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~~Assignment:3~~

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Q1 Find the convolution sum for the two sequences $x[n] = \{1, 2, -1, 1\}$ and $h[n] = \{1, 3, 2, 1, 1\}$ using
ⓐ Graphical method
ⓑ Mathematical method
ⓒ Overlap and add method

⇒ Solution

Given,

$x[n] = \{1, 2, -1, 1\}$ $\quad N_1 = 4$

$h[n] = \{1, 3, 2, 1, 1\}$ $\quad N_2 = 5$

a) Graphical method

The convolution sum of $x[n]$ and $h[n]$ is

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

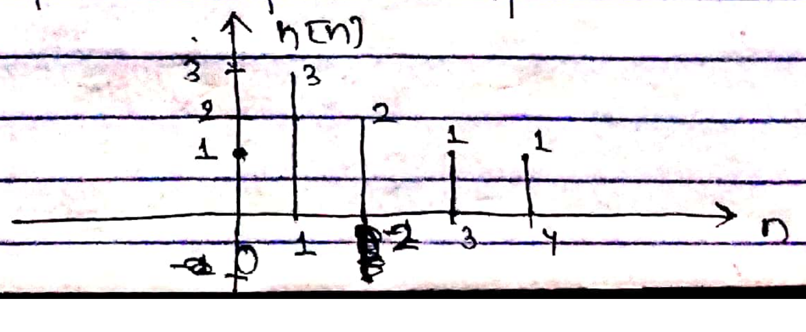
$$= \sum_{k=0}^{k=3} x[k]h[n-k]$$

$$= x[0]h[n-0] + x[1]h[n-1] + x[2]h[n-2] + x[3]h[n-3]$$

$$= h[n] + 2h[n-1] + (-1)h[n-2] + h[n-3]$$

~~The signal of~~

The graphical form of $h[n]$ is



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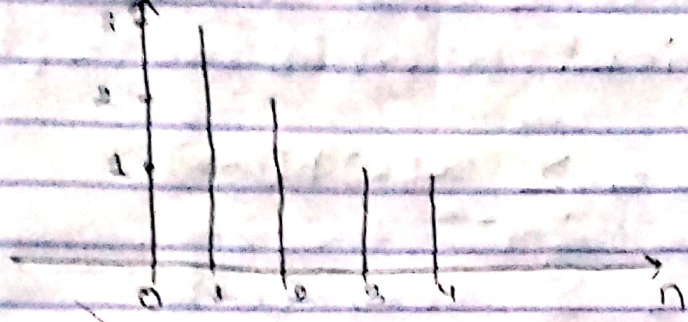
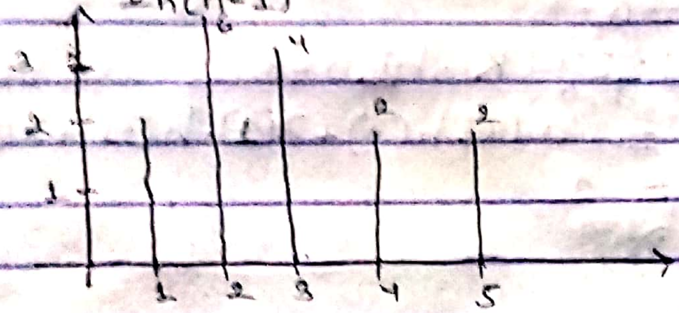
Now we calculate $h(n)$, $2h(n-1)$, $-h(n-2)$, $h(n-3)$

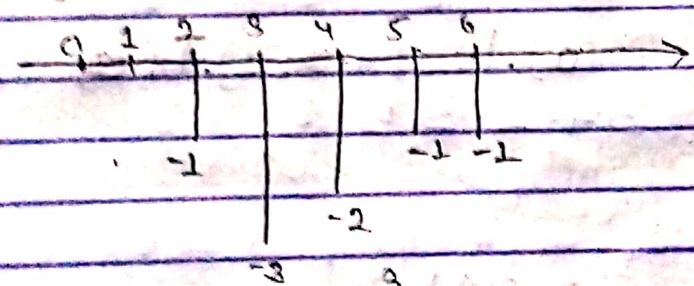
$h(n)$



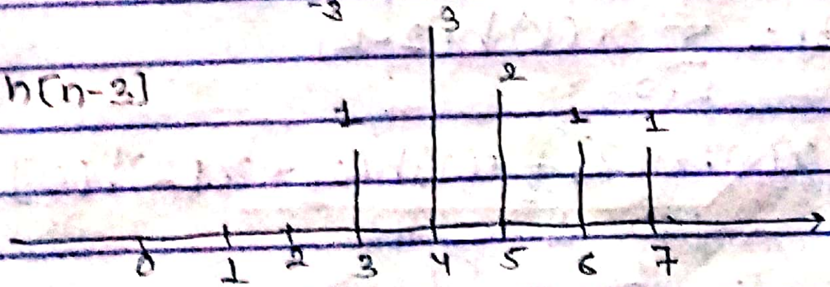
$2h(n-1)$

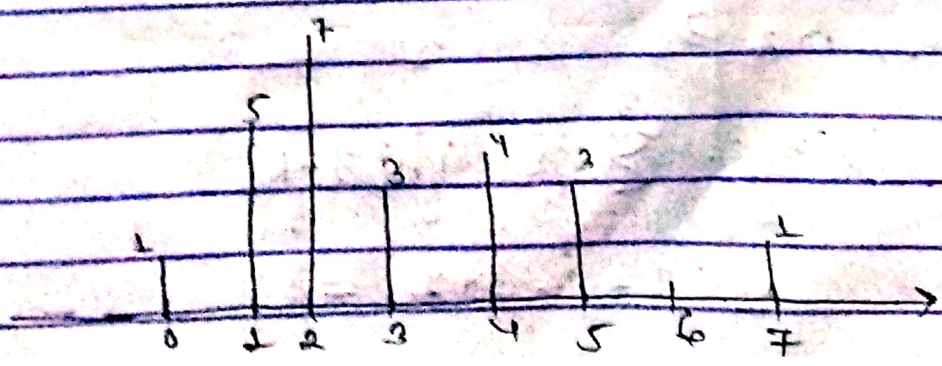


$-h(n-2)$



$h(n-3)$





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$y(n) = \{1, 5, 7, 3, 4, 3, 0, 1\}$

(b) Mathematical Method

We know

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

$$= \sum_{k=0}^{3} x[k]\, h[n-k]$$

When, $n=0$

$$y[0] = \sum_{k=0}^{3} x[k] \cdot h[0-k]$$

$$= x[0].h[0] + x[1].h[-1] + x[2]\, h[-2] + x[3]\, h[-3]$$

$$= 1$$

When, $n=1$

$$y[1] = \sum_{k=0}^{3} x[1]\, h[1-k]$$

$$= x[0].h[1] + x[1].h[0]$$

$$= 3+2 = 5$$

When, $n=2$

$$y[2] = \sum_{k=0}^{3} x(k)\, h[2-k]$$

$$= x[0] \cdot h[2] + x[1]\, h[1] + x[2]\, h[0]$$

$$= 2+6-1 = 7$$

When, $n=3$

$$y[3] = \sum_{k=0}^{3} x[k]\, h[3-k]$$

$$= 1+4-3+1 = 3$$

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when $n=4$

$$y[4] = \sum_{k=0}^{3} x[k]h[4-k]$$

$$= 1+2-2+3 = 4$$

when $n=5$

$$y[5] = \sum_{k=0}^{3} x[k]\cdot h[5-k]$$

$$= 2-1+2 = 3$$

when $n=6$

$$y[6] = \sum_{k=0}^{3} x[k]h[6-k]$$

$$= -1+1 = 0$$

when $n=7$

$$y[7] = \sum_{k=0}^{3} x[k]h[7-k]$$

$$= 1 = 1$$

$$y(n) = \{1, 5, 7, 3, 4, 3, 0, 1\}$$

(c) Overlap and Add method

$x[n]$ \ $h[n]$	1	3	2	1	1
1	1	3	2	1	1
2	2	6	4	2	2
-1	-1	-3	-2	-1	-1
+1	1	3	2	1	1
0					

$y[4]$ $y[5]$ $y[6]$ $y[7]$

$$y[n] = \{1, 5, 7, 3, 4, 3, 0, 1\}$$

Q.2 Verify the commutative property of convolution where input signal $x[n]=\{1,1,1,1\}$ and response of system is $h[n]=\{1,1,1,1\}$

⇒ Sol^n:

We know, to obey the commutative

$$x[n]\,h[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k] = \sum_{k=-\infty}^{\infty} h[k]\cdot x[n-k]$$

Using overlap and add method,

For $x[k]\,h[n-k]$

x[k] \ h[k]	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1

y(0) y(1) y(2) y(3) y(4) y(5) y(6)

$y[n] = \{1, 2, 3, 4, 3, 2, 1\}$

For ~~x[k~~ $h[k]\,x[n-k]$

h[k] \ x(k)	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1

y(0) y(1) y(2) y(3) y(4) y(5) y(6)

$y(n) = \{1, 2, 3, 4, 3, 2, 1\}$.

$$\therefore \sum_{k=-\infty}^{\infty} x(k) \cdot h(n-k) = \sum_{k=-\infty}^{\infty} h(k)\, x(n-k)$$

$\therefore$ Hence, commutative property of convolution is proved.