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Answer) for a DFT matrix of 4x4 order

$$X_N = W_N \cdot x_N$$

Where $N = 4$

$$\begin{bmatrix} X(0) \\ X(1) \\ X(2) \\ X(3) \end{bmatrix} \begin{matrix} 0 \\ 1 \\ 2 \\ 3 \end{matrix} = \begin{bmatrix} W_4^0 & W_4^0 & W_4^0 & W_4^0 \\ W_4^0 & W_4^1 & W_4^2 & W_4^3 \\ W_4^0 & W_4^2 & W_4^4 & W_4^6 \\ W_4^0 & W_4^3 & W_4^6 & W_4^9 \end{bmatrix} \begin{bmatrix} x(0) \\ x(1) \\ x(2) \\ x(3) \end{bmatrix}$$

$$W_N = e^{-j 2\pi/4}$$

i.e. $W_N^0 = 1 \Rightarrow W_4^0 = 1$

So, $W_4^1 = e^{-j 2\pi/4 \cdot 1}$

$$= \cos\left(\frac{2\pi}{4}\right) - j \sin\left(\frac{2\pi}{4}\right)$$

$$= -j$$

$W_4^2 = -1$	$W_4^4 = 1$	$W_4^9 = -j$
$W_4^3 = +j$	$W_4^6 = -1$	

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1.5.

$$\begin{bmatrix} x(0) \\ x(1) \\ x(2) \\ x(3) \end{bmatrix} = \underbrace{\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix}}_{\text{Kernel}} \begin{bmatrix} x(0) \\ x(0) \\ x(2) \\ x(3) \end{bmatrix}$$

$$F(k) = \sum_{n=0}^{N-1} f(n) e^{-j 2\pi kn/N}$$

where $k = 0, 1, 2, 3$

& $N = 4$

$$\text{So, } F[k] = \sum_{n=0}^{3} f(n) e^{-j 2\pi kn/4}$$

$$= f(0) e^{\cdot} + f(1) e^{-j 2\pi k/4} + f(2) e^{-j \pi k} + f(3) e^{-j 3\pi k/4_2}$$

$$= 1 + 0 + 0 + 1 \times e^{-j 3\pi k/2}$$

$$F[k] = 1 + e^{-j 3\pi k/2}$$

Now

$$f = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 1 & 0 & 2 & 3 \\ 1 & 4 & 5 & 5 \\ -3 & 4 & 5 & 5 \\ 6 & 4 & 7 & 7 \end{bmatrix}$$

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$$F = T f T$$

$$= \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 & 4 \\ 1 & 0 & 2 & 3 \\ 3 & 4 & 5 & 5 \\ 6 & 4 & 7 & 2 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix}$$

$$= \begin{bmatrix} 11 & 10 & 12 & 12 \\ 5j-2 & 4j-2 & 5j-2 & -3j-1 \\ -3 & 2 & -1 & 6 \\ -5j-2 & -4j-2 & -5j-2 & 3j-1 \end{bmatrix} \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix}$$

$$= \begin{bmatrix} 50 & -22j-6 & 6 & 10j+28 \\ 11j-7 & -j(-3j-1)-j(4j-2) & 9j-1 & j(4j-2)-21j-7 \\ 4 & -8j-2 & -12 & -j(-4j-2) \\ -11j-7 & -j(-4j-2)-j(3j-1) & -9j-1 & +21j-7 \end{bmatrix}$$