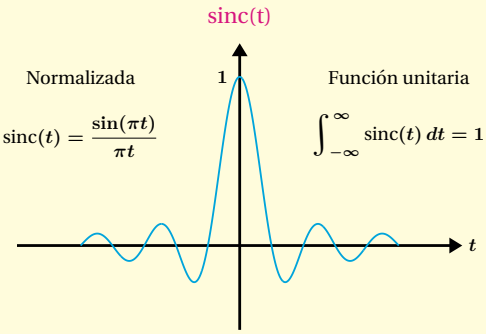


Función Rampa discreta ramp[n]

$$\text{ramp}[n] = \begin{cases} n & n \geq 0 \\ 0 & n < 0 \end{cases}$$



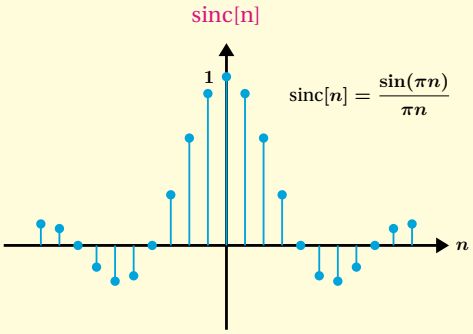
Función seno cardinal sinc(t)



$$\text{sinc}(t) = \frac{\sin(\pi t)}{\pi t}$$

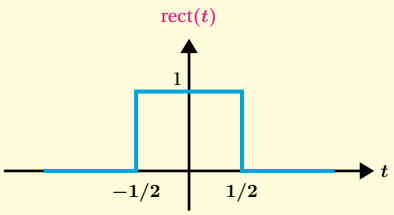
$$\int_{-\infty}^{\infty} \text{sinc}(t)\,dt = 1$$

Función seno cardinal sinc[n]

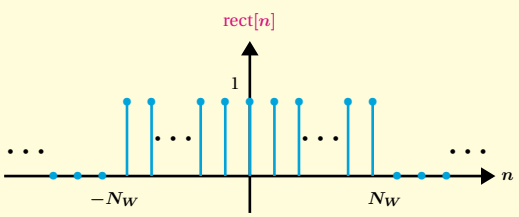


$$\text{sinc}[n] = \frac{\sin(\pi n)}{\pi n}$$

Función rectángulo rect(t), $\Pi(t)$

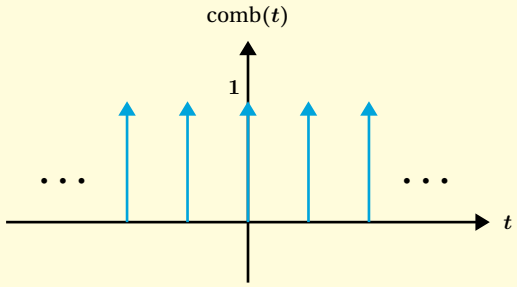


Función rectángulo rect[n]



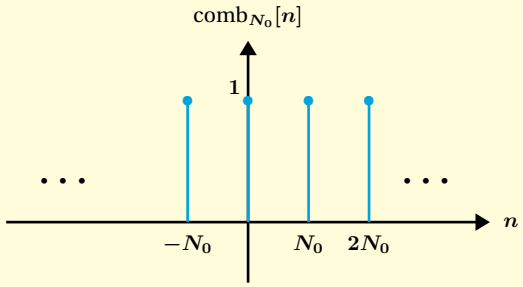
Tren de impulsos TC y en TD

Tren de impulsos comb(t)



$$\text{comb}(t) = \sum_{n=-\infty}^{\infty} \delta(t-n) \quad \text{donde } n \text{ es entero}$$

Tren de impulsos discretos



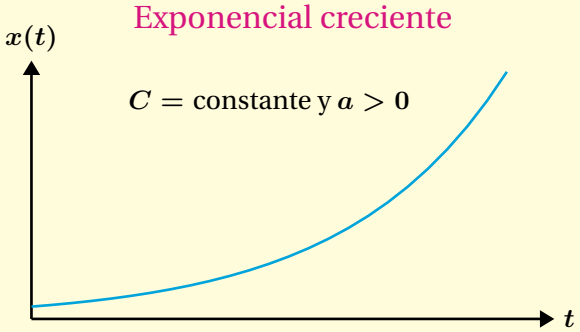
$$\text{comb}_{N_0}[n] = \sum_{m=-\infty}^{\infty} \delta[n - mN_0]$$

Exponenciales Generalizadas en TC y TD

Exponencial real $x(t) = Ce^{at}$

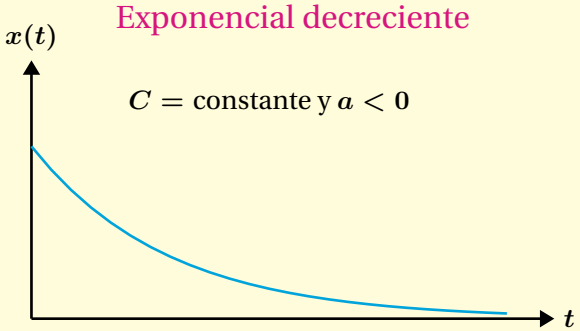
$x(t)$ es una función real si C y a son reales:

Exponencial creciente



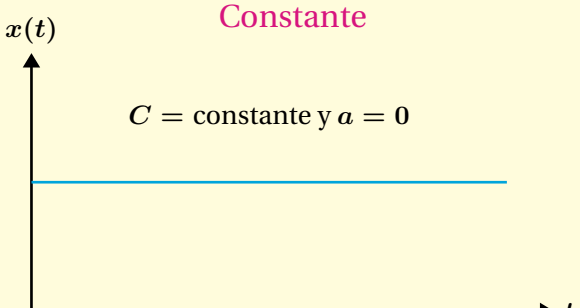
C = constante y $a > 0$

Exponencial decreciente



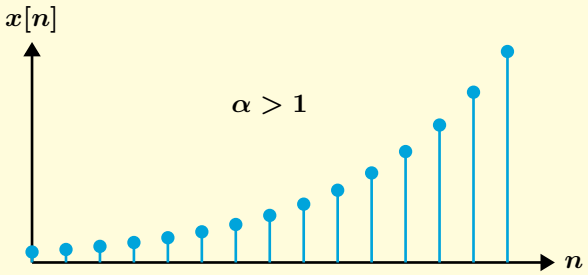
C = constante y $a < 0$

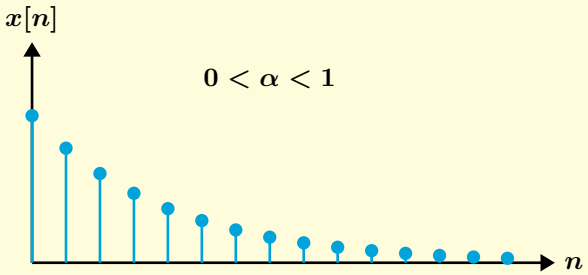
Constante

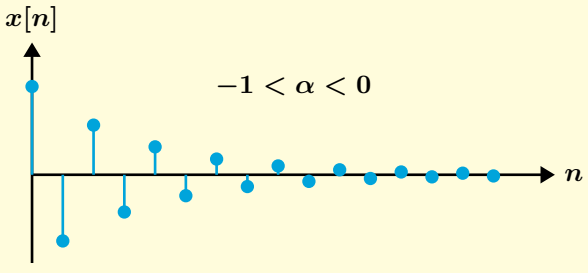


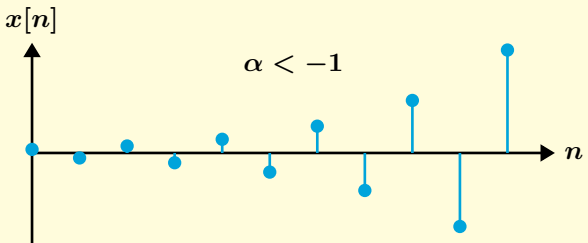
C = constante y $a = 0$

Exponencial real $x[n] = C\alpha^n$





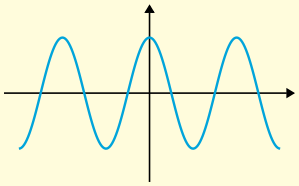




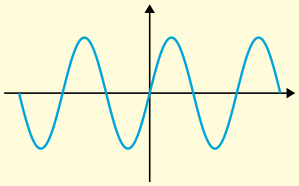
Exponencial compleja, periódica
C = **constante y** $a = j\omega$

$$x(t) = Ce^{j\omega_0 t} = C\cos(\omega_0 t) + jC\sin(\omega_0 t)$$

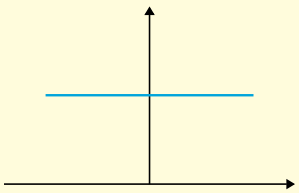
Parte real de $f(t)$



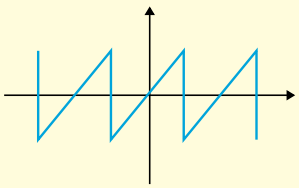
Parte imaginaria de $f(t)$



Magnitud de $f(t)$



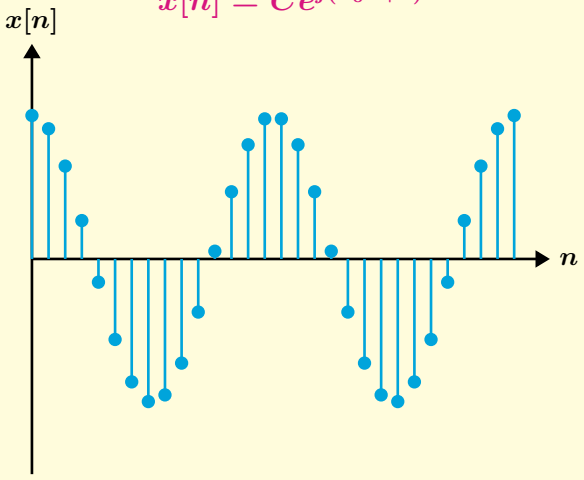
Angulo de $f(t)$



Exponencial compleja, periódica

$$C = C_1 e^{j\theta} \text{ y } \alpha = e^{j\omega_0}$$

$$x[n] = Ce^{j(\omega_0 n+\theta)}$$



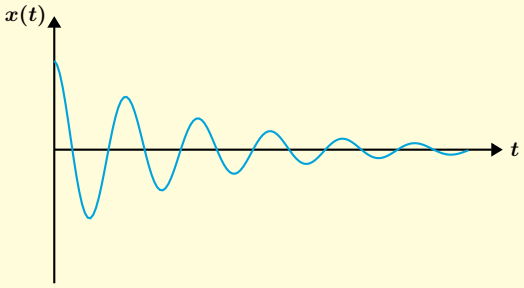
Exponenciales Generalizadas en TC y TD

Exponencial Compleja, periódica y aperiódica $x(t) = Ce^{at}$

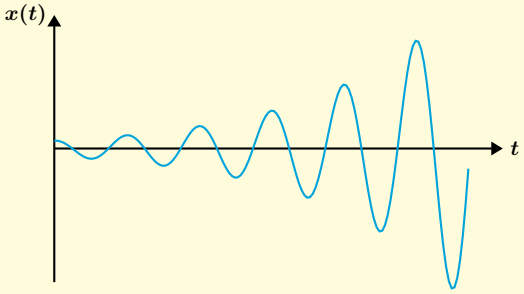
$$C = C_1 e^{j\theta} \quad \text{y} \quad a = r + j\omega_0$$

$$x(t) = C_1 e^{rt}\left(\cos(\omega_0 t + \theta) + j\sin(\omega_0 t + \theta)\right)$$

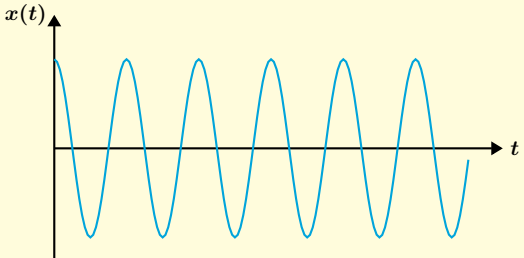
Exponencial compleja decreciente $r < 0$



Exponencial compleja creciente $r > 0$



Exponencial compleja $r = 0$

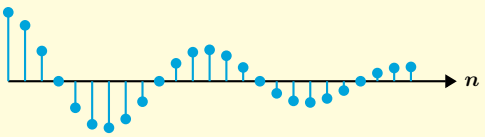


Exponencial Compleja aperiódica

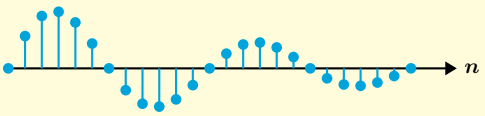
$$C = C_1 e^{j\theta} \quad \text{y} \quad \alpha = \alpha_1 e^{j\omega_0}$$

$$x[n] = C_1\alpha_1^n\left(\cos(\omega_0 n + \theta) + j\sin(\omega_0 n + \theta)\right)$$

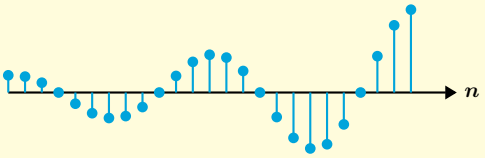
Re $\{x[n]\}$, $|\alpha| < 1$



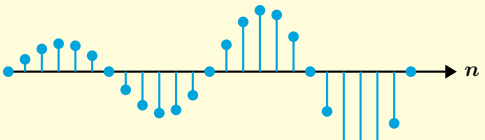
Im $\{x[n]\}$, $|\alpha| < 1$



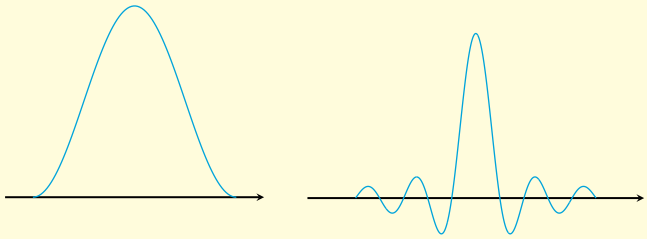
Re $\{x[n]\}$, $|\alpha| > 1$



Im $\{x[n]\}$, $|\alpha| > 1$

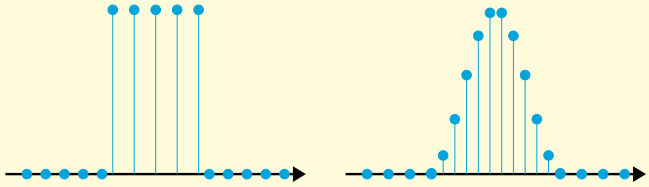


Señales de Energía en TC (Energía finita)



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

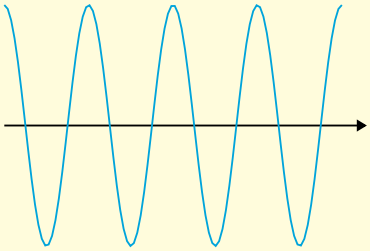
Señales de Energía en TD (Energía finita)



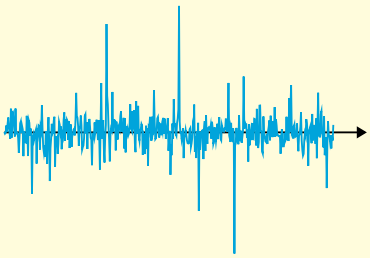
$$E_x = \sum_{-\infty}^{\infty} |x[n]|^2$$

Señales de potencia en TC (Potencia finita)

$$P_x = \frac{1}{T} \int_{-(T/2)}^{T/2} |x(t)|^2 \, dt$$

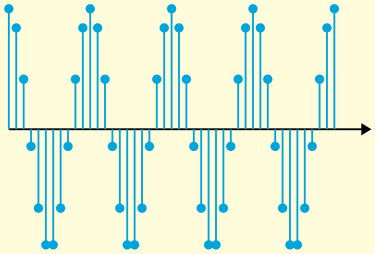


$$P_x = \lim_{t \to \infty} \frac{1}{T} \int_{-(T/2)}^{T/2} |x(t)|^2 \, dt$$



Señales de potencia en TD (Potencia finita)

$$P_x = \frac{1}{N} \sum_{n=<N>} |x[n]|^2$$



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