Q.1] Solve the following using Linear convolution - Tabular method:

1. $x[n] = [10, 11, 12, 13]$
$h[n] = [1, -1, 2, 2]$

Calculating the length of the signal.

$l_1 = l(x[n]) = 4$
$l_2 = l(h[n]) = 4$

Length of the signal,

$l_3 = l_1 + l_2 - 1$
$= 4 + 4 - 1$
$= 7$

Arranging $x[n]$ and $h[n]$ in tabular format.

		$x[n]$			
		10	11	12	13
$h[n]$	1	10	11	12	13
	-1	-10	-11	-12	-13
	2	20	22	24	26
	2	20	22	24	26

$y[n] = [10, (-10)+11, 20+(-11)+12, 20+22+(-12)+13,$
$22+24+(-13), 24+26, 26]$

$y[n] = [10, 1, 21, 43, 33, 50, 26]$

2. $x[n] = [-5, -6, -7, -8]$
$h[n] = [-1, -1, 2, -2]$

Calculating the length of the signal.

$l_1 = l(x[n]) = 4$
$l_2 = l(h[n]) = 4$

∴ Length of the signal,
$l_3 = l_1 + l_2 - 1$
$= 4 + 4 - 1$
$= 7$

Arranging $x[n]$ and $h[n]$ in tabular format

		$x[n]$			
		-5	-6	-7	-8
	-1	5	6	7	8
$h[n]$	-1	5	6	7	8
	2	-10	-12	-14	-16
	-2	10	12	14	16

$y[n] = [5, 5+6, (-10)+6+7, 10+(-12)+7+8, 12+(-14)+8, 14+(-16), 16]$

$= [5, 11, 3, 13, 6, -2, 16]$

$y[n] = [5, 11, 3, 13, 6, -2, 16]$

Q.2) Solve the following using Linear Convolution - Sum by column method.

1. $x[n] = [8, 13, 11, 12]$

$h[n] = [2, 1, 1, 2]$

Calculating the length of the signal

$l_1 = l(x[n]) = 4$

$l_2 = l(h[n]) = 4$

length of output signal $(l_3) = l_1 + l_2 - 1$

$= 4 + 4 - 1$

$= 7$

Arranging $x[n]$ and $h[n]$ in Sum by column format

8	13	11	12	... x[n]
2	1	1	2	... h[n]

8	13	11	12			
2	1	1	2			
16	26	22	24			
	8	13	11	12		
		8	13	11	12	
			16	26	22	24
16	34	43	64	49	34	24

$y[n] = [16, 34, 43, 64, 49, 34, 24]$

2. $x[n] = [-9, -10, -11, -12]$

$h[n] = [1, -2, -1, 1]$

calculating the length of the signal

$l_1 = l(x[n]) = 4$

$l_2 = l(h[n]) = 4$

length of the output signal $(l_3) = l_1 + l_2 - 1$

$= 4 + 4 - 1$

$= 7$

-9	-10	-11	-12			
1	-2	-1	1			
-9	-10	-11	-12			
	18	20	22	24		
		9	10	11	12	
			-9	-10	-11	-12
-9	8	18	11	25	1	-12

$y[n] = [-9, 8, 18, 11, 25, 1, -12]$

Q.3) Solve the following using Circular convolution - Matrix method.

1. $x[n] = [10, 11, 12, 13]$
$h[n] = [1, -1, 2, 2]$

Length of the output signal,
$l_1 = l_2 = l(y[n]) = 4$

$$\begin{bmatrix} 10 & 13 & 12 & 11 \\ 11 & 10 & 13 & 12 \\ 12 & 11 & 10 & 13 \\ 13 & 12 & 11 & 10 \end{bmatrix} \begin{bmatrix} 1 \\ -1 \\ 2 \\ 2 \end{bmatrix} = \begin{bmatrix} 10+(-13)+24+22 \\ 11+(-10)+26+24 \\ 12+(-11)+20+26 \\ 13+(-12)+22+20 \end{bmatrix}$$

$$= \begin{bmatrix} 43 \\ 51 \\ 47 \\ 43 \end{bmatrix}$$

$\therefore y[n] = [43, 51, 47, 43]$

2. $x[n] = [-5, -6, -7, -8]$

$h[n] = [-1, -1, 2, -2]$

Length of the output signal,

$$l_1 = l_2 = l(y[n])$$

$$\therefore \quad l(y[n]) = 4$$

$$= \begin{bmatrix} -5 & -8 & -7 & -6 \\ -6 & -5 & -8 & -7 \\ -7 & -6 & -5 & -8 \\ -8 & -7 & -6 & -5 \end{bmatrix} \begin{bmatrix} -1 \\ -1 \\ 2 \\ -2 \end{bmatrix}$$

$$= \begin{bmatrix} 5+8+(-14)+12 \\ 6+5+(-16)+14 \\ 7+6+(-10)+16 \\ 8+7+(-12)+10 \end{bmatrix} = \begin{bmatrix} 11 \\ 9 \\ 19 \\ 13 \end{bmatrix}$$

$y[n] = [11, 9, 19, 13]$

Q.4) Solve the following using Circular Convolution - Sum by column

1. $x[n] = [8, 13, 11, 12]$
$h[n] = [2, 1, 1, 2]$

Length of output signal l_3,

$l_1 = l_2 = l(y[n])$

$\therefore l(y[n]) = 4$

×	8	13	11	12			
	2	1	1	2			
	16	26	22	24			
+		8	13	11	12		
+			8	13	11	12	
+				16	26	22	24
	16	34	43	64	49	34	24

Adding last 3 values with the first 3 values.

+	16	34	43	64
	49	34	24	
	65	68	67	64

$\therefore y[n] = [65, 68, 67, 64]$

2. $x[n] = [-9, -10, -11, -12]$

$h[n] = [1, -2, -1, 1]$

$l_1 = l_2 = l(y[n]) = 4$

-9	-10	-11	-12				
1	-2	-1	1				
-9	-10	-11	-12				
	18	20	22	24			
		9	10	11	12		
			-9	-10	-11	-12	
-9	8	18	11	25	1	-12	

Adding last 3 values to the first 3 values.

	-9	8	18	11
+	25	1	-12	
	16	9	6	11

$y[n] = [16, 9, 6, 11]$