Question 6 .

Original Image :

After taking FFT twice :

Observation : The image is inverted.

Explanation :

Date:

The original Signal is $X[n]$

First take the FFT.

$$X_k = \sum_{n=0}^{N-1} x(n) \, e^{\frac{-2\pi k n j}{N}}$$

let $e^{-\frac{2\pi j}{N}} = W$.

$$X_k = \sum_{n=0}^{N-1} x[n] \, W^{kn}$$

Now take the FFT in frequency domain

$$Y[n_1] = \sum_{k=0}^{N-1} X_k \, e \, W^{n_1 k}$$

$$= \sum_{k=0}^{N-1} \sum_{n=0}^{N-1} x[n] \, W^{(n_1+n)k}$$

$$\Rightarrow \sum_{n=0}^{N-1} \left[x[n] \sum_{k=0}^{N-1} W^{(n_1+n)k} \right]$$

when $(n_1+n) \bmod N = 0$ $\sum_{k=0}^{N-1} W^{(n_1+n_2)k} = N.$

other wise

$$\sum_{k=0}^{N-1} W^{(n_1+n_2)k} = 0.$$

$$\therefore \text{we get} \quad Y(n_1) = X[N-n_1]$$

This is the reason we get inverted image

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Correction :

In frequency domain we can take the conjugate of the fft and then find the next fft , then we get

the original image back .