SNS COLLEGE OF ENGINEERING

(Autonomous)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

UNIT- I

Discrete Fourier Transform

Introduction to IDFT

Discrete Fourier Transform:

$$DFT\{x(n)\} = X(k) = \sum_{n=0}^{N-1} x(n) \cdot e^{\frac{-j2\pi kn}{N}}; \quad k = 0, 1, \ldots N-1$$

Inverse Discrete Fourier Transform:

$$IDFT\{X(k)\} = x(n) = \frac{1}{N} \sum_{k=0}^{N-1} X(k) \cdot e^{\frac{j2\pi kn}{N}};$$

$$n = 0, 1, \ldots N-1$$

Find the IDFT of $X(k) = \{1, 0, 1, 0\}$

Sol:

IDFT :

$$x(n) = \frac{1}{N}\sum_{k=0}^{N-1} X(k) \cdot e^{\frac{j2\pi kn}{N}}, \text{ where } n = 0, 1 \ldots N-1$$

Here, $X(k) = \{1, 0, 1, 0\}$

$\boxed{N = 4}$

$$x(n) = \frac{1}{4}\sum_{k=0}^{3} X(k)\, e^{\frac{j2\pi kn}{4}}$$

$$x(n) = \frac{1}{4}\left[X(0) \cdot e^{0} + X(1)\, e^{\frac{j2\pi n}{4}} + X(2)\, e^{\frac{j2\pi 2n}{4}} + X(3)\, e^{\frac{j2\pi 3n}{4}}\right]$$

$$x(n) = \frac{1}{4}\left[X(0) \cdot e^{0} + X(1)\, e^{\frac{j\pi n}{2}} + X(2)\, e^{j\pi n} + X(3)\, e^{\frac{j\pi 3n}{2}}\right]$$

$n = 0, 1, 2, 3.$

$$x(0) = \frac{1}{4}\left[1 \cdot 1 + 0 \cdot e^{\frac{j\pi 0}{2}} + 1 \cdot e^{j\pi 0} + 0 \cdot e^{\frac{j3\pi 0}{2}}\right].$$

$$= \frac{1}{4}[1+1]$$

$$= \frac{2}{4}$$

$$= 2.$$

$X(0) = 1, X(1) = 0, X(2) = 1, X(3) = 0.$

$$= \frac{1}{4}\left[1 \cdot 1 + 0 + 1 \cdot e^{j\pi n} + 0\right].$$

$$x(n) = \frac{1}{4}\left[1 + \cos \pi n + j \sin \pi n\right].$$

$n = 0, 1, 2, 3$

$$x(0) = \frac{1}{4}\left[1 + \cos 0 + j \sin 0\right].$$

$$= \frac{1}{4}[1+1] = \frac{1}{\cancel{4}_2} \cancel{2} = \frac{1}{2}.$$

$$x(1) = \frac{1}{4}\left[1 + \cos \pi + j \sin \pi\right]$$

$$= \frac{1}{4}[1 + -1 + 0]$$

$$= 0$$

$$x(2) = \frac{1}{4}\left[1 + \cos 2\pi - j \sin 2\pi\right]$$

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$$\frac{1}{4}[1+1]$$

$$x(2) = 1/2 .$$

$$x(3) = \frac{1}{4}[1+\cos 3\pi - j\sin 3\pi]$$

$$= \frac{1}{4}[1-1]$$

$$x(3) = 0 .$$

ANSWER:

$$x(n) = \{1/2, 0, 1/2, 0\}.$$

Thank You!