7. Discrete Fourier Transform

Multiple Choice Questions

Q.1 The first six points of the 8-point DFT of a real valued sequence are 5, $1 - j3$, 0, $3 - j4$, and $3 + j4$. The last two points of the DFT are respectively

(a) 0, $1 - j3$
(b) 0, $1 + j3$
(c) $1 + j3$, 5
(d) $1 - j3$, 5

[GATE-2011]

Q.2 The DFT of a vector [a b c d] is the vector [α β γ δ]. Consider the product

$$[p \ q \ r \ s] = [a \ b \ c \ d] \begin{bmatrix} a & b & c & d \\ d & a & b & c \\ c & d & a & b \\ b & c & d & a \end{bmatrix}$$

The DFT of the vector [p q r s] is a scaled version of

(a) $\begin{bmatrix} \alpha^2 & \beta^2 & \gamma^2 & \delta^2 \end{bmatrix}$

(b) $\begin{bmatrix} \sqrt{\alpha} & \sqrt{\beta} & \sqrt{\gamma} & \sqrt{\delta} \end{bmatrix}$

(c) $\begin{bmatrix} \alpha + \beta & \beta + \delta & \delta + \gamma & \gamma + \alpha \end{bmatrix}$

(d) $\begin{bmatrix} \alpha & \beta & \gamma & \delta \end{bmatrix}$

[GATE-2013]

Q.3 The N-point DFT of a sequence $x[n]$, $0 \le n \le N-1$ is given by

$$X[K] = \frac{1}{\sqrt{N}} \sum_{n=0}^{N-1} x[n] e^{-j\frac{2\pi}{N}nK}, \quad 0 \le K \le N-1.$$

Denote this relation as X = DFT (x). For N = 4, which one of the following sequences satisfies DFT (DFT (x)) = x.

(a) $x = [1 \ 2 \ 3 \ 4]$
(b) $x = [1 \ 2 \ 3 \ 2]$
(c) $x = [1 \ 3 \ 2 \ 2]$
(d) $x = [1 \ 2 \ 2 \ 3]$

[GATE-2014]

Numerical Data Type Questions

Q.4 The DFT of a real valued signal $x[n]$ is given as {6, 1 + 2j, A, 3 + j, –3, B, 4 + 2j, C}
The value of the auto correlation function $x[n]$ at origin is _____.

Q.5 If twiddle factor $W_N = e^{-j2\pi/N}$, then the value of
$$W_6^{31} + W_6^{35} = \underline{\quad}?$$

Try Yourself

T1. The DFT of a vector [a b c d] is the vector [1 3 5 8] then the value of vector defined as
$$\bar{k} = DFT\{[a \ b \ c \ d] \otimes [a \ b \ c \ d]\}$$
is (where ⊗ denotes circular convolution).

(a) [1 3 5 8]
(b) [2 6 10 16]
(c) [1 9 25 64]
(d) [1 + 3j 3 + 5j 5 + 8j 8 + j]

[Ans. (c)]

T2. The 4-point DFT of $x[n] = \begin{cases} \dfrac{1}{3}; & 0 \le n \le 2 \\ 0; & \text{elsewhere} \end{cases}$ is

(a) $X[k] = \left\{ 1, \dfrac{-j}{3}, \dfrac{1}{3}, \dfrac{j}{3} \right\}$

(b) $X[k] = \left\{1, \dfrac{j}{3}, \dfrac{1}{3}, \dfrac{-j}{3}\right\}$

(c) $X[k] = \left\{1, \dfrac{1}{3}, \dfrac{j}{3}, \dfrac{-j}{3}\right\}$

(d) $X[k] = \left\{1, \dfrac{-1}{3}, \dfrac{-j}{3}, \dfrac{j}{3}\right\}$

[Ans. (a)]

T3. Assume that a complex multiplication takes 1 µsec and that the amount of time to complete a DFT or FFT is determined by the amount of time it takes to perform all the complex multiplications. The time required to compute 1024 point DFT with radix-2 FFT algorithm is

(a) 10.24 msec   (b) 5.12 msec

(c) 10 msec   (d) 5 msec

[Ans. (b)]

T4. Let a discrete time signal be given as $x[n]$ with its DFT $X[k]$, then DFT of circular time shifted sequence $\{x[n + M]_N\}$ can be expressed as

(a) $X(k)e^{\frac{-j2\pi kM}{N}}$ (b) $X(k)e^{\frac{-j2\pi k}{MN}}$

(c) $X(k)e^{\frac{j2\pi kM}{N}}$ (d) $X(k)e^{\frac{j\pi k}{MN}}$

[Ans. (c)]

T5. An 8-point Discrete Fourier transform of a real discrete time signal $x[n]$ is given as

$$X_{DFT}[k] = \left\{1, 2, a, b, 0, 1 - j, -2, c\right\}$$

Then the value of $a =$ _____.

[Ans. –2]

T6. The first six points of the 8-point DFT of a real valued sequence are 5, 1 – j3, 0, 3 – j4, and 3 + j4. The last two points of the DFT are respectively

(a) 0, 1 – j3   (b) 0, 1 + j3

(c) 1 + j3, 5   (d) 1 – j3, 5

[Ans:(b)]

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