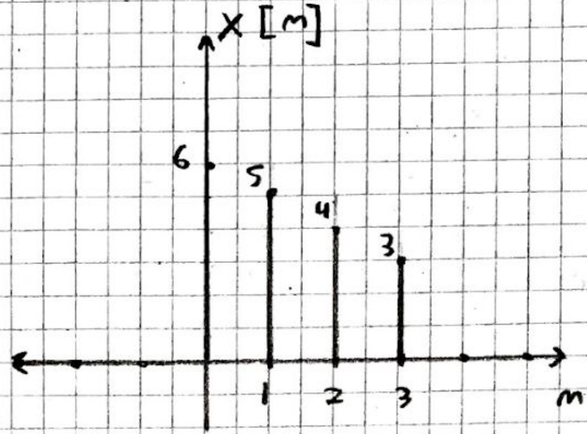
Procesamiento digital de señales

Convolucion circular

Integrantes:

- Barco Valentín
- Estrada Anselmo

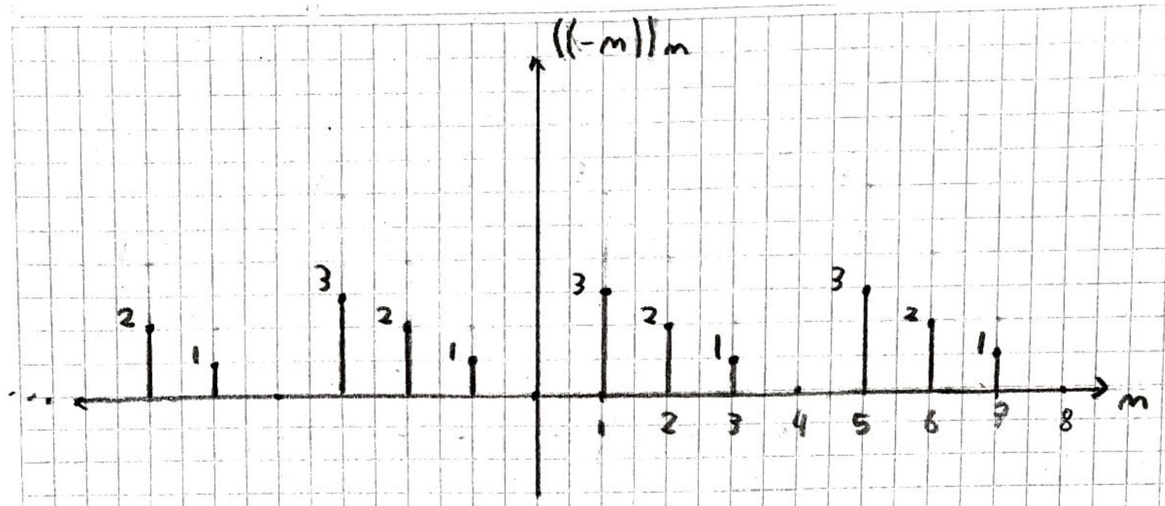
Ejercicio 1



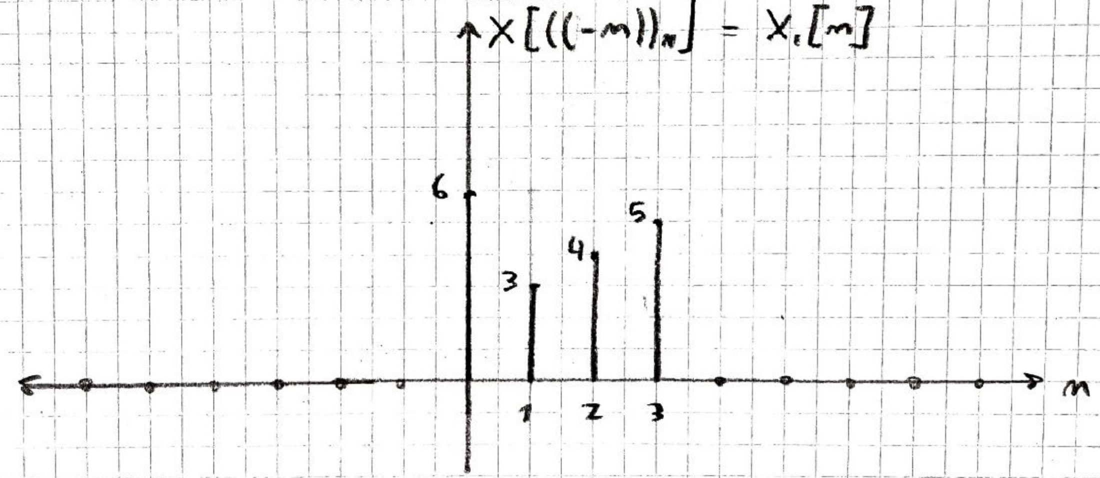
a)

$$x_1[n] = x[((-n))_N]$$

n	$-n - \left\lfloor \frac{-n}{4} \right\rfloor \cdot 4$
-3	$3 - (0) \cdot 4 = 3$
-2	$2 - (0) \cdot 4 = 2$
-1	$1 - (0) \cdot 4 = 1$
0	0
1	$-1 - (-1) \cdot 4 = 3$
2	$-2 - (-1) \cdot 4 = 2$
3	$-3 - (-1) \cdot 4 = 1$
4	0
5	$-5 - (-2) \cdot 4 = 3$
⋮	⋮ ⋮



((-m))ₙ
m
1 2 3 4 5 6 7 8
3 2 1 3 2 1 2 1 3 2 1

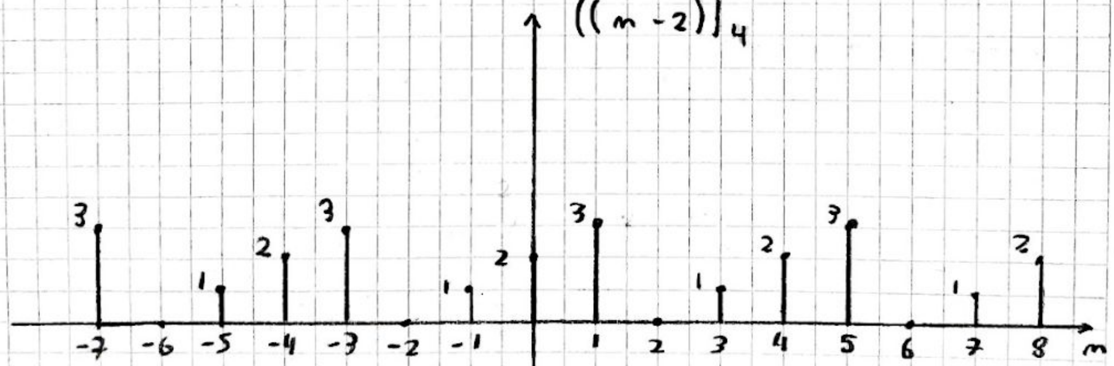


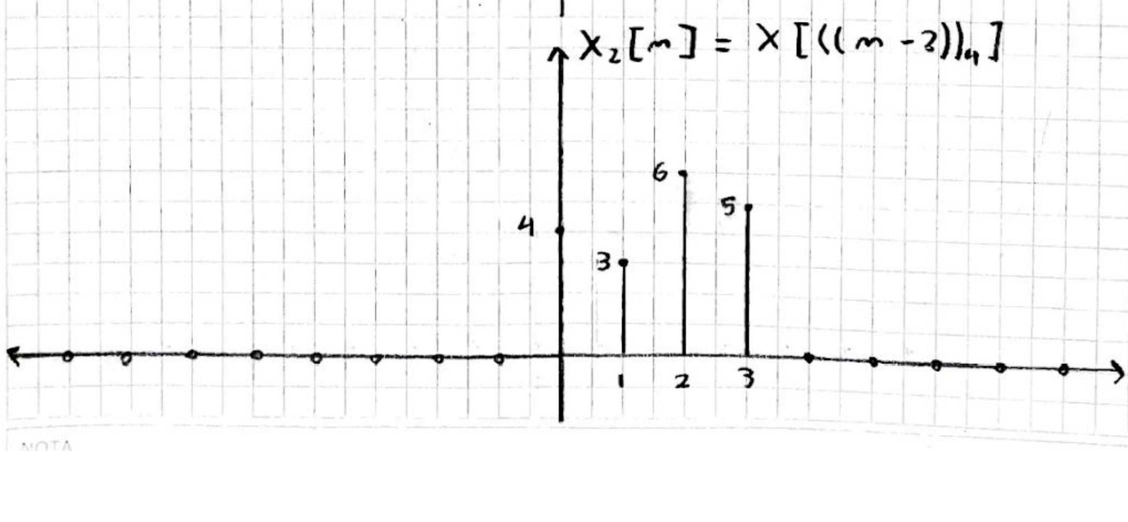
X[((-m))ₙ] = X₁[m]
m
1 2 3
6 3 4 5

b)

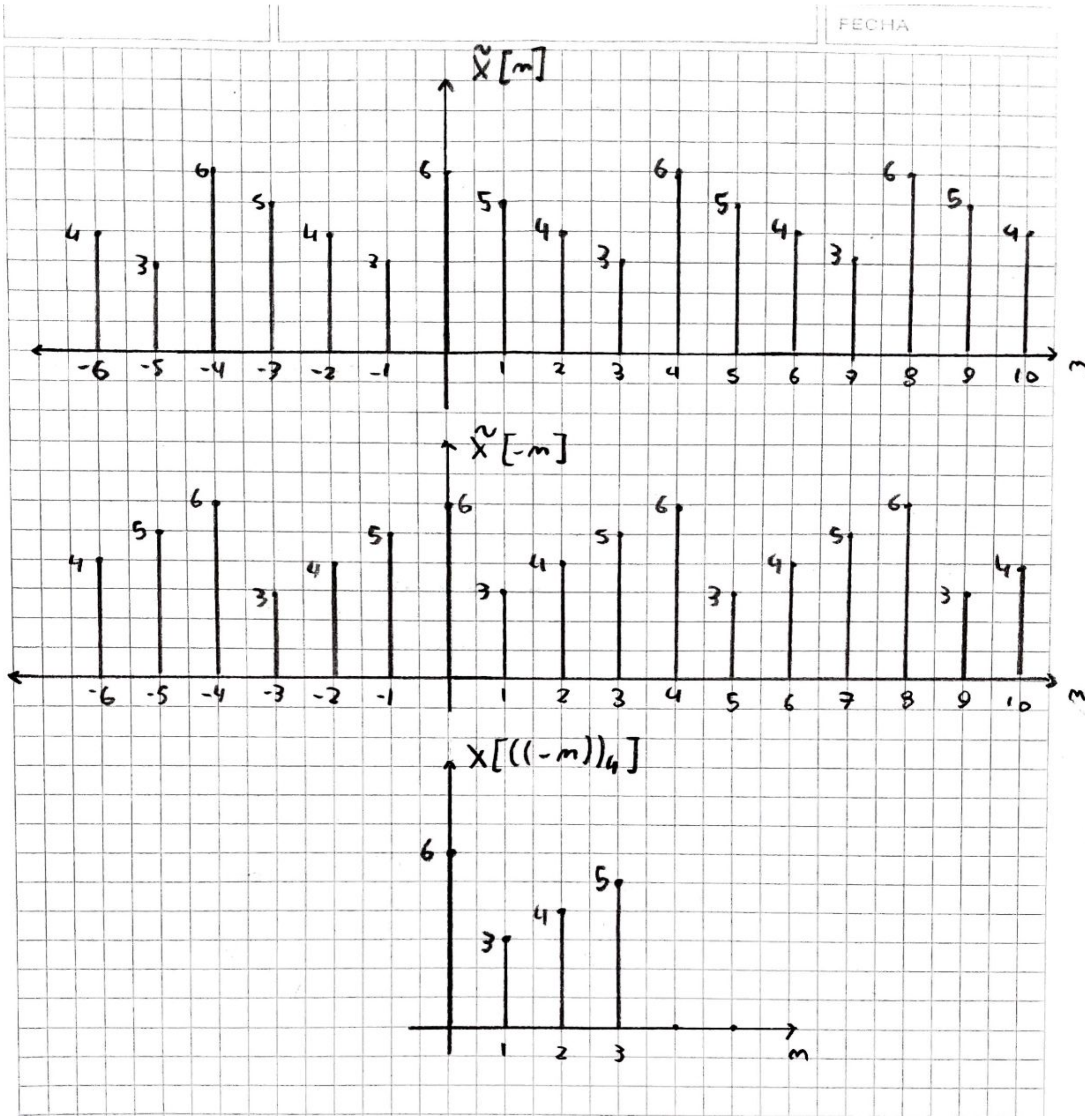
$$x_2[m] = x[((m-2))_4]$$

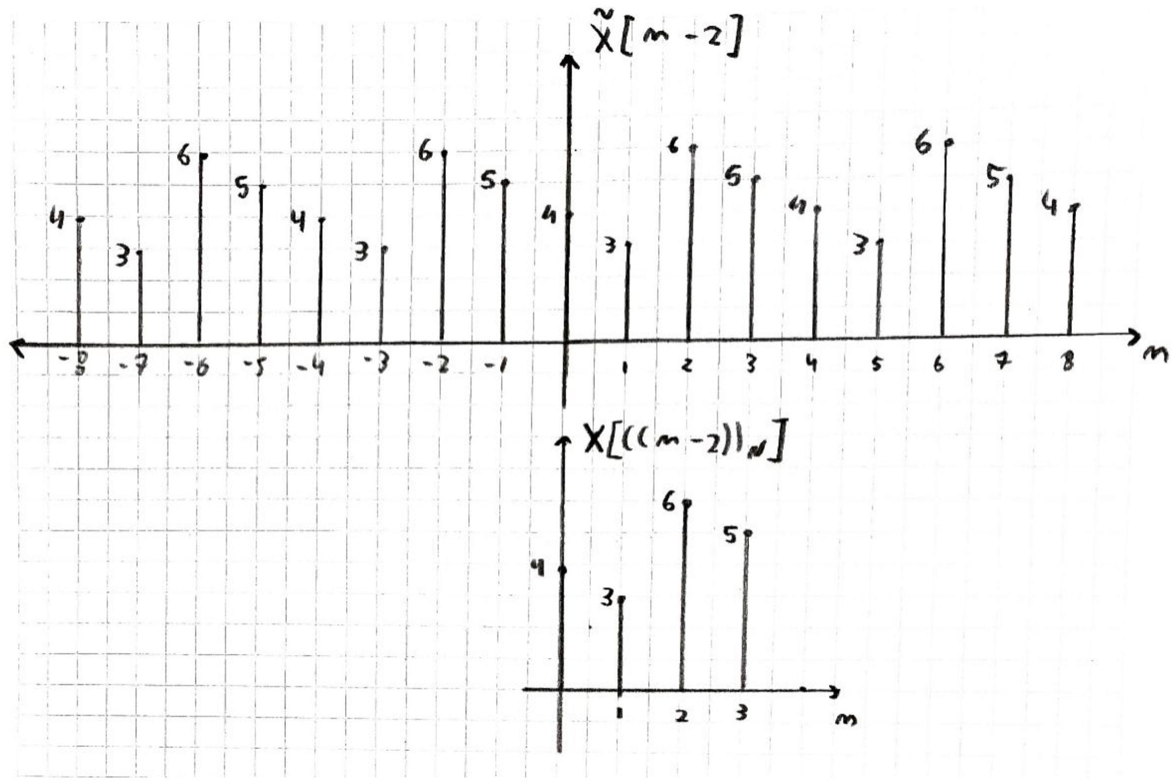
m	$m-2-\left\lfloor \frac{m-2}{4} \right\rfloor \cdot 4$
-3	$-5-(-2).4 = 3$
-2	$-4-(-1).4 = 0$
-1	$-3-(-1).4 = 1$
0	$-2-(-1).4 = 2$
1	$-1-(-1).4 = 3$
2	0
3	$1-0.4 = 1$
4	$2-0.4 = 2$





c)



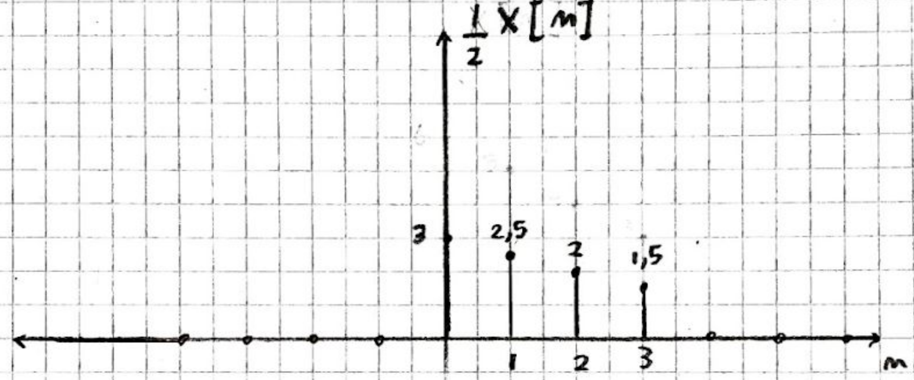


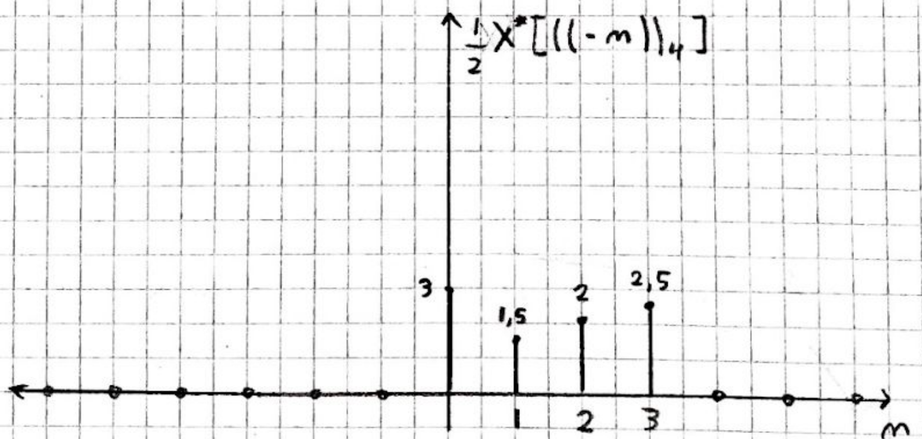
x̃[n-2]
4
3
6
5
4
3
6
5
4
3
6
5
4
3
6
5
4
-8 -7 -6 -5 -4 -3 -2 -1 1 2 3 4 5 6 7 8
n
x[((n-2))_N]
4
3
6
5
1 2 3
n

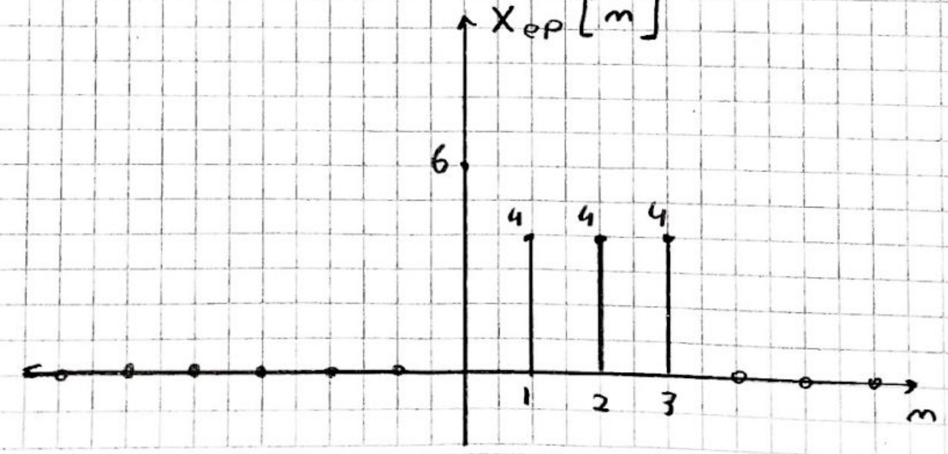
d)

$$x_{ep}[n] = \frac{\left(x[n] + x^*[((-n))_4]\right)}{2}$$

$x^*[((-n))_4] = x[((-n))_4]$ ya que es Real Puro.



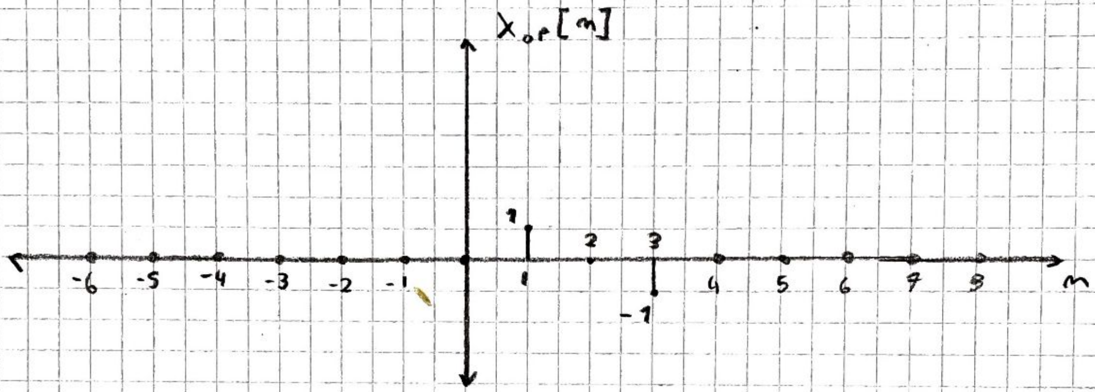




e)

$$x_{op}[n] = \frac{x[n] - x^*[((-n))_4]}{2}$$

Utilizando los graficos anteriores



g) como $x_{ep}[n] \overset{TDF}{\Longleftrightarrow} Re\{X[k]\}$

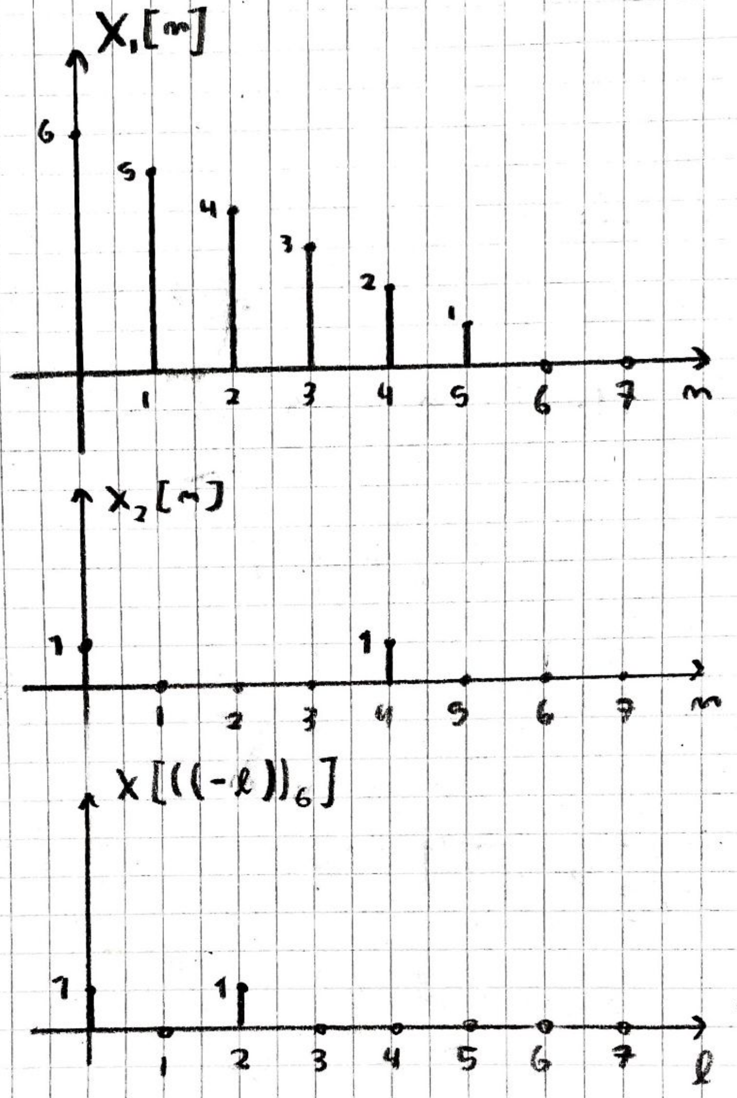
entonces $y[n] = x_{ep}[n]$

y como $x_{op}[n] \overset{TDF}{\Longleftrightarrow} Im\{X[k]\}$

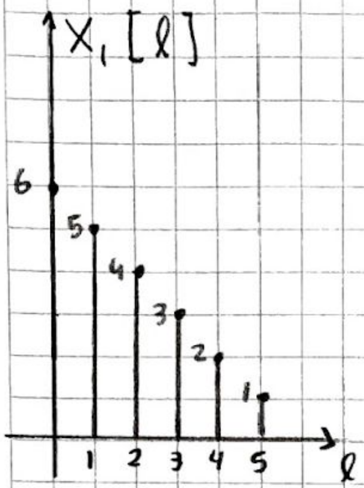
entonces $y[n] = x_{op}[n]$

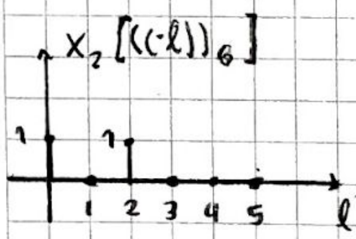
Ejercicio 2

a)

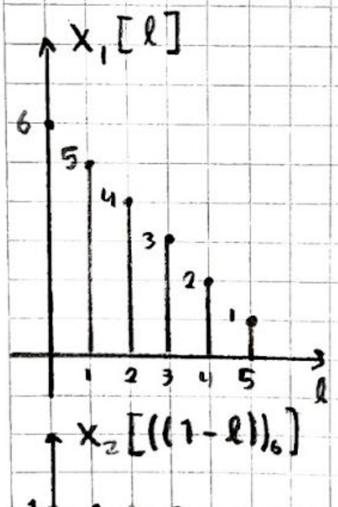


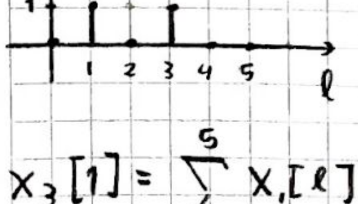
a)



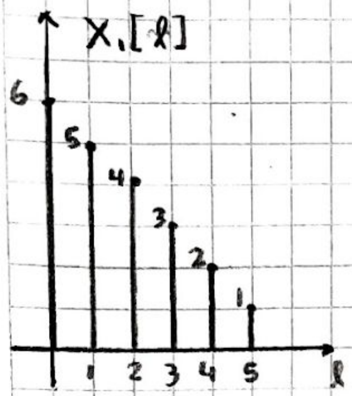


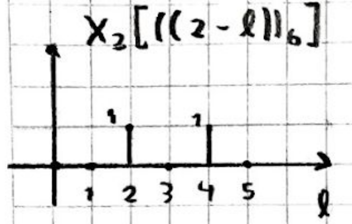
$$x_3[0] = \sum_{\ell=0}^{5} x_1[\ell] \cdot x_2[((-\ell))_6] = 6 + 4 = 10$$



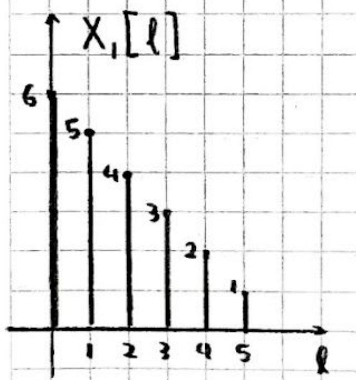


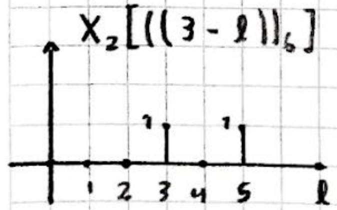
$$x_3[1] = \sum_{\ell=0}^{5} x_1[\ell] \cdot x_2[((1-\ell))_6] = 5 + 3 = 8$$



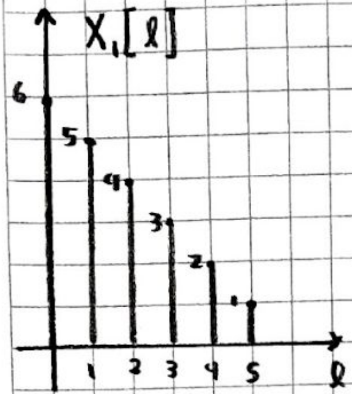


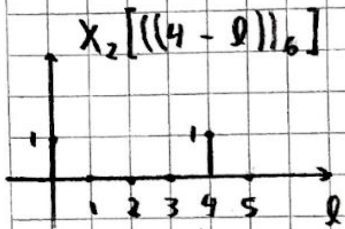
$$X_3[2] = \sum_{\ell=0}^{5} X_1[\ell]\, X_2[((2-\ell))_6] = 4 + 2 = 6$$



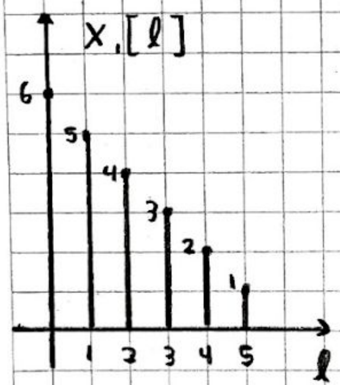


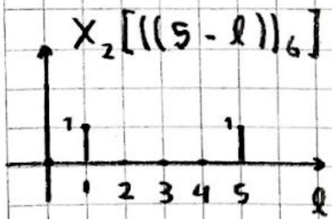
$$X_3[3] = \sum_{\ell=0}^{5} X_1[\ell]\, X_2[((3-\ell))_6] = 3 + 1 = 4$$



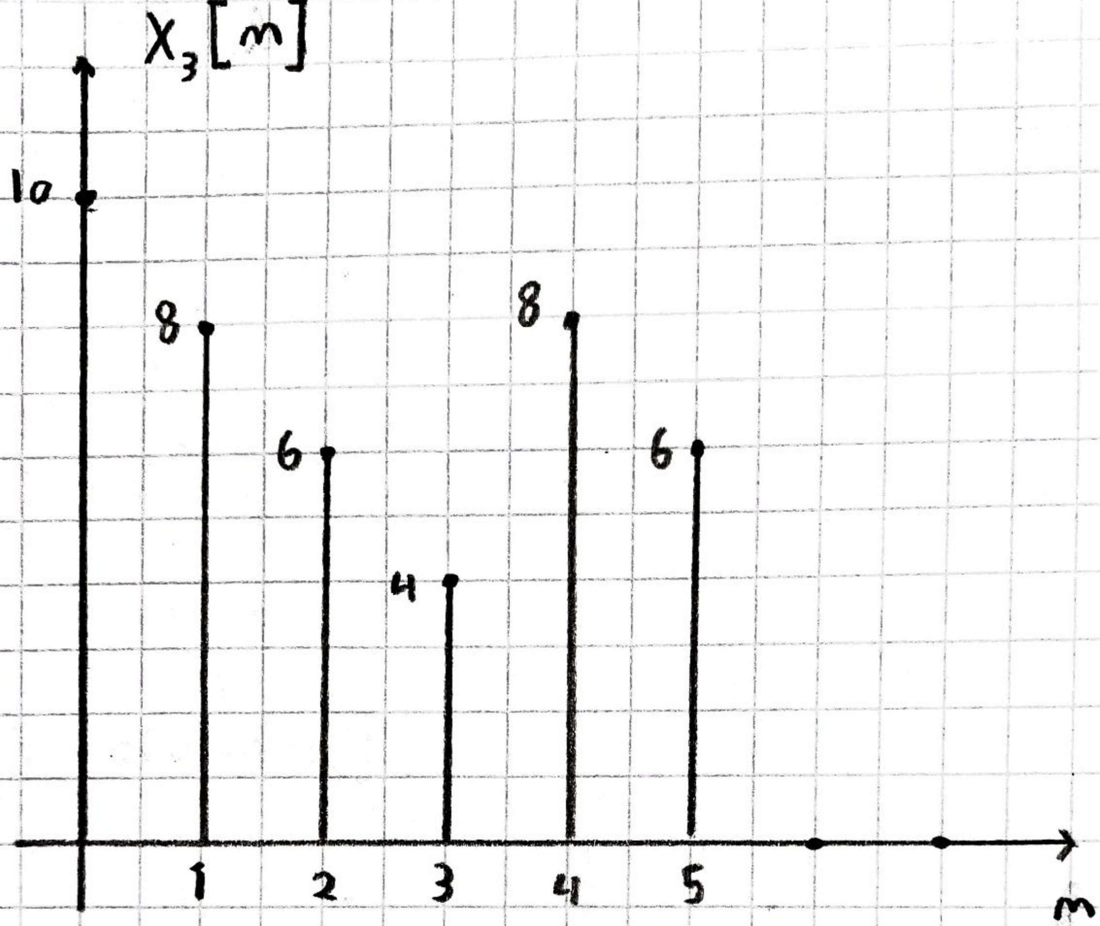


$$X_3[4] = \sum_{\ell=0}^{5} X_1[\ell]\, X_2[((4-\ell))_6] = 6 + 2 = 8$$

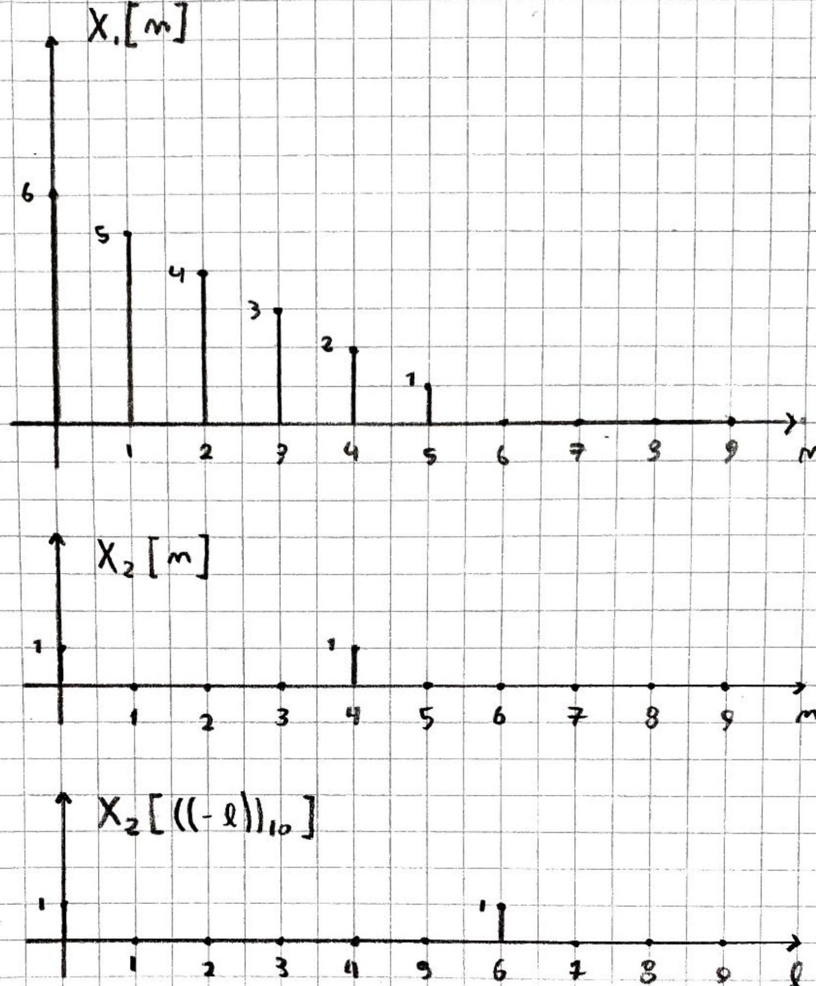




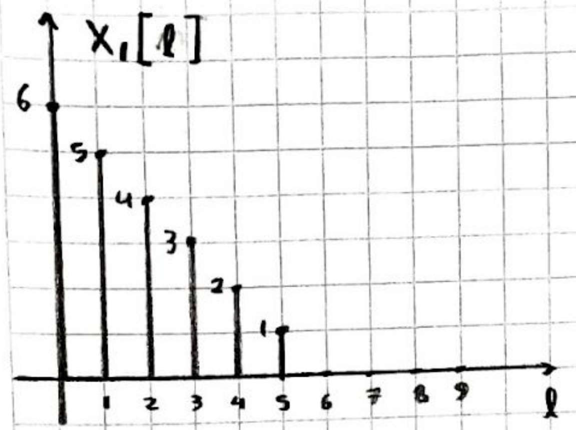
$$X_3[5] = \sum_{\ell=0}^{5} X_1[\ell]\, X_2[((5-\ell))_6] = 5 + 1 = 6$$

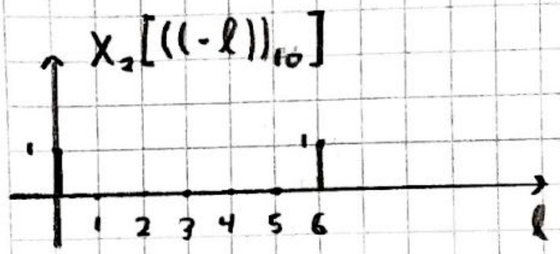

X3[n]
10
8
6
4
8
6
1
2
3
4
5
n

b)

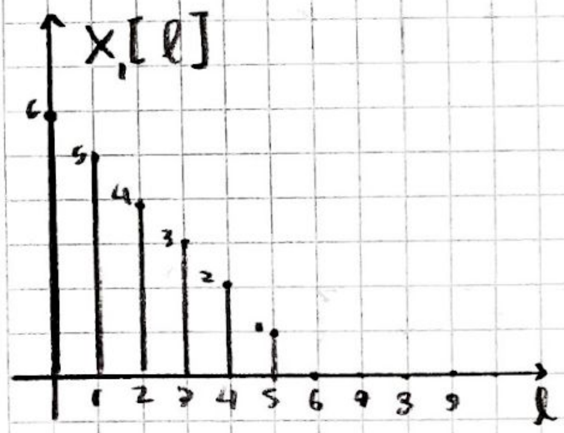


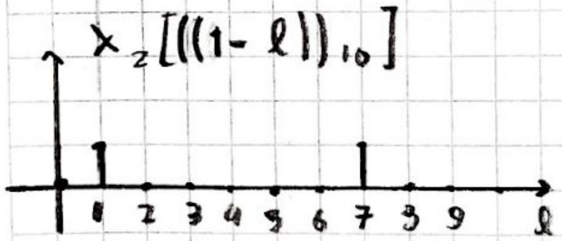
$X_1[m]$
6
5
4
3
2
1
1 2 3 4 5 6 7 8 9 m
$X_2[m]$
1
1
1 2 3 4 5 6 7 8 9 m
$X_2[((-\ell))_{10}]$
1
1
1 2 3 4 5 6 7 8 9 ℓ



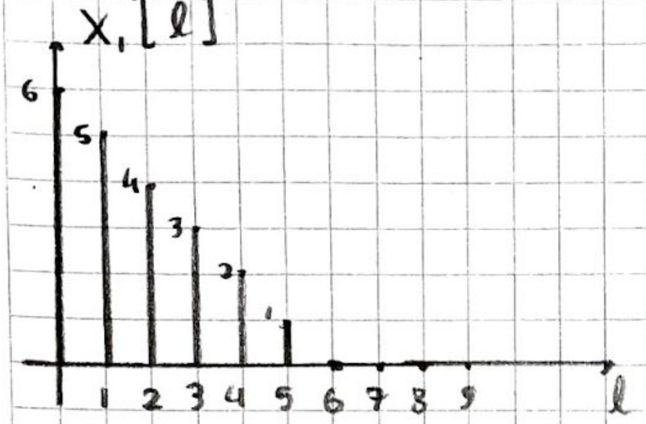


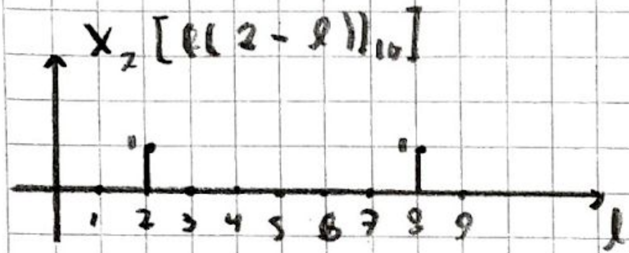
$$x_3[0] = \sum_{l=0}^{9} x_1[l]\, x_2[((-l))_{10}] = 6$$



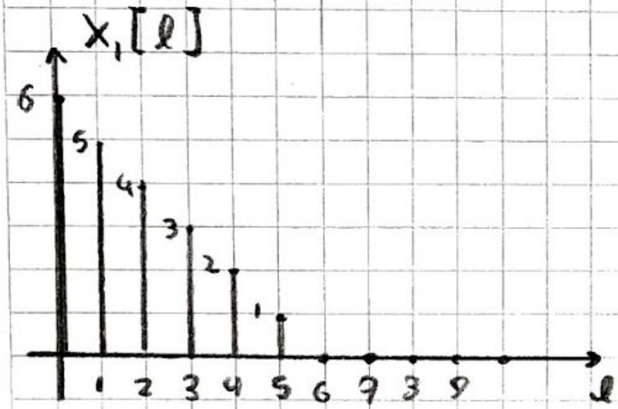


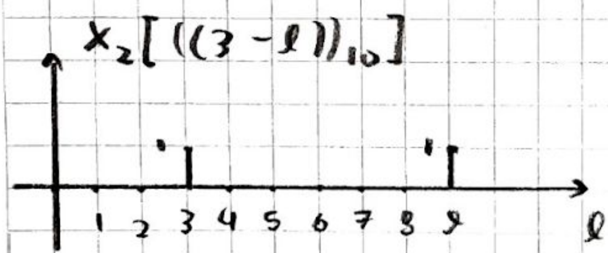
$$x_3[1] = \sum_{l=0}^{9} x_1[l]\, x_2[((1-l))_{10}] = 5$$



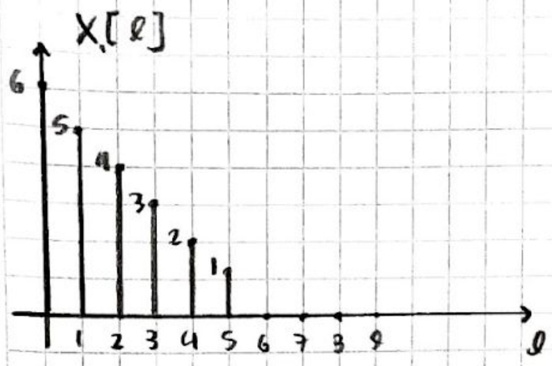


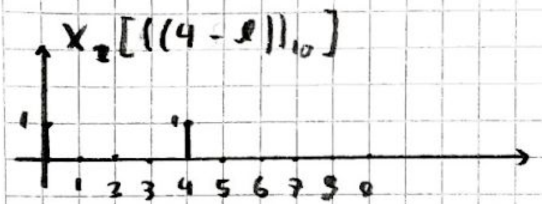
$$X_3[2] = \sum_{l=0}^{9} X_1[l] \cdot X_2[((2-l))_{10}] = 4$$





$$X_3[3] = \sum_{l=0}^{9} X_1[l] \cdot X_2[((2-l))_{10}] = 3$$





$$x_3[4] = \sum_{\ell=0}^{9} x_1[\ell] \, x_2[((4-\ell))_{10}] = 6 + 2 = 8$$

Siguiendo esta logica

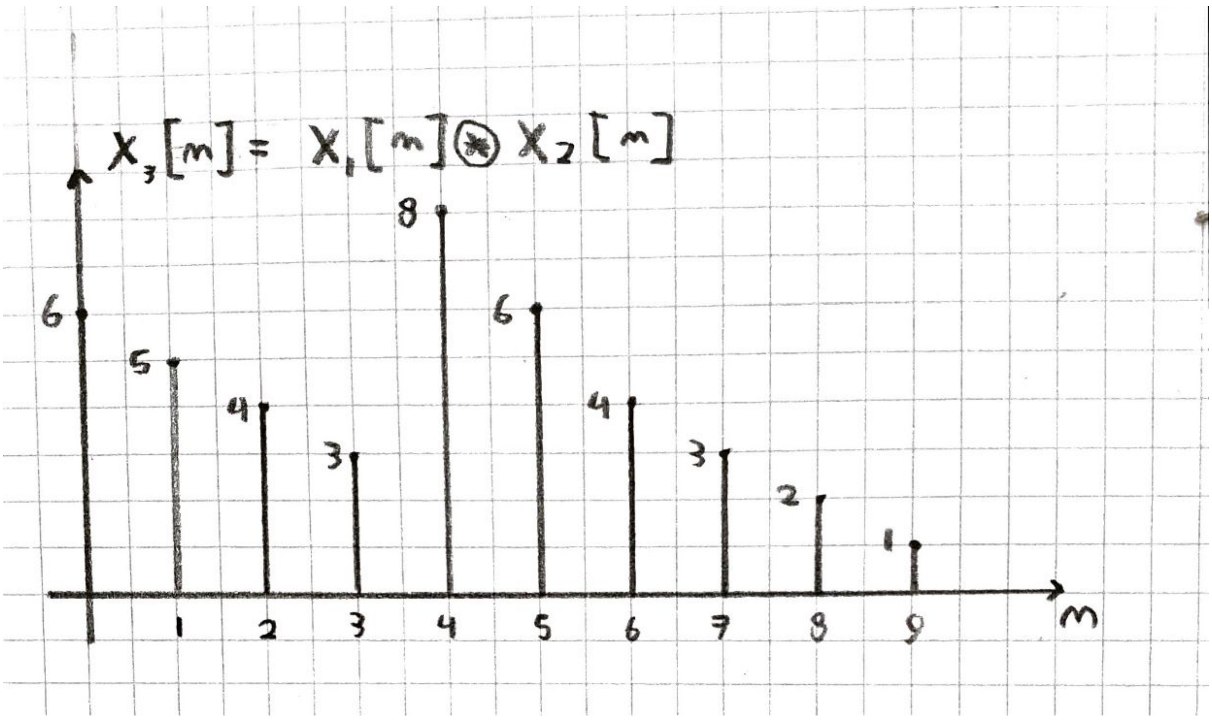
$$x_3[5] = \sum_{\ell=0}^{9} x_1[\ell] \, x_2[((5-\ell))_{10}] = 5 + 1 = 6$$

$$x_3[6] = \sum_{\ell=0}^{9} x_1[\ell] \, x_2[((6-\ell))_{10}] = 4$$

$$x_3[7] = \sum_{\ell=0}^{9} x_1[\ell] \, x_2[((7-\ell))_{10}] = 3$$

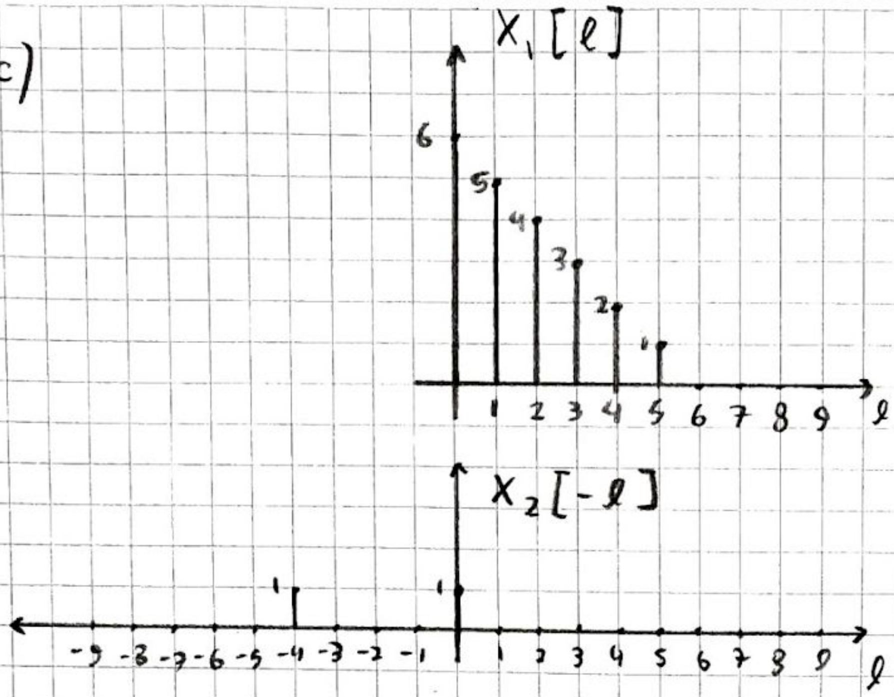
$$x_3[8] = \sum_{\ell=0}^{9} x_1[\ell] \, x_2[((8-\ell))_{10}] = 2$$

$$x_3[9] = \sum_{\ell=0}^{9} x_1[\ell] \, x_2[((9-\ell))_{10}] = 1$$



$x_3[m] = x_1[m] \circledast x_2[m]$
8
6
6
5
4
4
3
3
2
1
1
2
3
4
5
6
7
8
9
m

c)



$$x_3[0] = \sum_{\ell=-\infty}^{\infty} x_1[\ell]\, x_2[-\ell] = 6$$

$$x_3[1] = \sum_{\ell=-\infty}^{\infty} x_1[\ell]\, x_2[1-\ell] = 5$$

$$x_3[2] = \sum_{\ell=-\infty}^{\infty} x_1[\ell]\, x_2[2-\ell] = 4$$

$$x_3[3] = 3$$

$$x_3[4] = 6 + 2 = 8$$

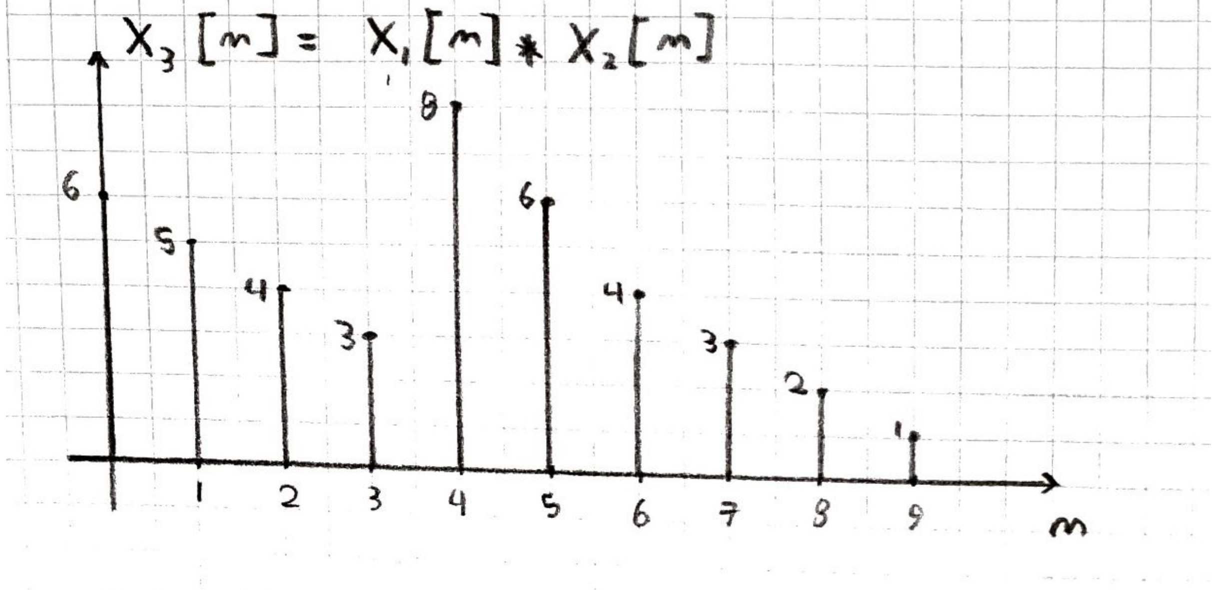
$$x_3[5] = 5 + 1 = 6$$

$$x_3[6] = 4$$

$$x_3[7] = 3$$

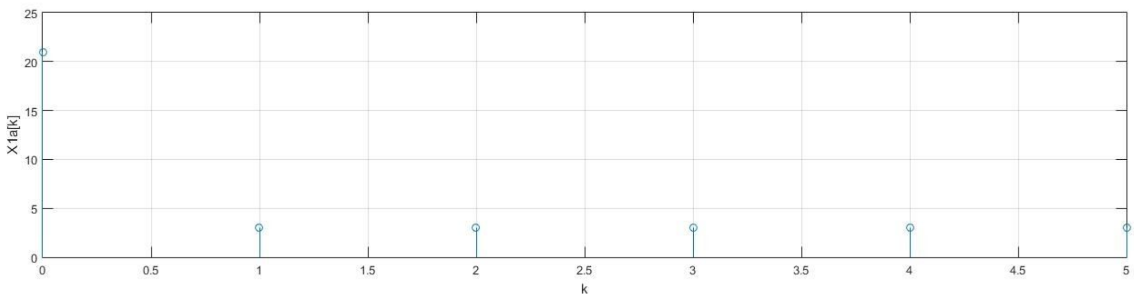
$X_3[8] = 2$

$X_3[9] = 1$

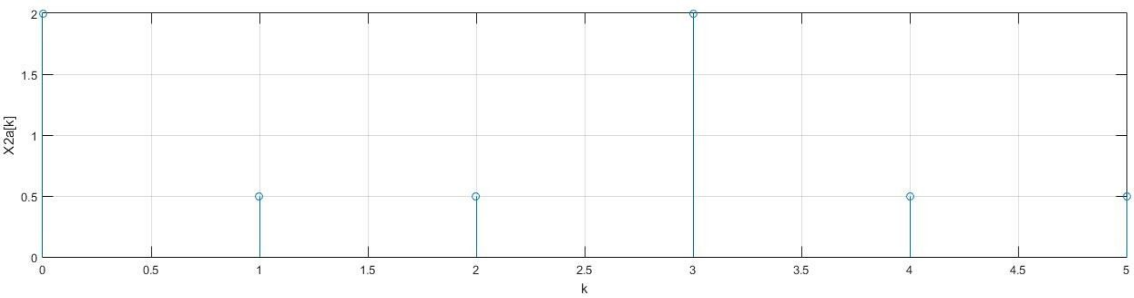


X_3[m] = X_1[m] * X_2[m]
6
5
4
3
8
6
4
3
2
1
1
2
3
4
5
6
7
8
9
m

d)

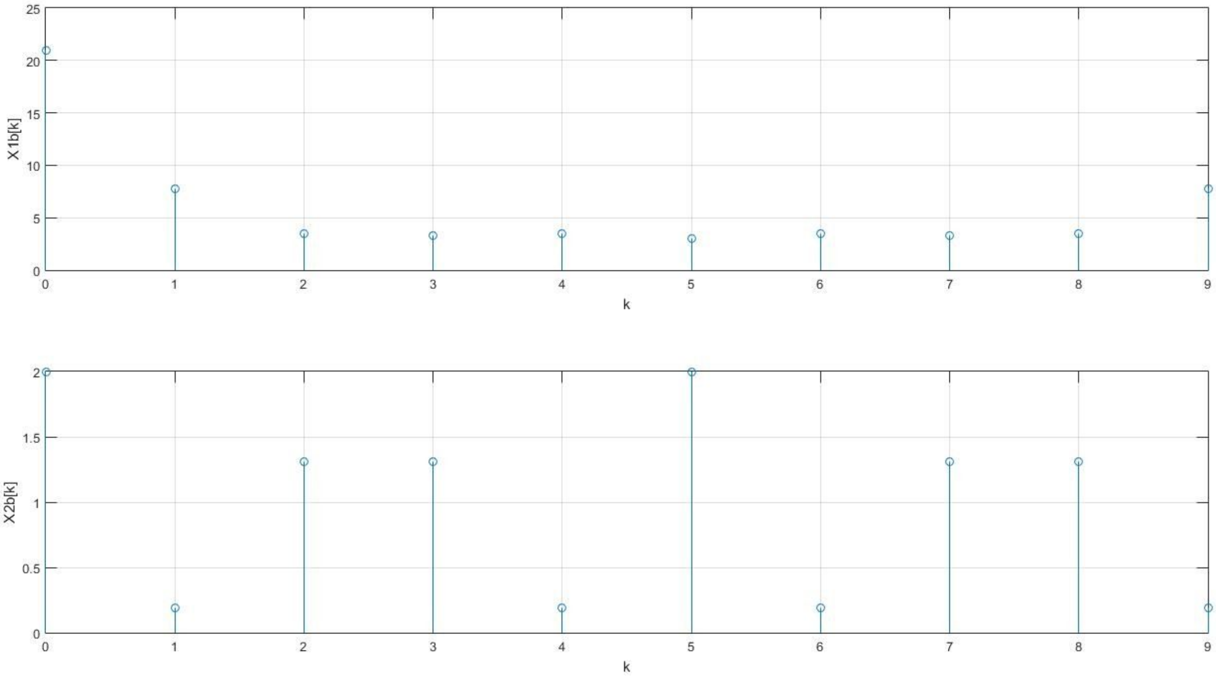


X1a[k]
k
0
5
10
15
20
25
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

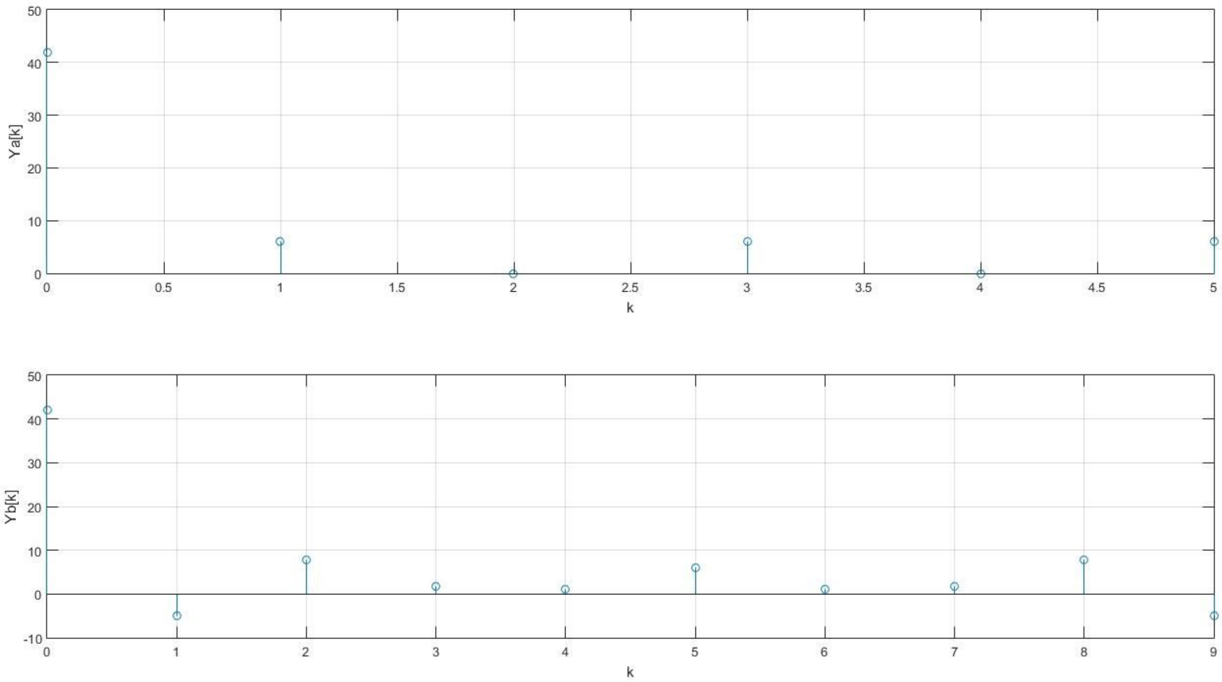


X2a[k]
k
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

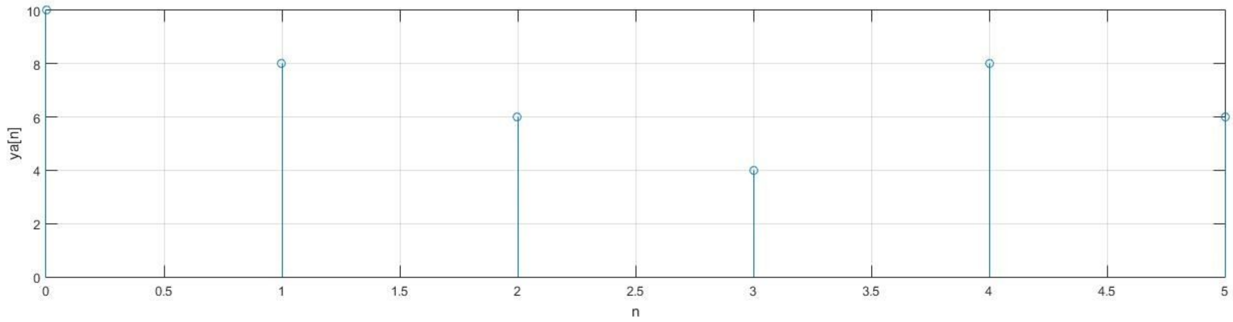
e)

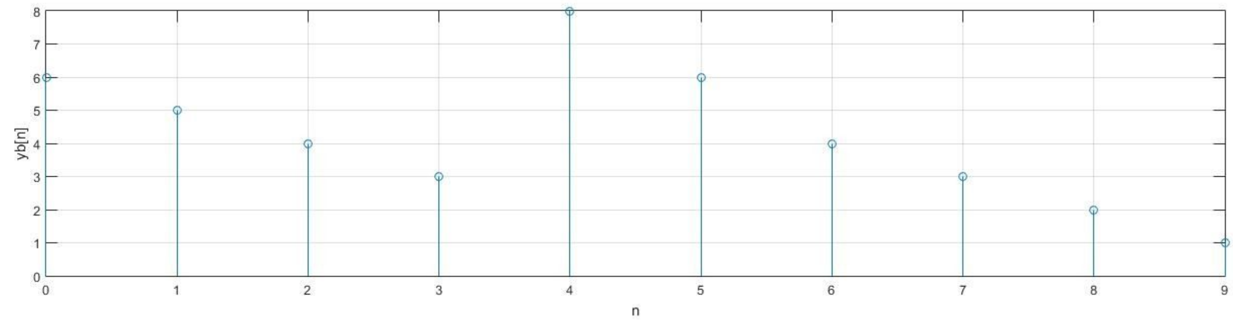


f)



g)





h) Se puede ver que la convolución circular con N = 10 y la convolución lineal dan iguales. En cambio la convolución circular con N = 6 da diferente, ya que al realizar la convolución lineal, el resultado no queda acotado entre 0 y N - 1 como en el caso de la convolución circular para N = 6.