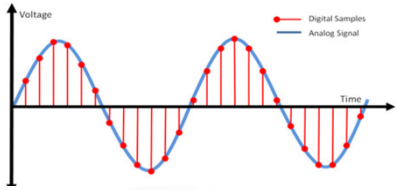
IEE 2103 Señales y Sistemas

Clase 5A: Señales y Sistemas discretos

Señales discretas

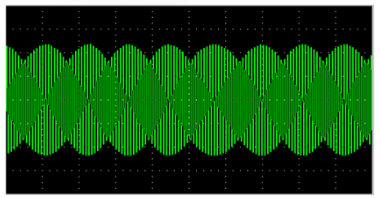
5.1 Muestreo



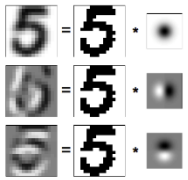
5.2 Conversor análogo digital



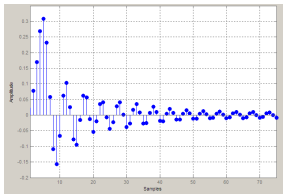
5.3 Teorema del muestreo



5.4 Convolución discreta



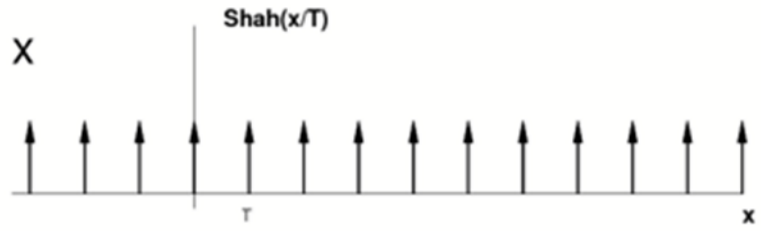
5.5 Convolución cíclica

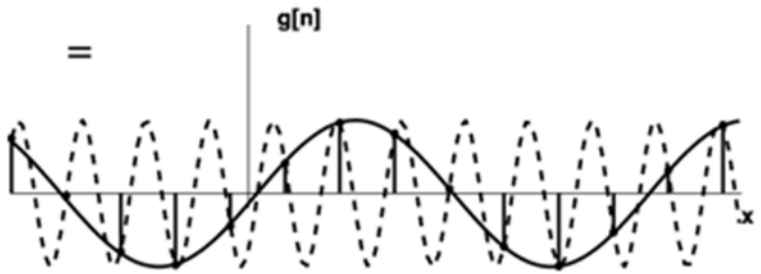


5.6 Respuesta al impulso

5.7 Representación en variables de estado

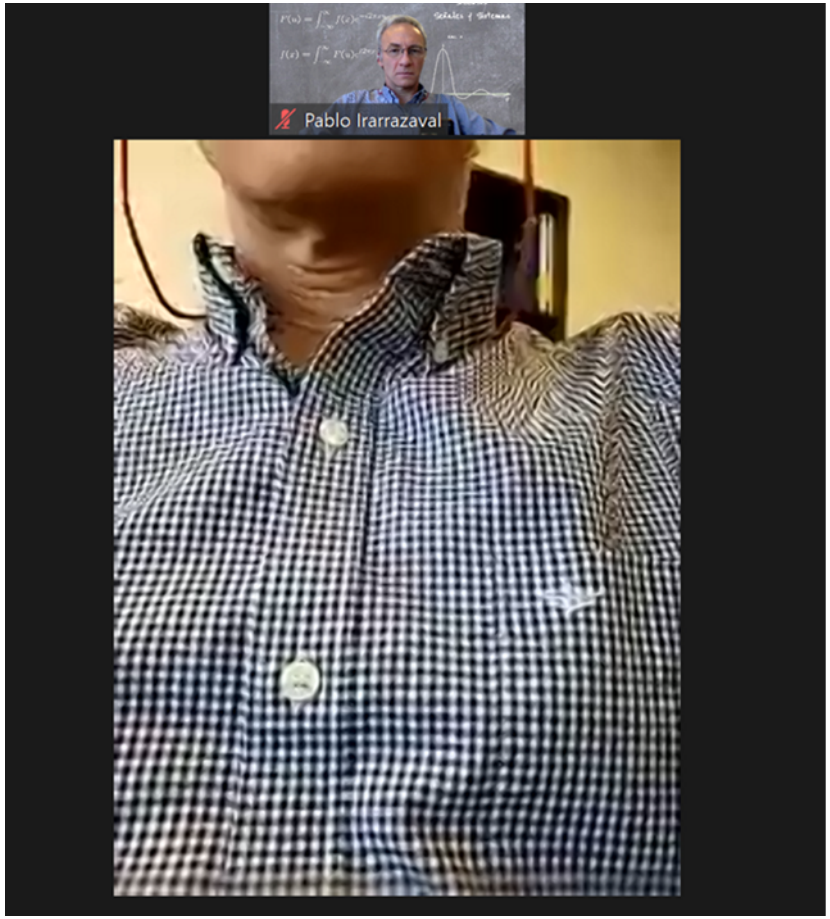

g(x)
x

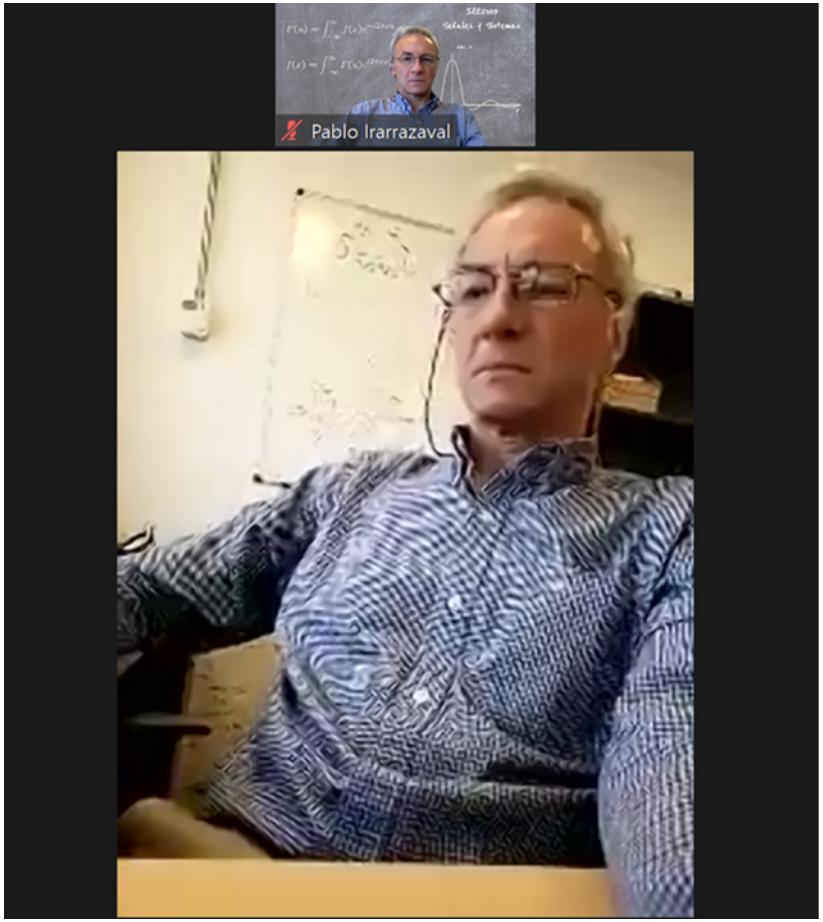

X
Shah(x/T)
T
x


=
g[n]
x

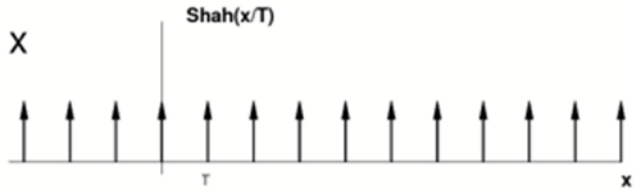

0:43 / 2:39

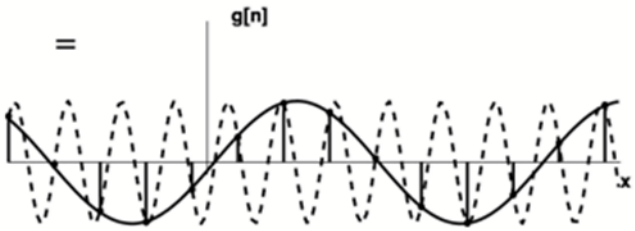

1:04 / 1:16


Pablo Irarrazaval

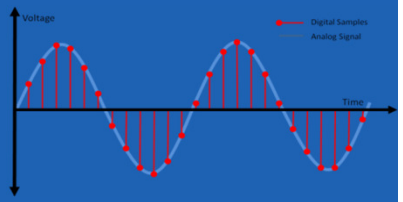

Pablo Irarrazaval


g(x)
x

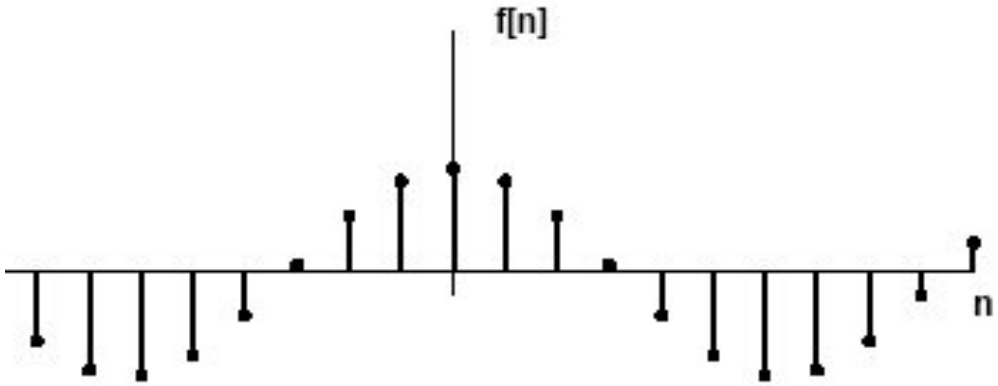

Shah(x/T)
X
T
x


g[n]
=
x

5 Señales discretas



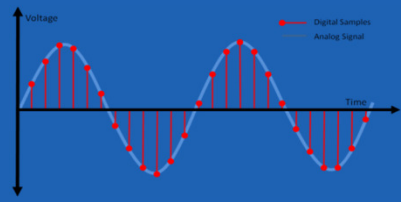
Solo toman valores en posiciones discretas de la variable libre



$$f[n] = (...2, 1, 2, 1, 2, ...),$$

indica discretización

5 Señales discretas



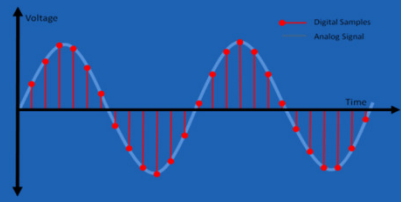
Notación

$$f[n] = (...0, 0, 0, 0, 1, 2, 0, 0, 0, ...) = (1, 2)$$

$$f[n] = (\underline{1}, 2) \qquad f[0] = 1 \text{ en } n = 0$$

$$\tilde{f}[n] = (1, 2) \quad \textit{es} \quad f[n] = (...2, 1, 2, 1, 2, ...)$$

5.1 Muestreo

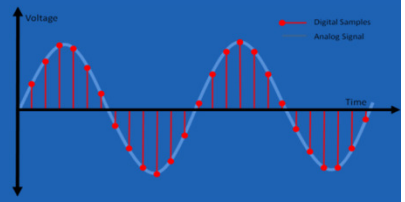


Muestreo de amplitud

$$f[n] = f(nT)$$

$$\int_{-\infty}^{\infty} \delta(x - nT) f(x)\, dx = f(nT)$$

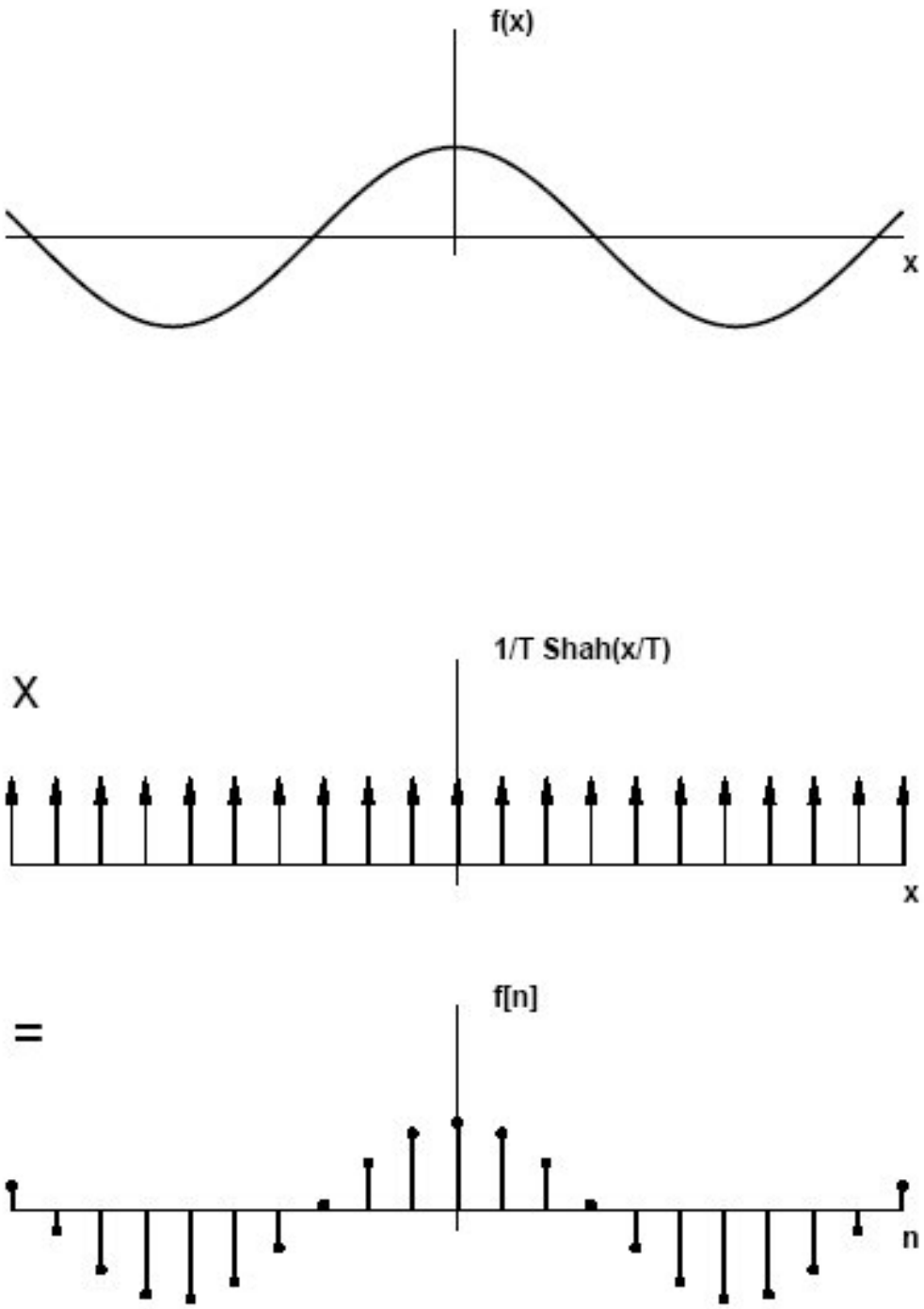
5.1 Muestreo



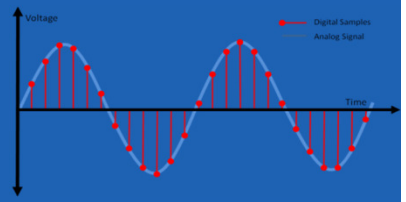
Muestreo de amplitud

$$
\begin{aligned}
f_s(x) &= \sum_{n=-\infty}^{\infty} f(x)\delta(x - nT) \\
&= \frac{1}{T}\text{Ш}(\frac{x}{T})f(x).
\end{aligned}
$$

5.1 Muestreo



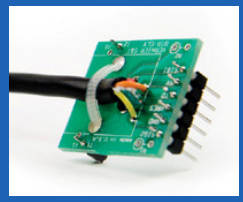
5.1 Muestreo



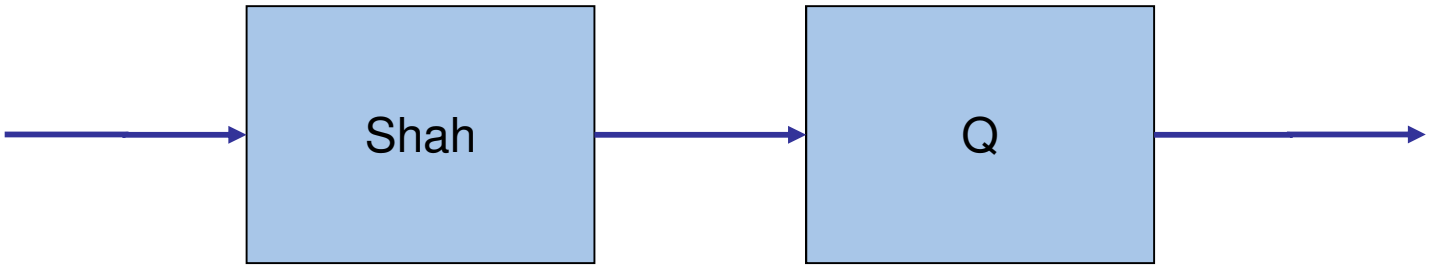
Muestreo de área

$$
\begin{aligned}
f_s(x) &= T \sum_{n=-\infty}^{\infty} f(x)\delta(x - nT) \\
&= \text{Ш}(\frac{x}{T}) f(x).
\end{aligned}
$$

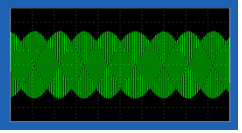
5.2 Conversor A/D



Muestreo seguido de cuantización



5.3 Teorema del muestreo



Teorema de Nyquist

Si $f(x) \longrightarrow F(u)$

$F(u) = 0 \quad \text{para} \ |u| > u_c$

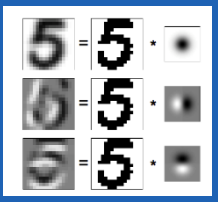
$f_s(x) = \sqcup\!\sqcup(x/T) f(x)$

Entonces

$f(x) \sim f_s(x) \quad \text{para} \ T < 1/2u_c$

$(u_m > 2u_c)$

5.4 Convolución discreta

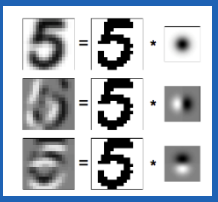


Convolución lineal o producto serial

$$f[n] *_l g[n] = \sum_{m=-\infty}^{\infty} f[m]g[n-m]$$

$$f[n] *_l g[n] = \sum_{m=-\infty}^{\infty} f[n-m]g[m]$$

5.5 Convolución cíclica

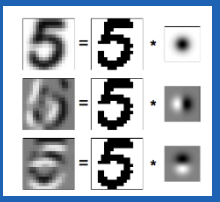


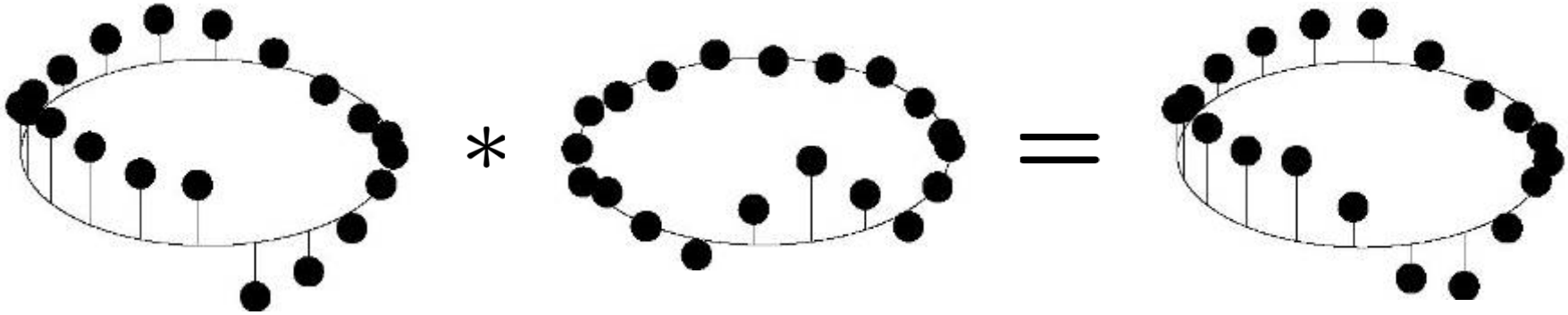
La convolución lineal de señales periódicas diverge, pero se puede definir la convolución cíclica

$$f[n] * g[n] = \sum_{m=0}^{Q-1} f[n-m|P]g[m]$$

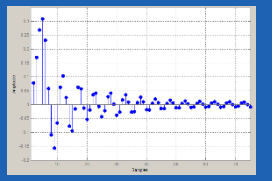
$$[x|P] = x \bmod P$$

5.5 Convolución cíclica





5.6 Respuesta al impulso



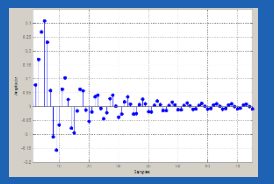
Se define el impulso discreto como

$$\delta[n] = (1) = (\ldots \quad 0 \quad 0 \quad \underline{1} \quad 0 \quad 0 \quad \ldots).$$

por lo que la función puede ser descompuesta en

$$f[n] = \sum_{m=-\infty}^{\infty} f[m]\delta[n-m]$$

5.6 Respuesta al impulso



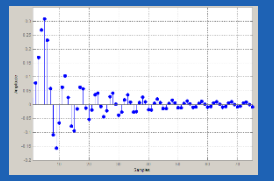
Buscamos

$$g[n] = L\{f[n]\}$$

$$g[n] = L\{\sum_{m=-\infty}^{\infty} f[m]\delta[n-m]\}$$

$$g[n] = \sum_{m=-\infty}^{\infty} f[m]L\{\delta[n-m]\}$$

5.6 Respuesta al impulso



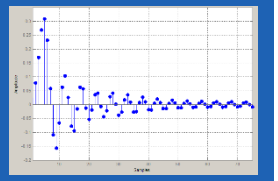
Sumatoria de superposición

$$g[n] = \sum_{m=-\infty}^{\infty} f[m]h[n,m]$$

si

$$h[n,m] = h[n-m]$$

5.6 Respuesta al impulso



$$h[n-m] = L\{\delta[n-m]\}$$

$$g[n] = \sum_{m=-\infty}^{\infty} f[m]h[n-m].$$

$$g[n] = f[n] *_l h[n]$$