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QUIZ 2

1. Derive the DFT of the sample data sequence $x(n) = \{1, 2, 1, 0\}$ and compute the responding amplitude and phase spectrum.

The N-point DFT of a finite duration sequence $x(n)$ is defined as

$$X[k] = \sum_{n=0}^{N-1} x[n] e^{-j2\pi nk/N} \quad , k = 0, 1, 2, \ldots N-1$$

① for $k = 0$

$$X[0] = \sum_{n=0}^{3} x(n) e^{-j\pi(0)n/4}$$

$$= \sum_{n=0}^{3} x(n) = 1 + 2 + 1 + 0 = 4$$

② for $k = 1$

$$X[1] = \sum_{n=0}^{3} x(n) e^{-j2\pi(1)n/4}$$

$$= \sum_{n=0}^{3} x(n) e^{-j\pi n/2}$$

$$= 1 + 2e^{-j1\pi/2} + 1e^{-j2\pi/2} + 0$$

$$= 1 + 2e^{-j\pi/2} + 1e^{-j3\pi/2}$$

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(2) for $k=2$

$$x[2] = \sum_{0}^{3} x(n)e^{-j2\pi(2)n/4}$$

$$= 1 + 2e^{-j2\pi/2} + 1e^{-j3\pi/2}$$

$$= 1 + 2e^{-j\pi} + 1e^{-j\frac{3}{2}\pi}$$

(3) for $k=3$

$$x[3] = 1 + 2e^{-j3\pi/2} + 1e^{-j4\pi/2}$$

$$= 1 + 2e^{-j\frac{3\pi}{2}} + 1e^{-j2\pi}$$

Amplitude spectrum

$$x(k) = \{\sqrt{4+4}, \sqrt{1+2e^{-j/2}+1e^{-j3\pi/2}}, \sqrt{1+2e^{-j\pi}+1e^{-j\frac{3}{2}\pi}}, \sqrt{1+2e^{-j\frac{3\pi}{2}}+1e^{-j2\pi}} + 0$$

Phase spectrum

convert rectangular form

$$\angle x(k) = \{\tan^{-1}(0), \tan^{-1}\left(\frac{2e^{-j/2}+1e^{-j3\pi/2}}{1}\right), \tan^{-1}\left(\frac{2e^{-j\pi}+e^{-j\frac{3}{2}\pi}}{1}\right),$$

$$\tan^{-1}\left(\frac{2e^{-j\frac{3\pi}{2}}+1e^{-j2\pi}}{1}\right)$$

$$= \{0, -\frac{\pi}{3}, -\frac{\pi}{6}, 0\}$$

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