

2384-18

**ICTP Latin-American Advanced Course on FPGA Design for Scientific
Instrumentation**

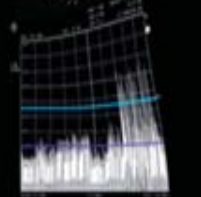
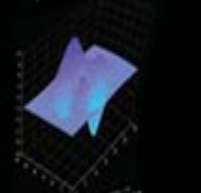
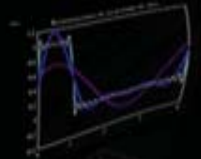
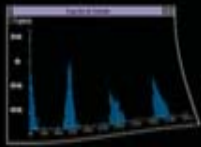
19 November - 7 December, 2012

Señales y sistemas

COSTA Diego Esteban

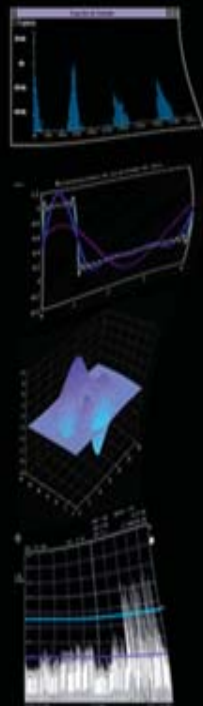
*Laboratorio de Electronica, Investigacion y Servicios
Fac. Cie. Fisico, Mat y Nat.
Universidad Nacional de San Luis, Av. Ejercito de los Andes
D5700HHW San Luis
ARGENTINA*



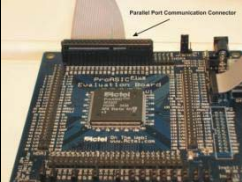

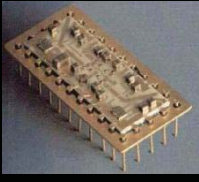
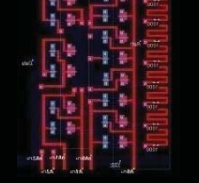


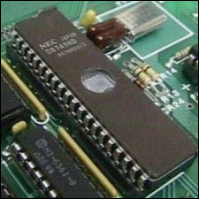
Señales y sistemas



Señales y sistemas

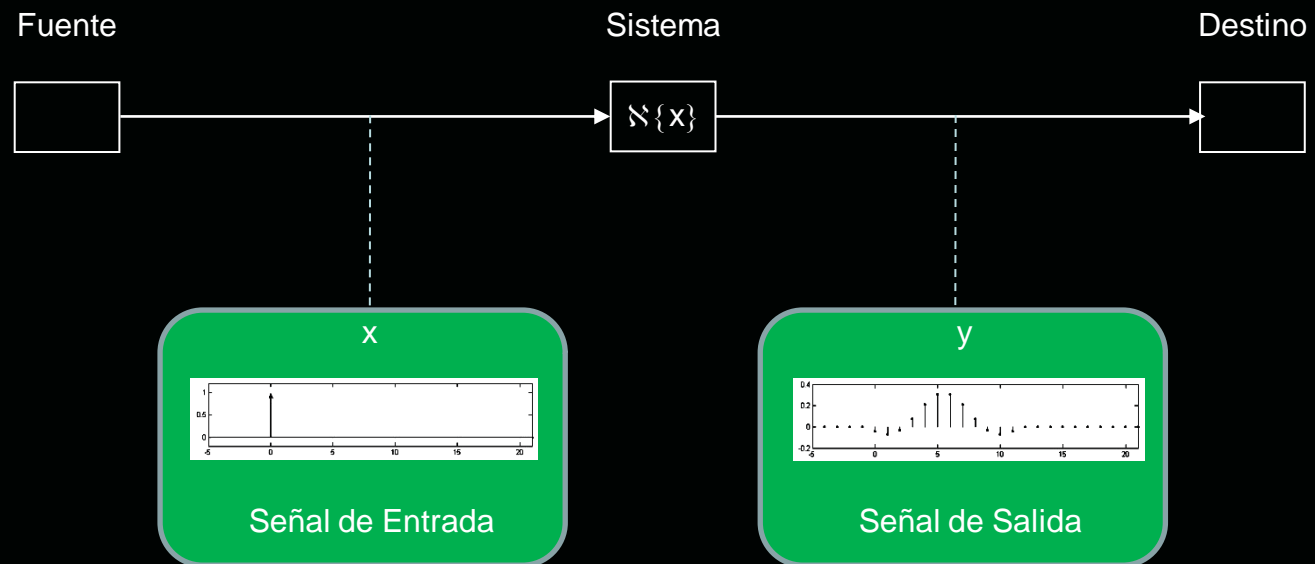
Implementación de sistemas digitales



DSP	Hardware		Software	
 	 	 		 
DSP	PLD	ASIC	PC	μ controlador
Reprogramable ↑ velocidad	↑ velocidad Reconfigurable ↓ costo	↑↑ velocidad	Versatilidad Reprogramable	Reprogramable ↓ costo
↓versatilidad sin compiladores	Requiere aprendizaje de HDL	↑↑ costo No reconfigurable	↓↓ velocidad	↓ velocidad Limitación de prestación

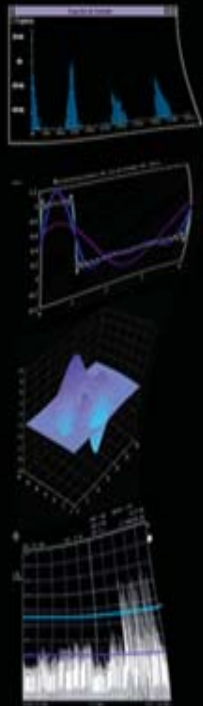
Señales y sistemas

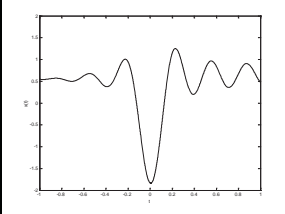
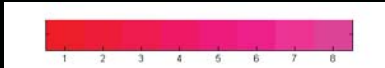
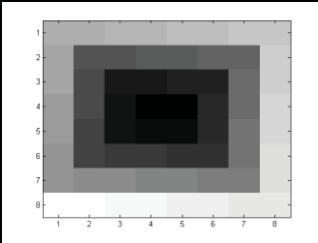
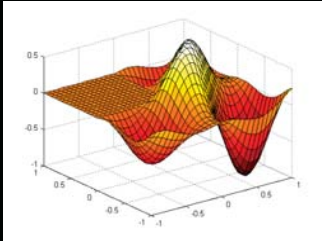
Elementos



Señales y sistemas

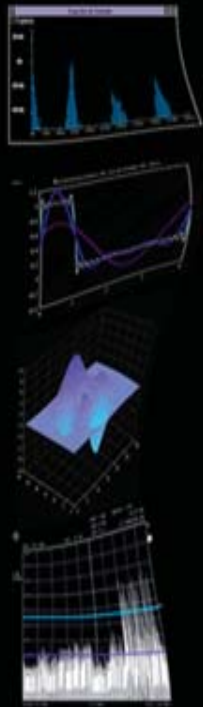
Tipos de señales

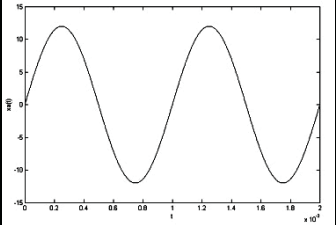
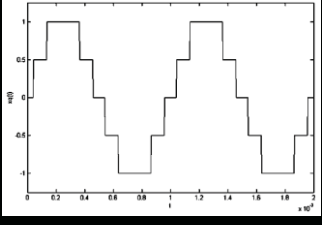
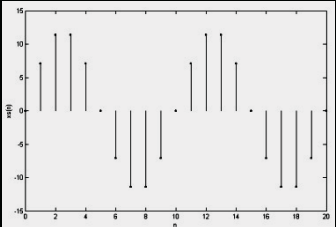
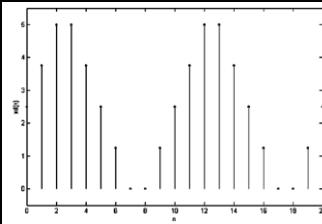


	Variable dependiente unidimensional	Variable dependiente multidimensional
Variable independiente unidimensional	 <p>Tensión vs tiempo</p>	 <p>Posición lineal vs color</p>
Variable independiente multidimensional	 <p>Posición en plano vs gris</p>	 <p>Posición espacial vs color</p>

Señales y sistemas

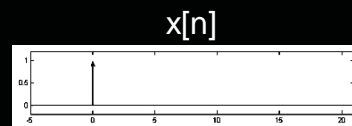
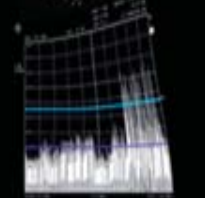
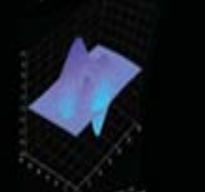
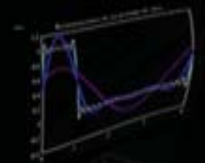
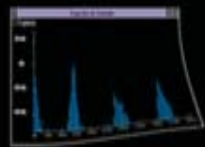
Tipos de señales



	Variable dependiente continua	Variable dependiente discreta
Variable independiente continua	 <p>Analógica</p>	 <p>Cuantizada</p>
Variable independiente discreta	 <p>Muestreada</p>	 <p>Digital</p>

Señales y sistemas

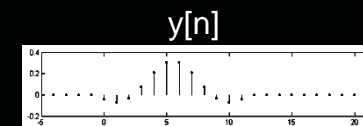
Tipos de sistemas



Señal de Entrada

Sistema
Discreto

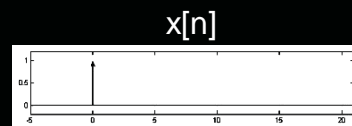
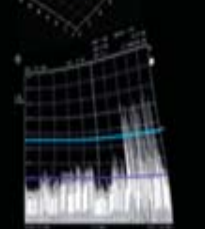
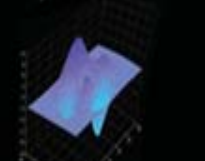
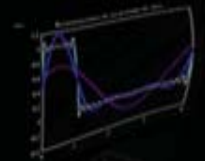
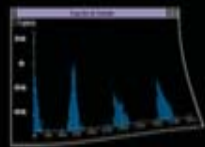
$\{x[n]\}$



Señal de Salida

Señales y sistemas

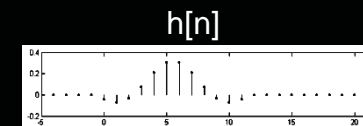
Tipos de sistemas



Señal de Entrada:
Impulso

Sistema
Discreto

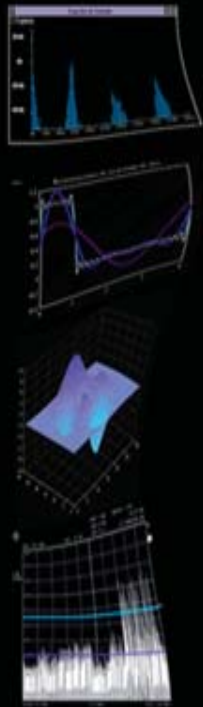
$h[n]$



Señal de Salida:
Respuesta al Impulso

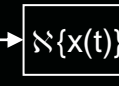
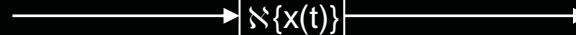
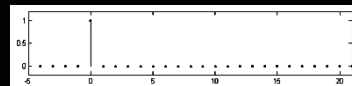
Señales y sistemas

Tipos de sistemas



Señal de Entrada

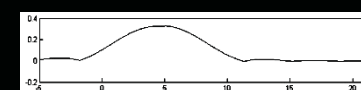
$x(t)$



Sistema
Continuo

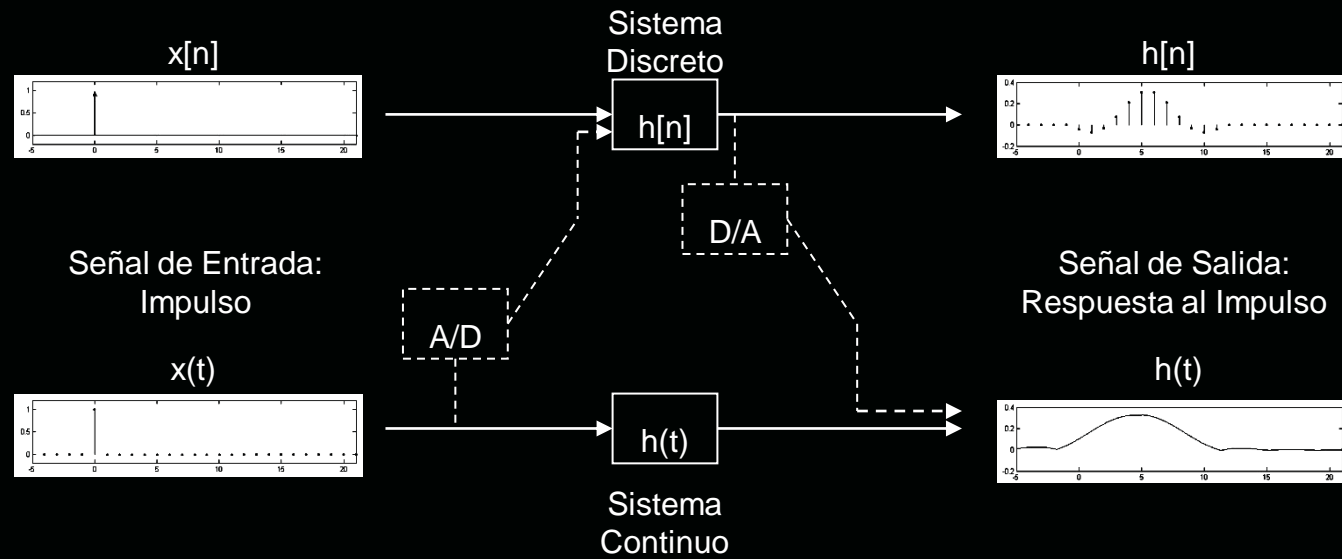
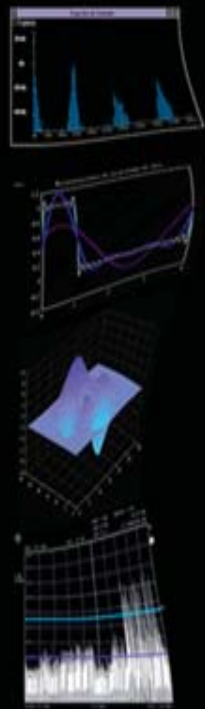
Señal de Salida

$y(t)$



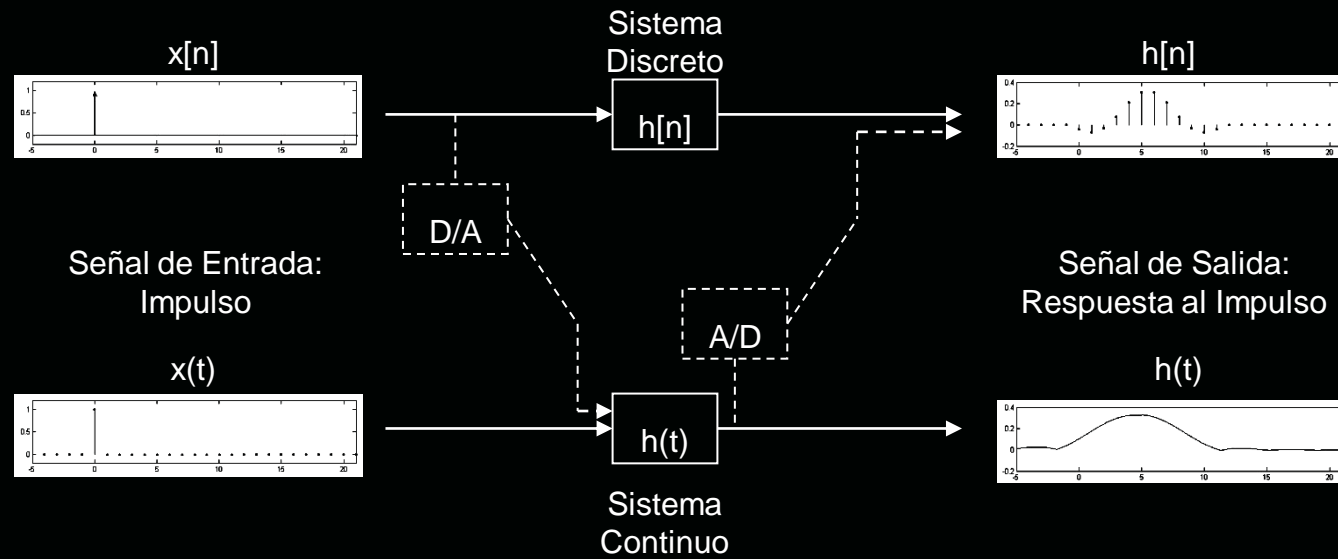
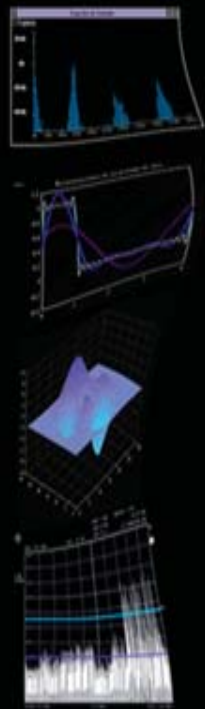
Señales y sistemas

Tipos de sistemas



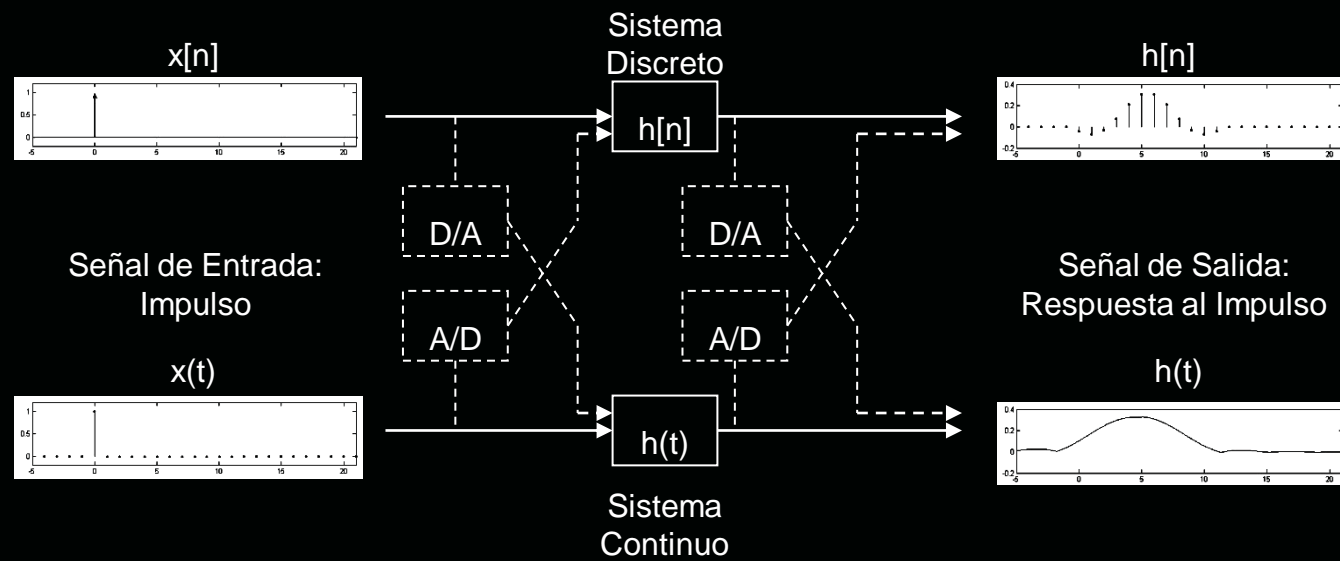
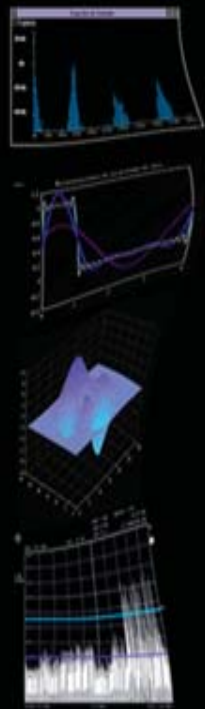
Señales y sistemas

Tipos de sistemas



Señales y sistemas

Tipos de sistemas



Señales y sistemas

Ejemplos de señales

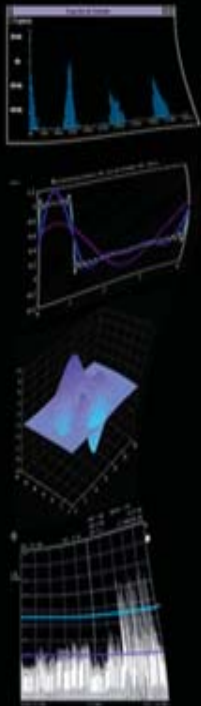
Impulso

$$\delta[n] = \begin{cases} 1 & \text{si } n = 0 \\ 0 & \text{cc} \end{cases}$$

$\delta[n]$

1

n

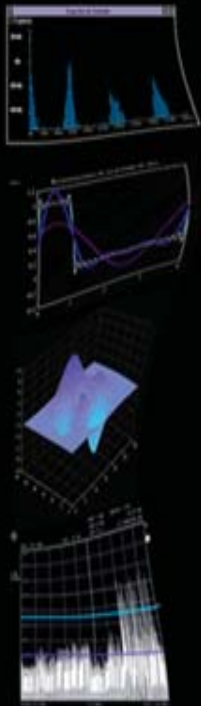
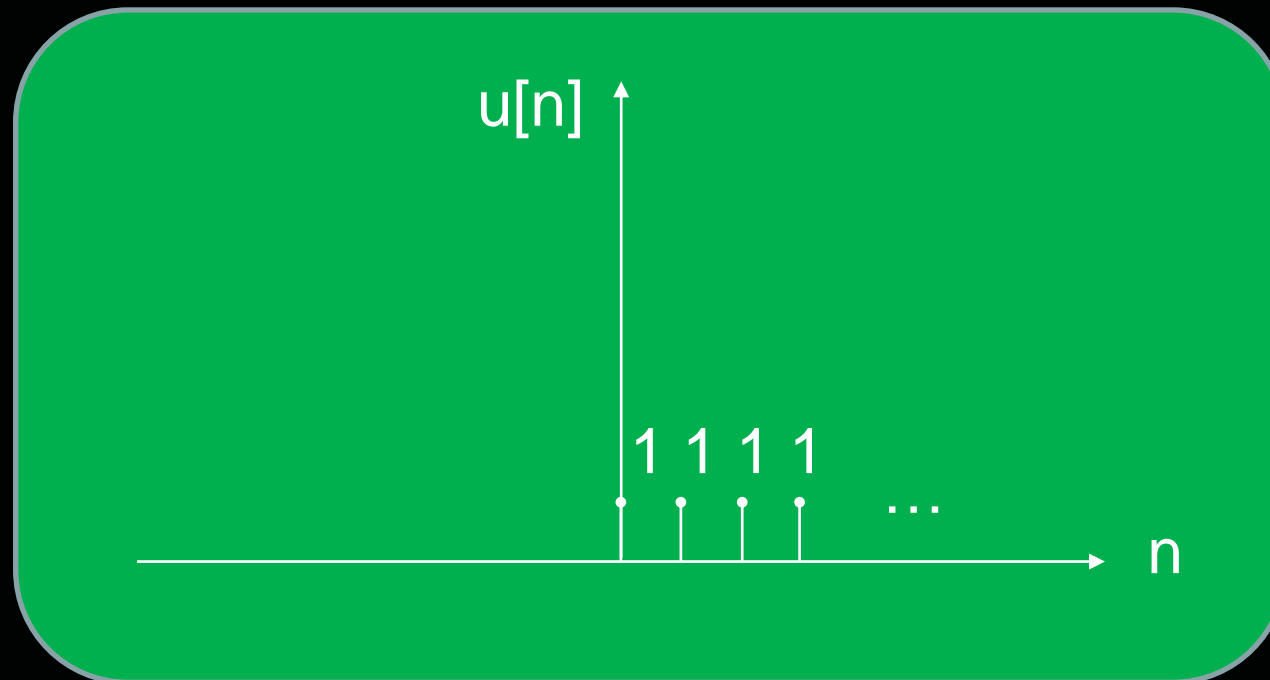


Señales y sistemas

Ejemplos de señales

Escalón

$$u[n] = \begin{cases} 1 & \text{si } n \geq 0 \\ 0 & \text{cc} \end{cases}$$

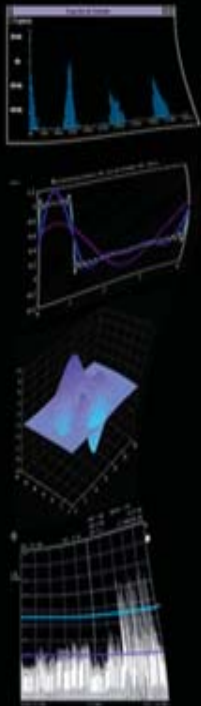
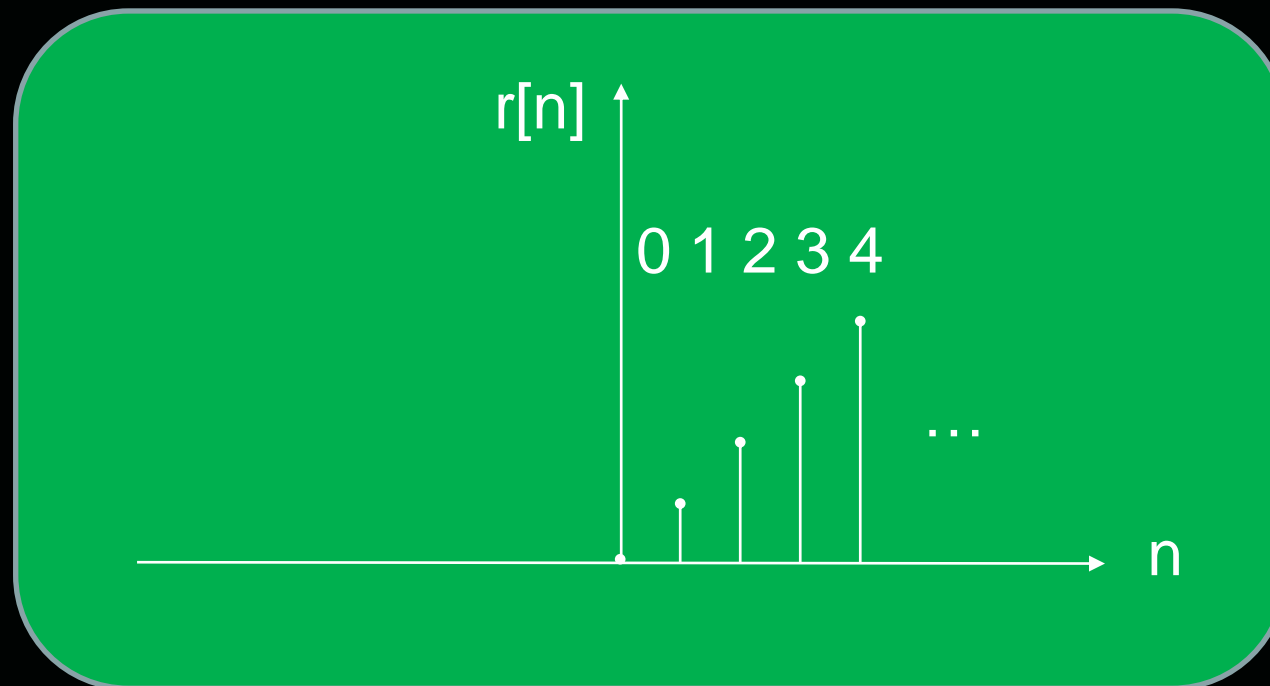


Señales y sistemas

Ejemplos de señales

Rampa

$$r[n] = \begin{cases} n & \text{si } n \geq 0 \\ 0 & \text{cc} \end{cases}$$

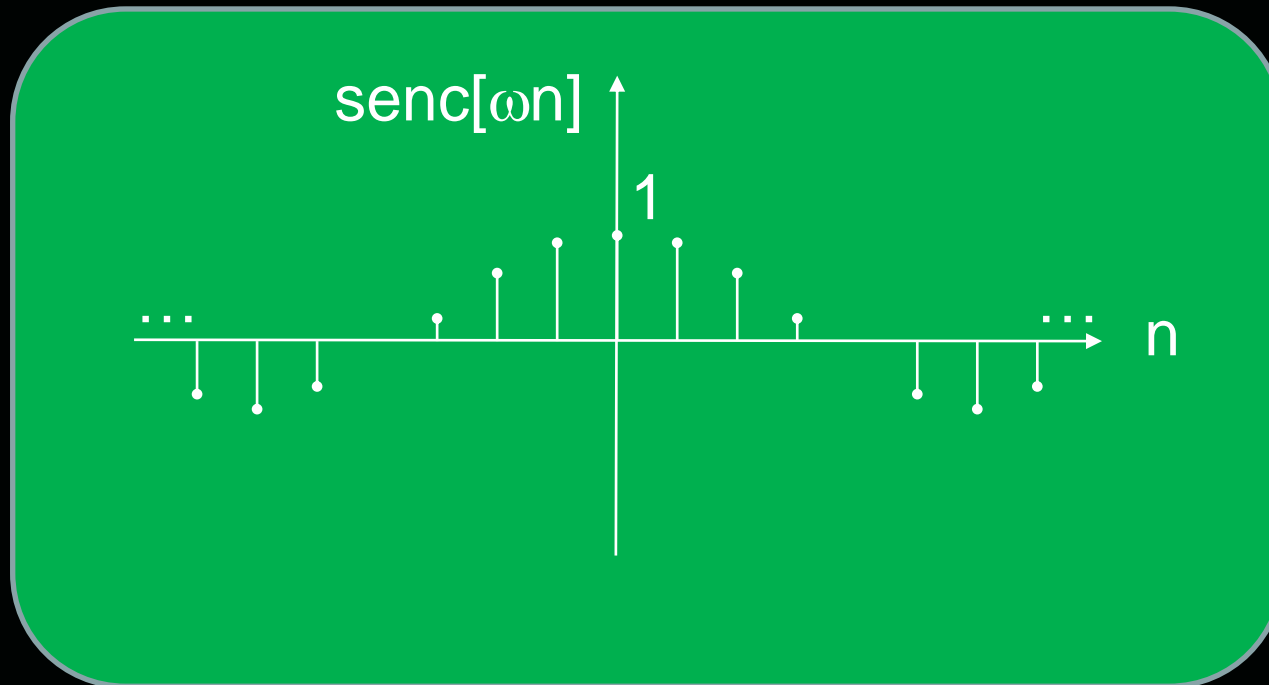
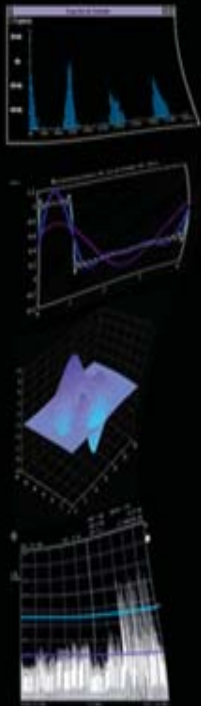


Señales y sistemas

Ejemplos de señales

Seno cardinal

$$\text{senc}\left[\frac{n}{L}\right] = \frac{\text{sen}\left[\frac{\pi n}{L}\right]}{\frac{\pi n}{L}}$$

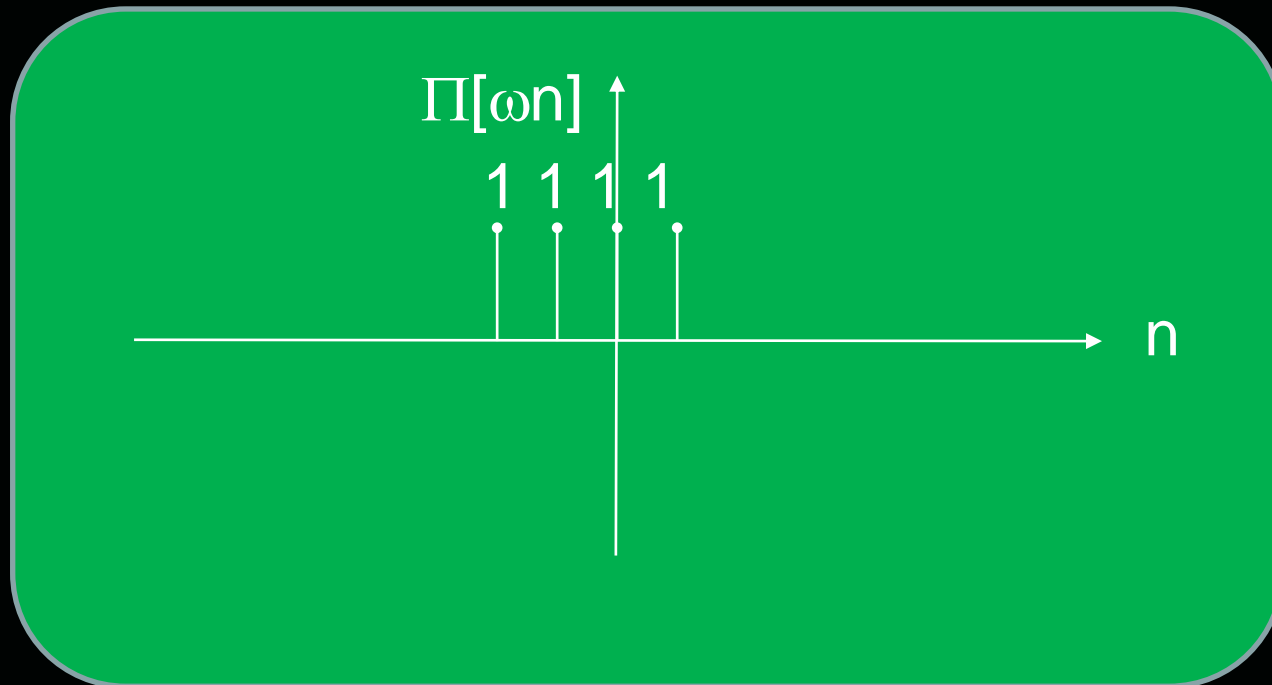
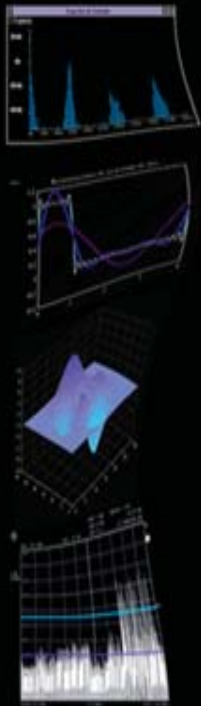


Señales y sistemas

Ejemplos de señales

Pulso rectangular

$$\Pi\left[\frac{n}{L}\right] = \begin{cases} 1 & \text{si } -\frac{L}{2} \leq n < \frac{L}{2} \\ 0 & \text{cc} \end{cases}$$

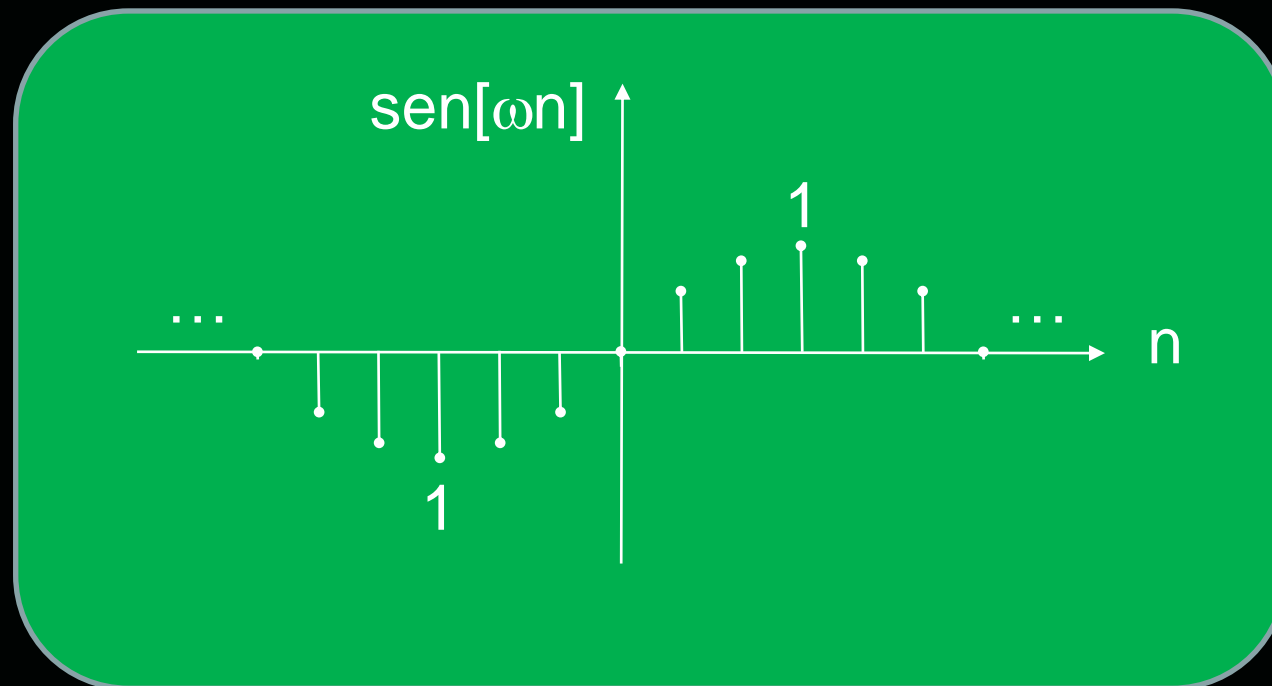
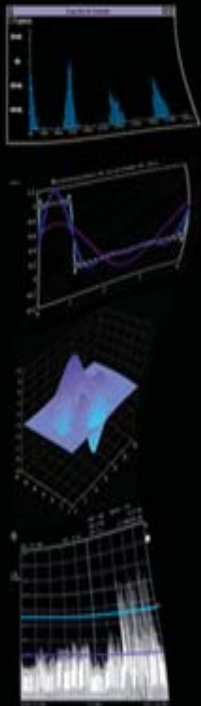


Señales y sistemas

Ejemplos de señales

Seno

$$\text{sen}[\omega n + \theta] = \text{sen}[2\pi f n + \theta]$$



Señales y sistemas

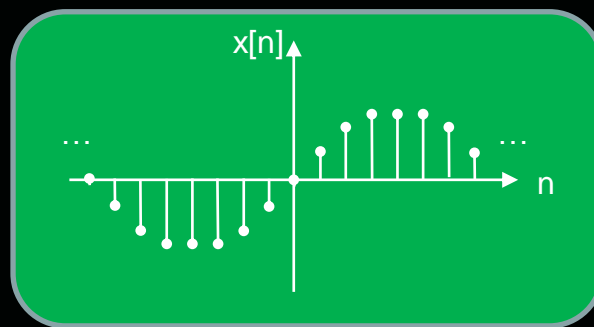
Ejemplos de señales

Seno: Periódica si $f_0 \in \mathbb{Z}$

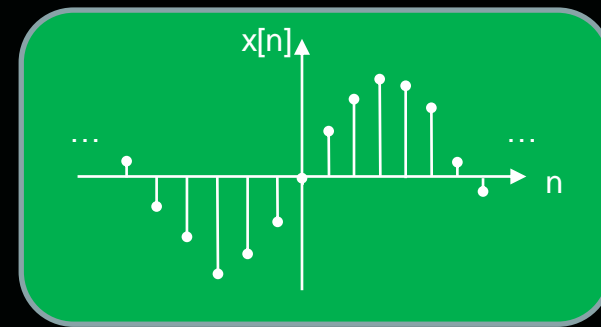
$$x[n] = x[n + N] \Rightarrow \text{sen}[2\pi f_0 n + \theta] \equiv \text{sen}[2\pi f_0 (n + N) + \theta]$$

$$2\pi f_0 N = 2\pi k \quad ; \quad k \in \mathbb{N}$$

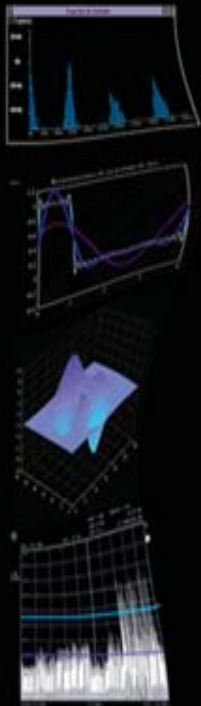
$$\therefore f_0 = \frac{k}{N}$$



$$f_0 = k/N$$



$$f_0 \neq k/N$$



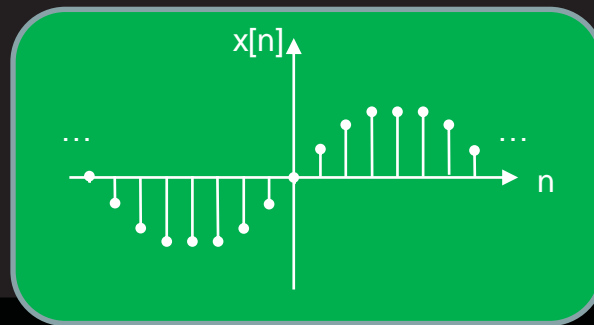
Señales y sistemas

Ejemplos de señales

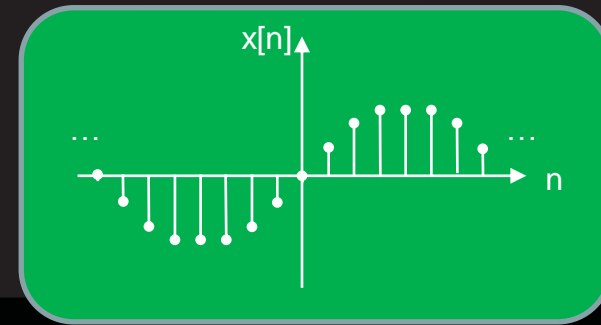
Seno: Idénticas para ω separadas por múltiplos de 2π

$$\text{sen}[\omega_0 n + \theta] \equiv \text{sen}[(\omega_0 + 2\pi)n + \theta] = \text{sen}[\omega_0 n + 2\pi n + \theta]$$

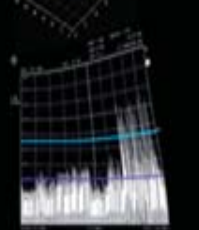
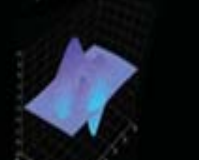
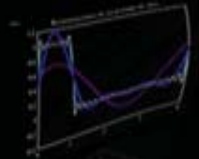
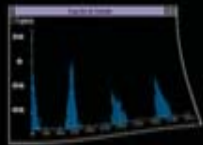
$$x_k[n] = \text{sen}[(\omega_0 + 2\pi k)n + \theta] \quad ; \quad k \in \mathbb{N}$$



$$\omega = \omega_0$$



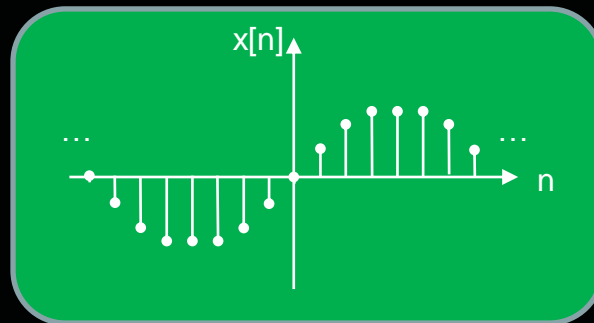
$$\omega = \omega_0 + 2\pi$$



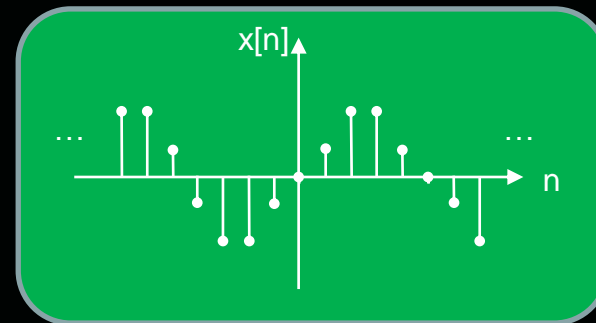
Señales y sistemas

Ejemplos de señales

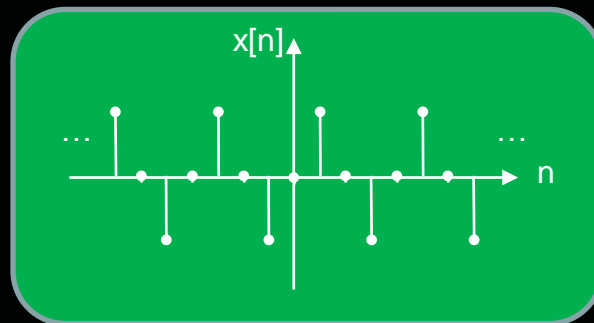
Seno: La mayor tasa de oscilación se da en $\omega = \pm\pi$



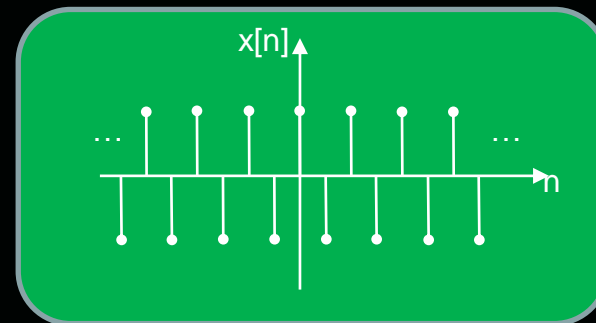
$$\omega = \pi/8 \Rightarrow N = 16$$



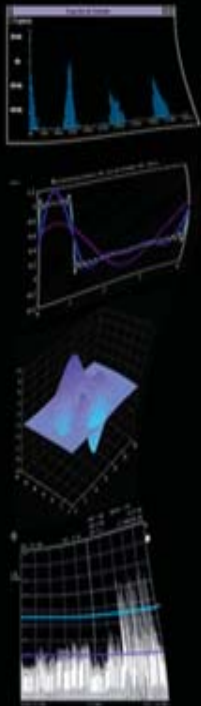
$$\omega = \pi/4 \Rightarrow N = 8$$



$$\omega = \pi/2 \Rightarrow N = 4$$



$$\omega = \pi \Rightarrow N = 2$$

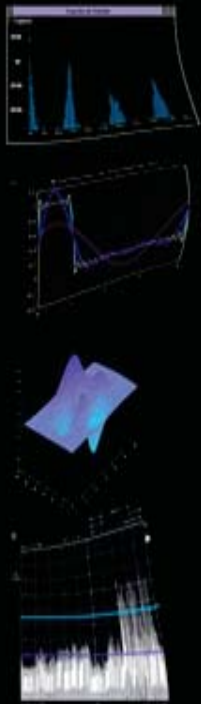
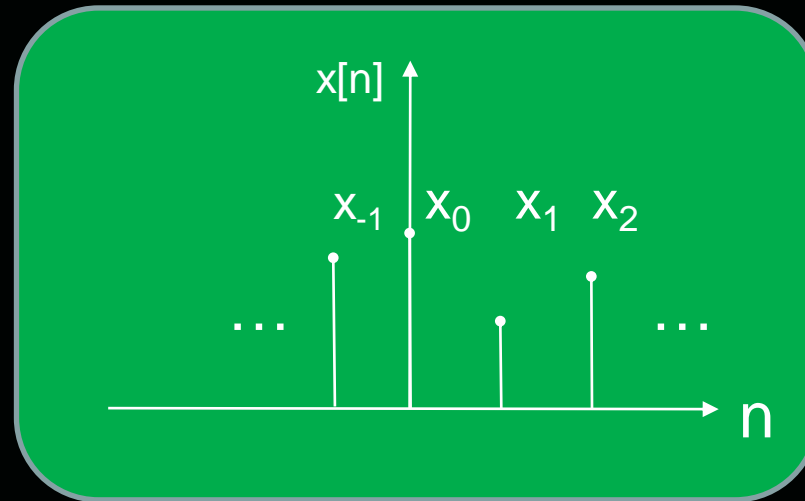


Señales y sistemas

Ejemplos de señales

$$x[n] = \left\{ \dots; \underset{\uparrow}{x_0}; x_1; x_2 \dots \right\} = \dots + x_0 \delta[n] + x_1 \delta[n-1] + x_2 \delta[n-2] + \dots =$$

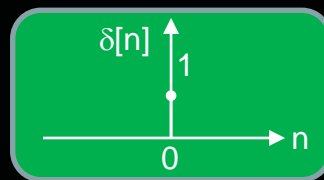
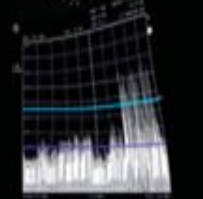
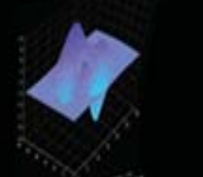
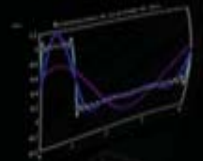
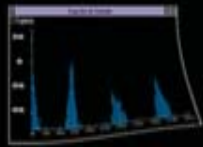
$$= \begin{cases} \vdots & \vdots & \vdots \\ x_0 & \text{si } n=0 \\ x_1 & \text{si } n=1 \\ \vdots & \vdots & \vdots \end{cases}$$



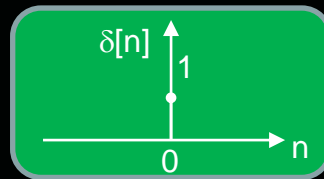
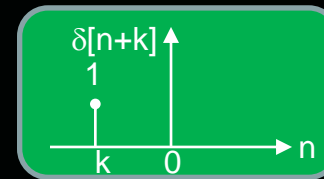
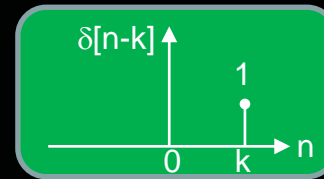
Señales y sistemas

Ejemplos de señales

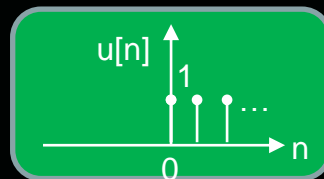
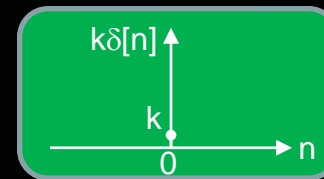
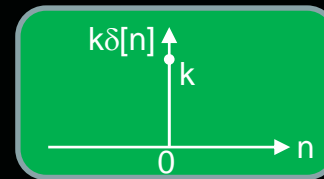
Operaciones con señales



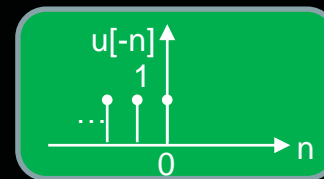
Traslación



Escalado



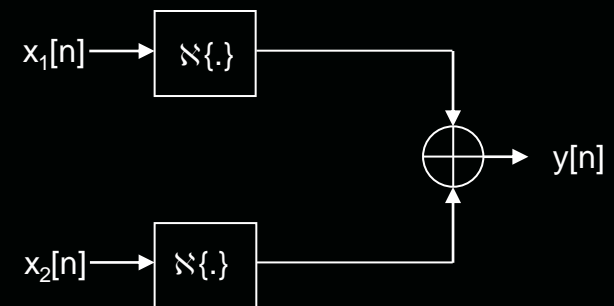
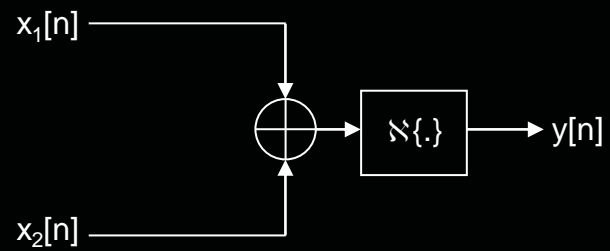
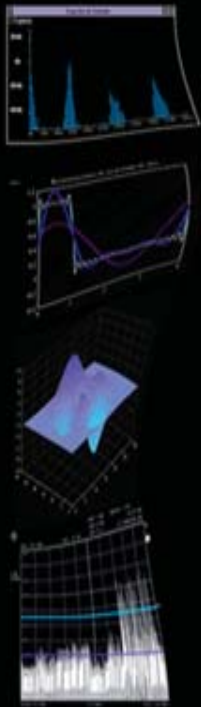
Reflejado



Señales y sistemas

Características de los sistemas

Linealidad

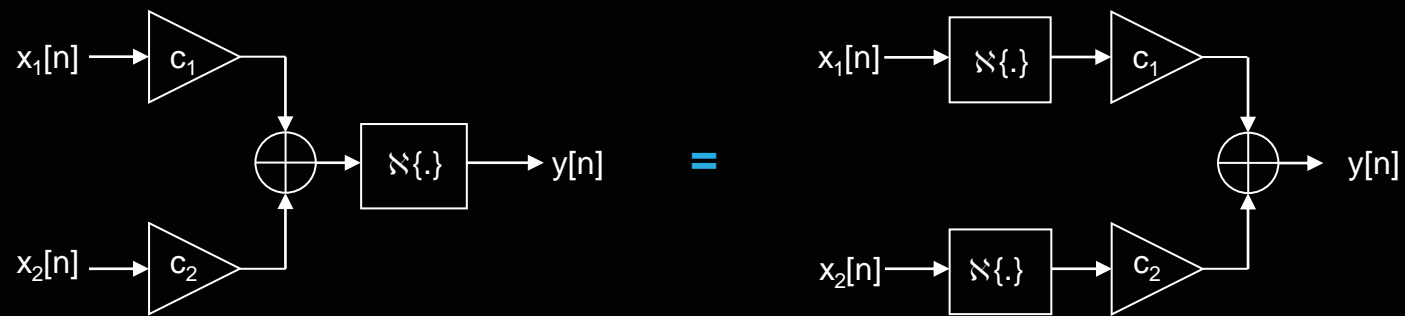


Señales y sistemas

Características de los sistemas

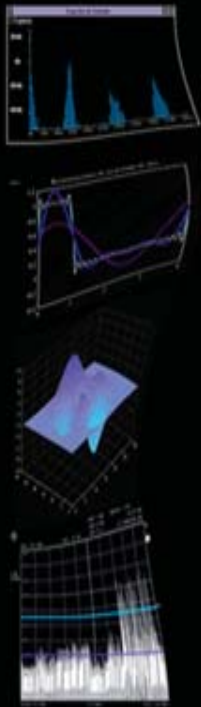
Linealidad

Sistema lineal



$$\mathcal{S}\{c_1x_1[n] + c_2x_2[n]\} = c_1\mathcal{S}\{x_1[n]\} + c_2\mathcal{S}\{x_2[n]\}$$

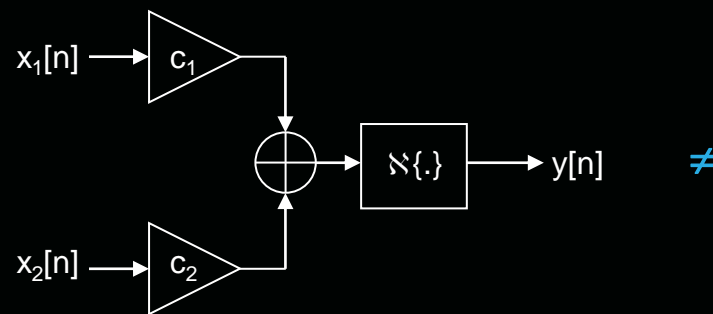
$$\forall x_1[n], x_2[n] \in C \wedge c_1, c_2 \in R$$



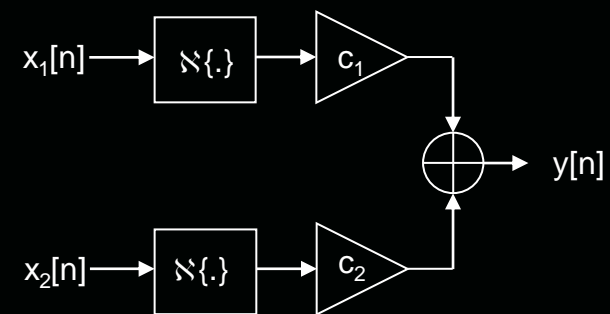
Señales y sistemas

Características de los sistemas

Linealidad

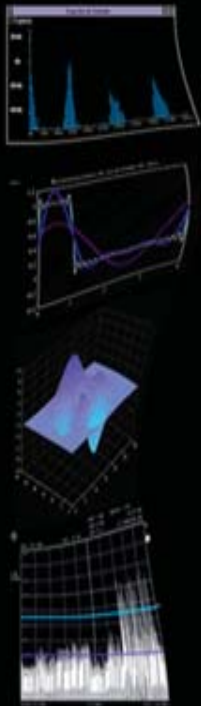


Sistema no lineal



$$S\{c_1 x_1[n] + c_2 x_2[n]\} \neq c_1 S\{x_1[n]\} + c_2 S\{x_2[n]\}$$

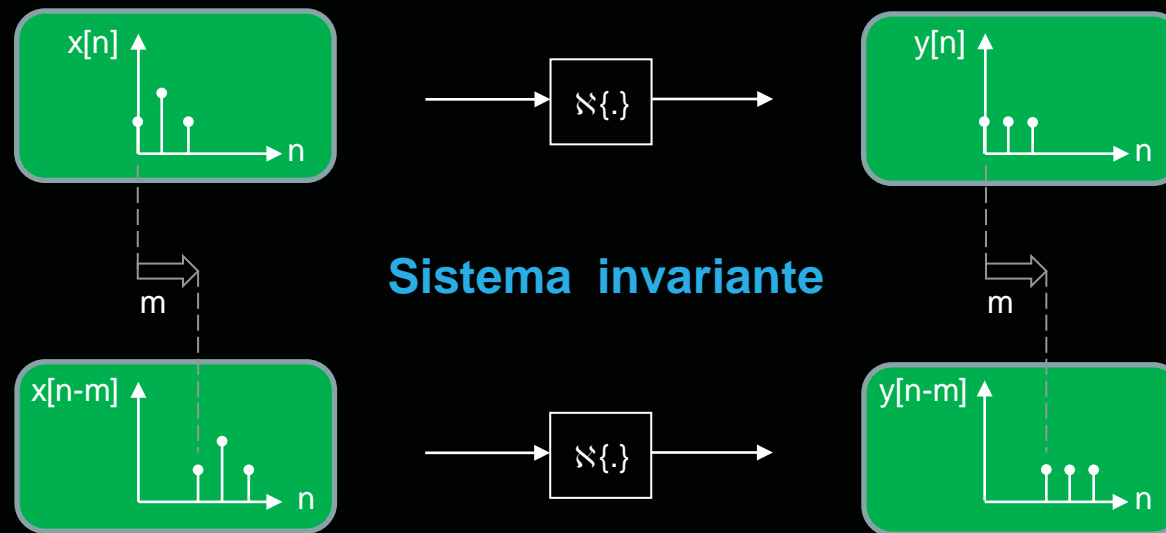
$$\forall x_1[n], x_2[n] \in C \wedge c_1, c_2 \in R$$



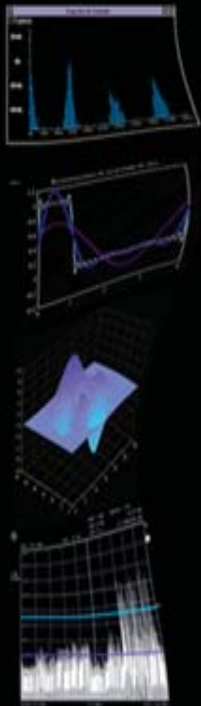
Señales y sistemas

Características de los sistemas

Invarianza temporal



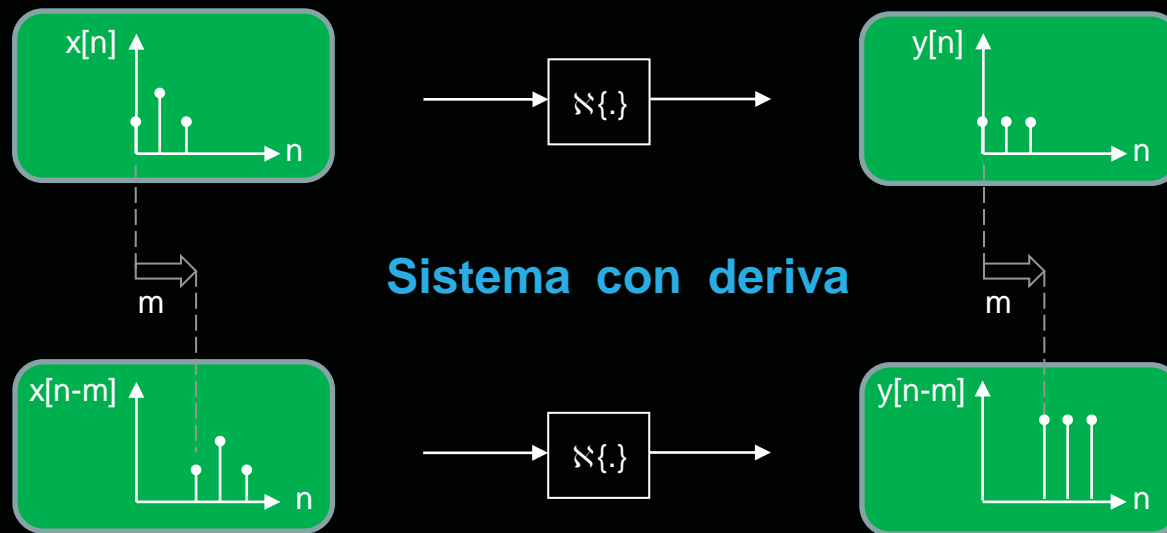
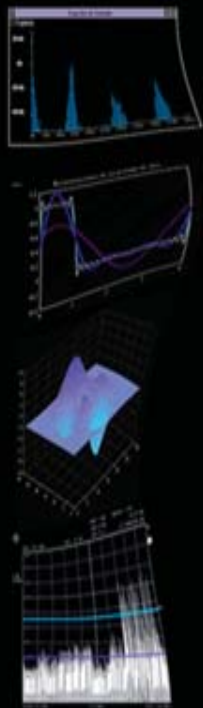
$$y[n] = \mathfrak{S}\{x[n]\} \Rightarrow y[n-m] = \mathfrak{S}\{x[n-m]\} \forall m \in \mathbb{Z}$$



Señales y sistemas

Características de los sistemas

Invarianza temporal

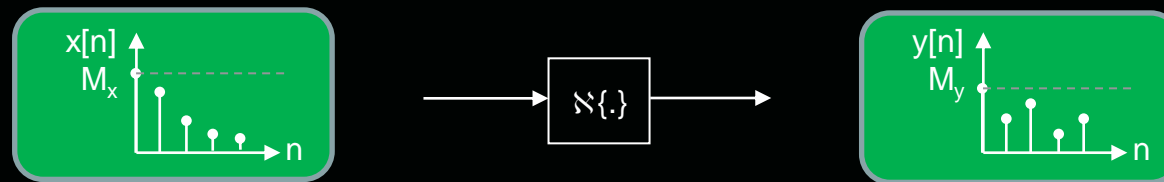


$$y[n] = \mathfrak{S}\{x[n]\} \Rightarrow y[n-m] \neq \mathfrak{S}\{x[n-m]\} \forall m \in \mathbb{Z}$$

Señales y sistemas

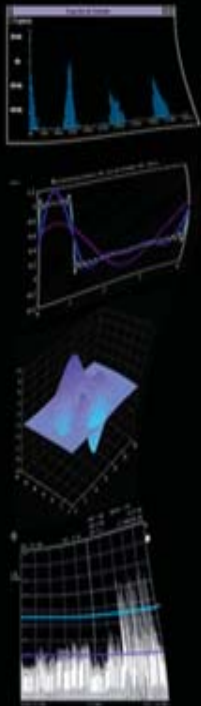
Características de los sistemas

Estabilidad EA/SA



Sistema estable

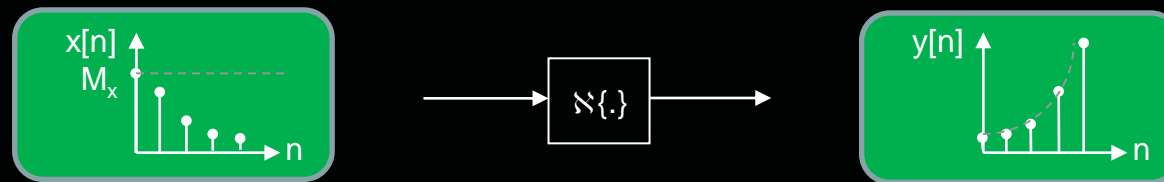
$$|x[n]| \leq M_x < \infty \Rightarrow |y[n]| \leq M_y < \infty \quad \forall n \in \mathbb{Z}$$



Señales y sistemas

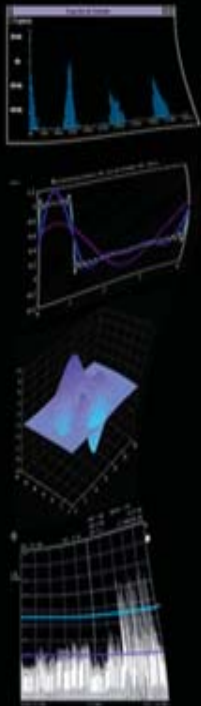
Características de los sistemas

Estabilidad EA/SA



Sistema inestable

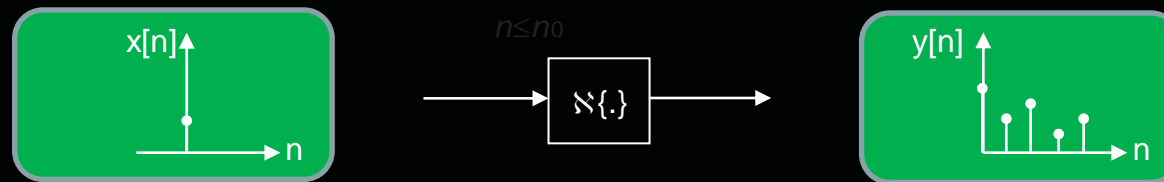
$$\exists \|x[n]\| \leq M_x < \infty \quad / \quad \|y[n]\| \rightarrow \infty$$



Señales y sistemas

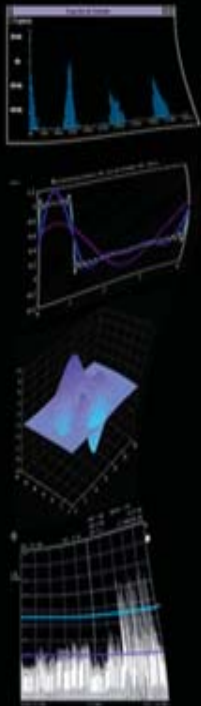
Características de los sistemas

Causalidad



Sistema causal

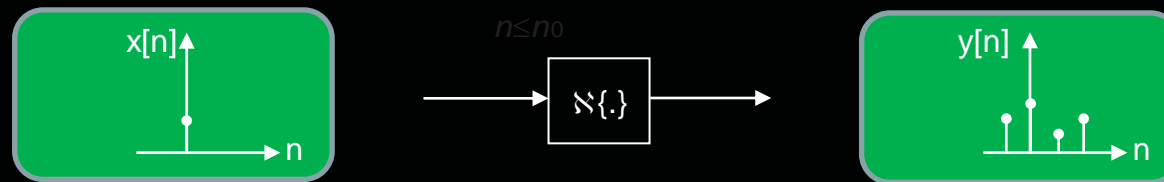
$$y[n] = F\{x[n]; x[n-1]; \dots\}$$
$$y[n] \neq F\{x[n+1]; x[n+2]; \dots\}$$



Señales y sistemas

Características de los sistemas

Causalidad



Sistema no causal

$$y[n] = F\{x[n+1]; x[n+2]; \dots\}$$

