

Universidad Nacional de Ingeniería

Facultad de Ingeniería Eléctrica y Electrónica
Especialidad de Ingeniería de Telecomunicaciones

” Solución del Examen Parcial”

Curso: Análisis de Señales y Sistemas

Código del Curso: EE410-M

Docente: Manuel Arevalo Villanueva

Alumno: Gian Carlos Chancavilcas Osoreo

Código de Alumno: 20191108K

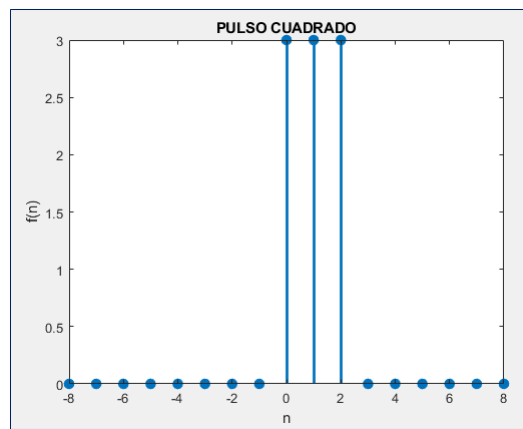
2021-I

2. Sea $f[n] = 3$, $0 \leq n \leq 2$, un pulso cuadrado, $g[n] = [1, 2, 3, 2, 1]$ un pulso triangular, sea $h[n] = (\frac{1}{2})^n$, $0 \leq n \leq 8$ una amortiguación exponencial

■ Usando el MATLAB grafique las señales $f[n]$, $g[n]$ y $h[n]$.

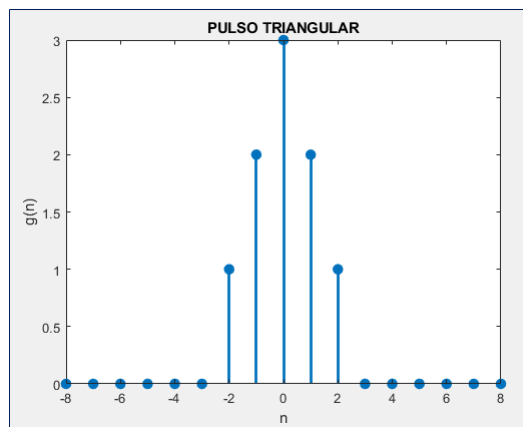
• Para la gráfica $f[n] = 3$, $0 \leq n \leq 2$, se utilizó la función stem de MATLAB para realizar un pulso cuadrado consideramos en un intervalo de $[-8, 8]$.

```
1 - clear clc
2 - n=-8:8;
3 - x=[0 0 0 0 0 0 0 0 0 3 3 3 0 0 0 0 0 0];
4 - stem (n,x,'filled','-', 'LineWidth',2);
5 - xlabel('n');
6 - ylabel('f(n)');
7 - title('PULSO CUADRADO','LineWidth',2)
```



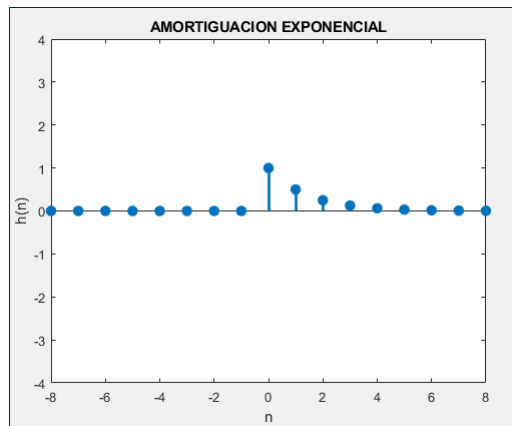
• Para la gráfica $g[n] = [1, 2, 3, 2, 1]$, $-2 \leq n \leq 2$, se utilizó la función stem de MATLAB para realizar un pulso rectangular consideramos en un intervalo de $[-8, 8]$.

```
1 - clear clc
2 - n=-8:8;
3 - x=[0 0 0 0 0 0 1 2 3 2 1 0 0 0 0 0 0];
4 - stem (n,x,'filled','-', 'LineWidth',2);
5 - xlabel('n');
6 - ylabel('g(n)');
7 - title('PULSO TRIANGULAR','LineWidth',2)
```



• Para la grafica $h[n] = (\frac{1}{2})^n$, se utilizo la funcion stem de MATLAB para realizar la amortiguacion exponencial $[-8, 8]$ con paso 1.

```
1 - clear clc
2 - n=-8:1:8;
3 - y=(0.5.^n).*(stepfun(n,0)-(0.5.^n).*(stepfun(n,9)));
4 - stem (n,y,'filled','-', 'LineWidth',2);
5 - axis ([-8 8 -4 4]);
6 - xlabel('n');
7 - ylabel('h(n)');
8 - title('AMORTIGUACION EXPONENCIAL','LineWidth',2 )
```



■ Encuentre en terminos de n y la señal escalon unitario las siguientes convoluciones:

Como nos piden la convolución de dos señales discretas por conocimiento previo:

$$y[n] = x[n] * h[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k]$$

• Hallamos la convolucion de $f[n] * g[n]$ con la formula previa hallada.

$$n < -2 \rightarrow y[n] = 0$$

$$n = -2 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]g[n-k] = f[0]g[-2] = (3)(1) = 3$$

$$n = -1 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]g[n-k] = f[0]g[-1] + f[1]g[-2] = 9$$

$$n = 0 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]g[n-k] = f[0]g[0] + f[1]g[-1] + f[2]g[-2] = 18$$

$$n = 1 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]g[n-k] = f[0]g[1] + f[1]g[0] + f[2]g[-1] = 21$$

$$n = 2 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]g[n-k] = f[0]g[2] + f[1]g[1] + f[2]g[0] = 18$$

$$n = 3 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]g[n-k] = f[1]g[2] + f[2]g[1] = 9$$

$$n = 4 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]g[n-k] = f[2]g[2] = 3$$

$$n > 4 \rightarrow y[n] = 0$$

$$y[n] = f[n] * g[n] = \begin{cases} 0 & \text{si } n < -2 \\ 3 & \text{si } n = -2 \\ 9 & \text{si } n = -1 \\ 18 & \text{si } n = 0 \\ 21 & \text{si } n = 1 \\ 18 & \text{si } n = 2 \\ 9 & \text{si } n = 3 \\ 3 & \text{si } n = 4 \\ 0 & \text{si } n > 4 \end{cases}$$

Expresamos en n y escalon unitario la señal:

$$y[n] = 3u[n+2] + 6u[n+1] + 9u[n] + 3u[n-1] - 3u[n-2] - 9u[n-3] - 6u[n-4] - 3u[n-5]$$

- Hallamos la convolucion de $f[n] * h[n]$ con la formula previa hallada.

$$f[n] * h[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k]$$

$$n < 0 \rightarrow y[n] = 0$$

$$n = 0 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[0] = 3$$

$$n = 1 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[1] + f[1]h[0] = \frac{9}{2}$$

$$n = 2 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[2] + f[1]h[1] + f[2]h[0] = \frac{21}{4}$$

$$n = 3 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[3] + f[1]h[2] + f[2]h[1] = \frac{21}{8}$$

$$n = 4 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[4] + f[1]h[3] + f[2]h[2] = \frac{21}{16}$$

$$n = 5 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[5] + f[1]h[4] + f[2]h[3] = \frac{21}{32}$$

$$n = 6 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[6] + f[1]h[5] + f[2]h[4] = \frac{21}{64}$$

$$n = 7 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[7] + f[1]h[6] + f[2]h[5] = \frac{21}{128}$$

$$n = 8 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[0]h[8] + f[1]h[7] + f[2]h[6] = \frac{21}{256}$$

$$n = 9 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[1]h[8] + f[2]h[7] = \frac{9}{256}$$

$$n = 10 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = f[2]h[8] = \frac{3}{256}$$

$$n > 10 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} f[k]h[n-k] = 0$$

$$y[n] = f[n] * h[n] = \begin{cases} 0 & \text{si } n < 0 \\ 3 & \text{si } n = 0 \\ \frac{9}{2} & \text{si } n = 1 \\ \frac{21}{4} & \text{si } n = 2 \\ \frac{21}{8} & \text{si } n = 3 \\ \frac{21}{16} & \text{si } n = 4 \\ \frac{21}{32} & \text{si } n = 5 \\ \frac{21}{64} & \text{si } n = 6 \\ \frac{21}{128} & \text{si } n = 7 \\ \frac{21}{256} & \text{si } n = 8 \\ \frac{9}{256} & \text{si } n = 9 \\ \frac{3}{256} & \text{si } n = 10 \\ 0 & \text{si } n > 10 \end{cases}$$

Expresamos en n y escalon unitario la señal:

$$y[n] = (0.5)^n (3u[n] + 6u[n-1] + 12u[n-2] - 12u[n-9]) - (0.5)^8 (6u[n-10] - 3u[n-11])$$

- Hallamos la convolucion de $g[n] * h[n]$ con la formula previa hallada.

$$g[n] * h[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k]$$

$$n < -2 \rightarrow y[n] = 0$$

$$n = -2 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-2]h[0] = 1$$

$$n = -1 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-1]h[0] + g[-2]h[1] = \frac{5}{2}$$

$$n = 0 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-2]h[2] + g[-1]h[1] + g[0]h[0] = \frac{17}{4}$$

$$n = 1 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-2]h[3] + g[-1]h[2] + g[0]h[1] + g[1]h[0] = \frac{33}{8}$$

$$n = 2 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-2]h[4] + g[-1]h[3] + g[0]h[2] + g[1]h[1] + g[2]h[0] = \frac{49}{16}$$

$$n = 3 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-2]h[5] + g[-1]h[4] + g[0]h[3] + g[1]h[2] + g[2]h[1] = \frac{49}{32}$$

$$n = 4 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-2]h[6] + g[-1]h[5] + g[0]h[4] + g[1]h[3] + g[2]h[2] = \frac{49}{64}$$

$$n = 5 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-2]h[7] + g[-1]h[6] + g[0]h[5] + g[1]h[4] + g[2]h[3] = \frac{49}{128}$$

$$n = 6 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-2]h[8] + g[-1]h[7] + g[0]h[6] + g[1]h[5] + g[2]h[4] = \frac{49}{256}$$

$$n = 7 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[-1]h[8] + g[0]h[7] + g[1]h[6] + g[2]h[5] = \frac{3}{32}$$

$$n = 8 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[0]h[8] + g[1]h[7] + g[2]h[6] = \frac{11}{256}$$

$$n = 9 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[1]h[8] + g[2]h[7] = \frac{1}{64}$$

$$n = 10 \rightarrow y[n] = \sum_{k=-\infty}^{\infty} g[k]h[n-k] = g[2]h[8] = \frac{1}{256}$$

$$n > 10 \rightarrow y[n] = 0$$

$$y[n] = g[n] * h[n] = \begin{cases} 0 & \text{si } n < -2 \\ 1 & \text{si } n = -2 \\ \frac{5}{2} & \text{si } n = -1 \\ \frac{17}{4} & \text{si } n = 0 \\ \frac{33}{8} & \text{si } n = 1 \\ \frac{49}{16} & \text{si } n = 2 \\ \frac{49}{32} & \text{si } n = 3 \\ \frac{49}{64} & \text{si } n = 4 \\ \frac{49}{128} & \text{si } n = 5 \\ \frac{49}{256} & \text{si } n = 6 \\ \frac{3}{32} & \text{si } n = 7 \\ \frac{11}{256} & \text{si } n = 8 \\ \frac{1}{64} & \text{si } n = 9 \\ \frac{1}{256} & \text{si } n = 10 \\ 0 & \text{si } n > 10 \end{cases}$$

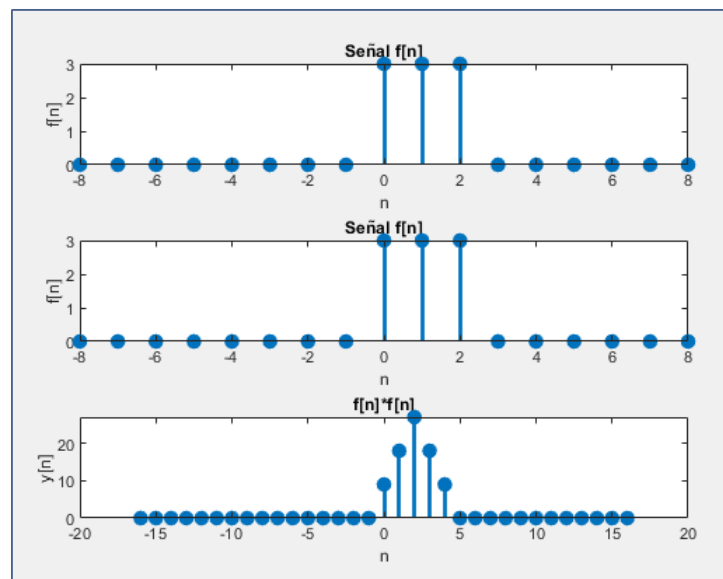
Expresamos en n y escalon unitario la señal:

$$y[n] = (0.5)^n (u[n+2] + 4u[n+1] + 12u[n] + 16u[n-1] + 16u[n-2] - 49u[n-7]) + (0.5)^5 (3u[n-7] - 3u[n-8]) \\ + (0.5)^8 (11u[n-8] - 11u[n-9]) + (0.5)^6 (u[n-9] - u[n-10]) + (0.5)^8 (u[n-10] - u[n-11])$$

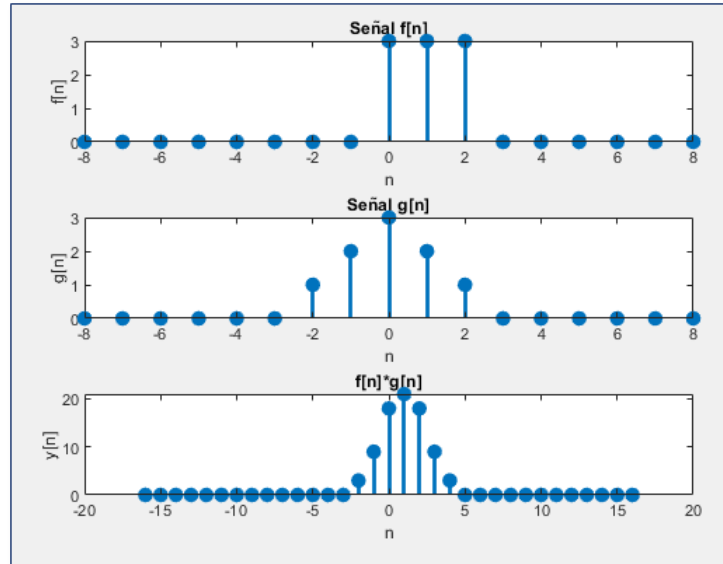
■ Usando el comando conv en MATLAB grafique las convoluciones :
Como el algoritmo es igual para todos solo bosquejamos las graficas:

```
1 %Convolucion de f*f
2 clear clc
3 x=[0 0 0 0 0 0 0 0 3 3 3 0 0 0 0 0]
4 nx=[-8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8]
5 h=[0 0 0 0 0 0 0 0 3 3 3 0 0 0 0 0 0]
6 nh=[-8 -7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8]
7 hmin=min(nh)
8 xmin=min(nx)
9 smin=abs(hmin)+abs(xmin)
10 %la funcion convolucion
11 y=conv(x,h)
12 Ly=length(y)
13
14 ny=-1*smin:Ly-smin-1
15
16 subplot(3,1,1)
17 stem(nx,x,'filled','-', 'LineWidth',2)
18 title('Señal f[n]')
19 subplot(3,1,2)
20 stem(nh,h,'filled','-', 'LineWidth',2)
21 title('Señal f[n]')
22 subplot(3,1,3)
23 stem(ny,y,'filled','-', 'LineWidth',2)
24 title('f[n]*f[n]')
```

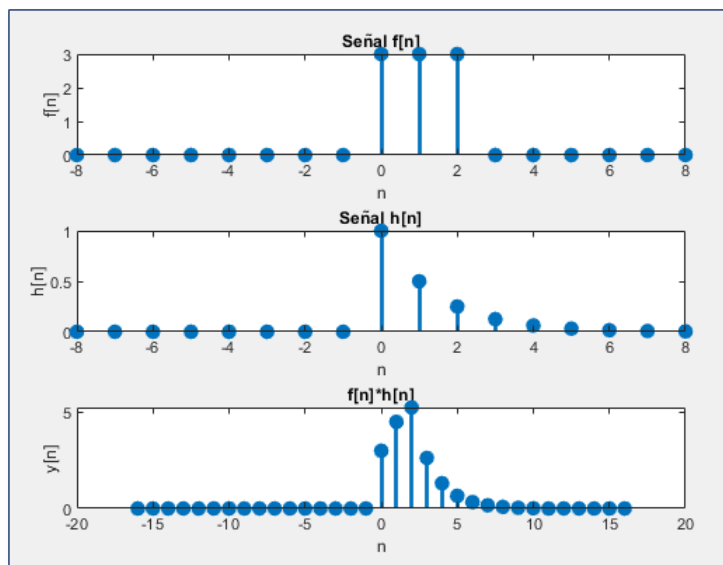
Convolucion : $f[n] * f[n]$



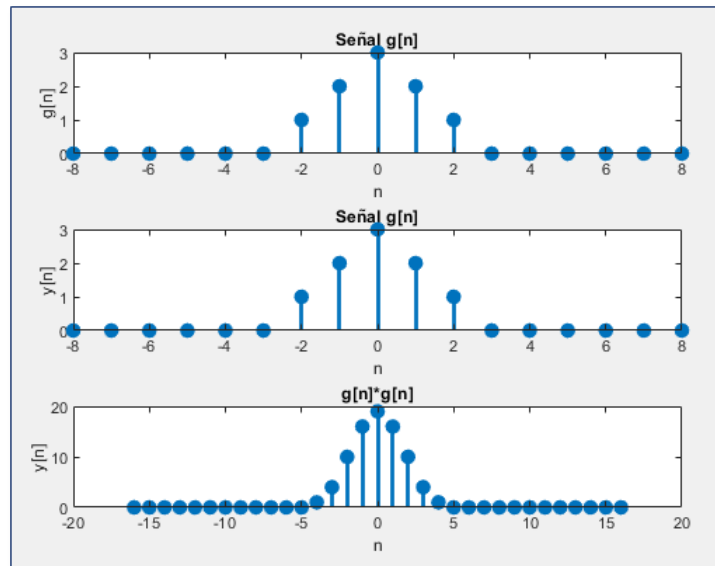
Convolution : $f[n] * g[n]$



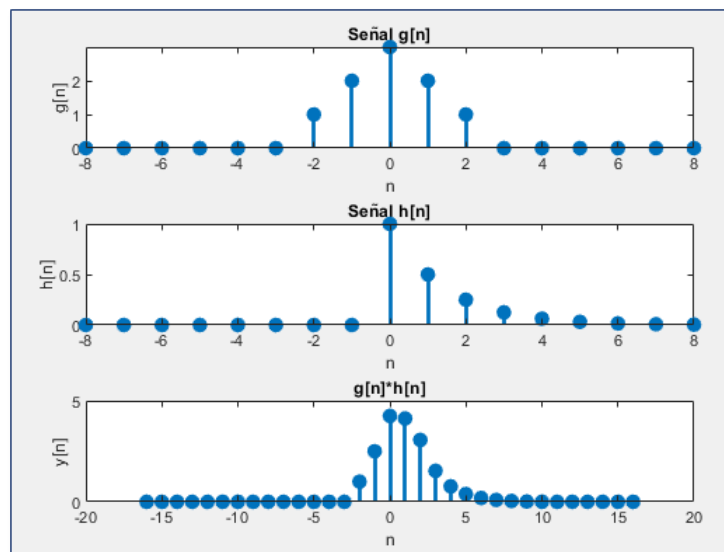
Convolution : $f[n] * h[n]$



Convolution : $g[n] * g[n]$



*Convolution : $g[n] * h[n]$*



*Convolution : $h[n] * h[n]$*

