# Gate 2022 EC Q55

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For a vector $\bar{x} = [x[0], x[1], \dots, x[7]]$, the 8-point discrete Fourier transform (DFT) is denoted by $\bar{X} = \text{DFT}(\bar{x}) = [X[0], X[1], \dots, X[7]]$, where

$$X[k] = \sum_{n=0}^{7} x[n] \exp\left(-j\frac{2\pi}{8}nk\right).$$

Here $j = \sqrt{-1}$. If $\bar{x} = [1, 0, 0, 0, 2, 0, 0, 0]$ and $\bar{y} = \text{DFT}(\text{DFT}(\bar{x}))$, then the value of $y[0]$ is

**Solution:**

| Parameter | Description | Value |
|---|---|---|
| $\bar{X}$ | DFT($\bar{x}$) | − |
| $\bar{x}$ | vector | $[1, 0, 0, 0, 2, 0, 0, 0]$ |
| $\bar{y}$ | DFT(DFT($\bar{x}$)) | − |

TABLE 0

GIVEN PARAMETERS

DFT of $\bar{x}$

$$X[k] = \sum_{n=0}^{7} x[n] \exp\left(-j\frac{2\pi}{8}nk\right) \tag{1}$$

As the only non-zero values in x are x[0] and x[4]:

$$X[k] = x[0] + x[4] \exp\left(-j\pi k\right) \tag{2}$$

After substituting the values of k ranging from0 to 7,

$$\bar{X} = \text{DFT}(\bar{x}) = [X[0], X[1], \dots, X[7]] \tag{3}$$

$$\bar{X} = [3, -1, 3, -1, 3, -1, 3, -1] \tag{4}$$

$$\bar{y} = \text{DFT}(\text{DFT}(\bar{x})) \tag{5}$$

$$\bar{y} = [3, -1, 3, -1, 3, -1, 3, -1] \tag{6}$$

$$y[0] = \sum_{n=0}^{7} x[n] \tag{7}$$

$$= x[0] + x[1] + \cdots + x[7] \tag{8}$$

$$= 3 - 1 + 3 - 1 + 3 - 1 + 3 - 1 = 8 \tag{9}$$