Ex. Perform linear convolution using DFT & IDFT method

$x(n) = \{1, -1\}$, $h(n) = \{2, 2, 1\}$

Soln $m = 3$, $n = 2$

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

After zero padding

$x(n) = \{1, -1, 0, 0\}$ $h(n) = \{2, 2, 1, 0\}$

By convolution property.

$y(n) = x(n) * h(n)$

By DFT

$Y(k) = X(k) * H(k)$

$$X(k) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1+j \\ 2 \\ 1-j \end{bmatrix}$$

$$H(k) = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 2 \\ 2 \\ 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 5 \\ 1-2j \\ 1 \\ 1+2j \end{bmatrix}$$

$Y(k) = X(k) * H(k)$

$$= \begin{bmatrix} 0 \\ 1+j \\ 2 \\ 1-j \end{bmatrix} \begin{bmatrix} 5 \\ 1-2j \\ 1 \\ 1+2j \end{bmatrix} = \begin{bmatrix} 0 \\ 3-j \\ 2 \\ 3+j \end{bmatrix}$$

By IDT

$$y(n) = \frac{1}{4} \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & j & -1 & -j \\ 1 & -1 & 1 & -1 \\ 1 & -j & -1 & j \end{bmatrix} \begin{bmatrix} 0 \\ 3-j \\ 2 \\ 3+j \end{bmatrix} = \frac{1}{4} \begin{bmatrix} 2 \\ 0 \\ -4 \\ -1 \end{bmatrix}$$

$-3+j+2-3-j = -4$, $\frac{-4}{4} = -1$

$y(n) = \{2, 0, -1, -1\}$

	2	2	1	0
1	2	2	1	0
-1	-2	-2	-1	0
0	0	0	0	0
0	0	0	0	0

$y(n) = \{2, 0, -1, -1\}$

* Perform the circular convolution of the following sequence $x(n) = \{i, 1, 2, 1\}$ $h(n) = \{1, 2, 3, 4\}$ using DFT & IDFT method. Ans = $\{13, 4, 11, 12\}$

② $x(n) = \{1, 2, 3, 1\}$ $x_2(n) = \{4, 3, 2, 2\}$
Ans $\{17, 19, 22, 19\}$

③ $x(n) = \{1, 1, 1, 2\}$ $y(n) = \{1, 2, 3, 2\}$
Ans $\{10, 11, 10, 9\}$

* Determine circular convolution using DFT & IDFT

$x_1(n) = \{15, 14, 30, 20\}$, $x_2(n) = \{12, 11, 10, 9\}$

$X_1(k) = \{79, -15+6j, 11, -15-6j\}$

$X_2(k) = \{42, 2-2j, 2, 2+2j\}$

$Y(k) = \{3318, -18+42j, 22, -18-42j\}$

$y(n) = \{826, 803, 844, 845\}$