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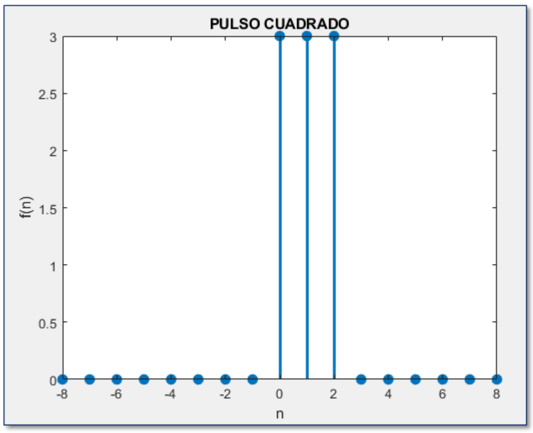
2. Sea $f[n] = 3$, $0 \leq n \leq 2$, un pulso cuadrado , $g[n] = [1, 2, 3, 2, 1]$ un pulso triangular , sea $h[n] = (\frac{1}{2})^n$, $0 \leq n \leq 8$ una amortiguacion exponencial

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

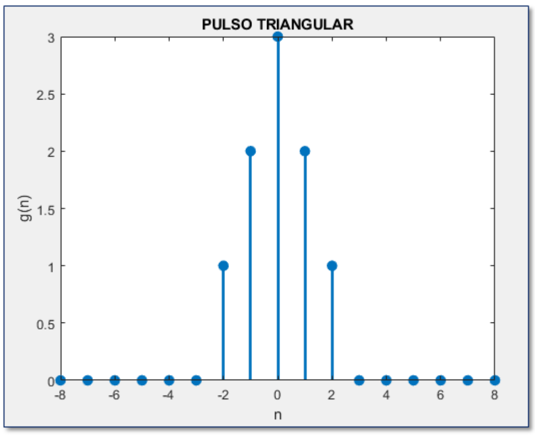
•Para la grafica $f[n] = 3$, $0 \leq n \leq 2$, se utilizo la funcion stem de MATLAB para realizar un pulso cuadrado consideramos en un intervalo de $[-8, 8]$.

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



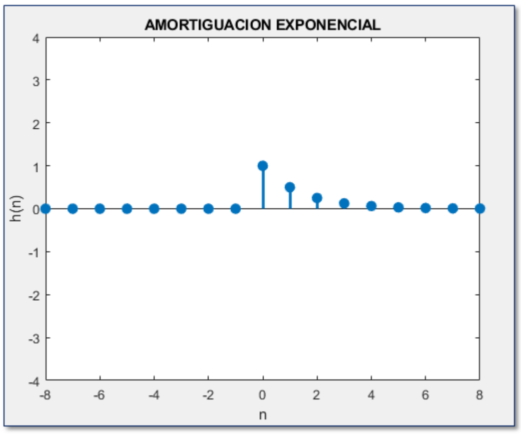
•Para la grafica $g[n] = [1, 2, 3, 2, 1]$, $-2 \leq n \leq 2$, se utilizo la funcion stem de MATLAB para realizar un pulso rectangular consideramos en un intervalo de $[-8, 8]$.

```
clear clc
n=-8:8;
x=[0 0 0 0 0 0 1 2 3 2 1 0 0 0 0 0 0];
stem (n,x,'filled','-','LineWidth',2);
xlabel('n');
ylabel('g(n)');
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.

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

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

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

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

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

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

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

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

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

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

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

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

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

Expresamos en n y escalon unitario la señal:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Expresamos en n y escalon unitario la señal:

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

- 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:

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