

# **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

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**Código de Alumno:** 20191108K

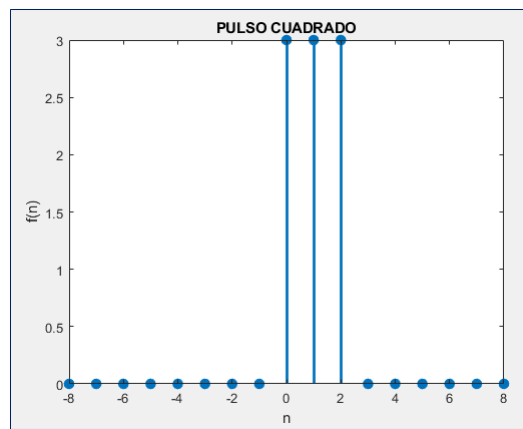
## **2021-I**

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  $h[n]$ .

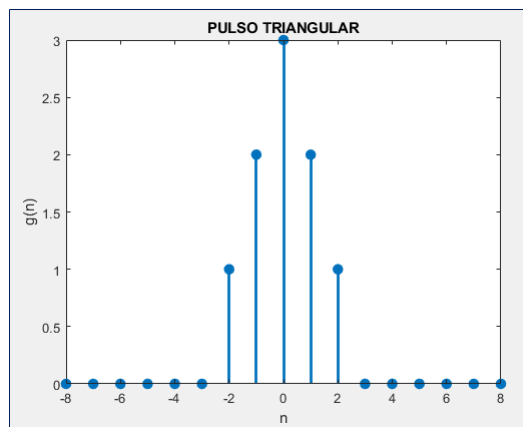
• Para la gráfica  $f[n] = 3$ ,  $0 \leq n \leq 2$ , se utilizó la función stem de MATLAB para realizar un pulso cuadrado consideramos en un intervalo de  $[-8, 8]$ .

```
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)
```



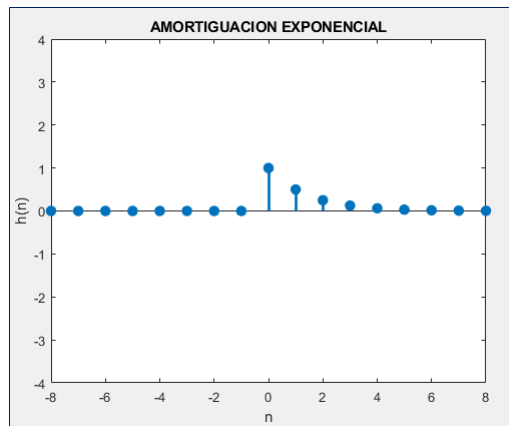
• Para la gráfica  $g[n] = [1, 2, 3, 2, 1]$ ,  $-2 \leq n \leq 2$ , se utilizó la función stem de MATLAB para realizar un pulso rectangular consideramos en un intervalo de  $[-8, 8]$ .

```
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:

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