Madan Mohan Malaviya University Of Technology, Gorakhpur

Electronics and Communication Engineering Department

DIGITAL SIGNAL PROCESSING (BEC-303)

TUTORIAL - UNIT-I

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1. Discuss different type of elementary discrete-time signals.
2. Discuss about the different classed of discrete-time systems.
3. Discuss the frequency-domain sampling and reconstruction of discrete-time signals.
4. Define the Discrete Fourier Transform (DFT) and Inverse Discrete Fourier Transform (IDFT).
5. What are 'twiddle factors' of the DFT?
6. Discuss in detail about the following properties of DFT.
   (a) Periodicity
   (b) Linearity
   (c) Shifting Property
   (d) Convolution Theorem
   (e) Time Reversal of a Sequence
   (f) Circular Time Shift
   (g) Circular Frequency Shift
   (h) Complex Conjugate Property
   (i) Circular Convolution
   (j) Circular Correlation
   (k) Multiplication of Two Sequences
   (l) Parseval's Theorem
7. Find the 4-point DFT of the sequence $x(n) = cos\frac{n\pi}{4}$.
8. Find the inverse DFT of $X(k) = \{1, 2, 3, 4\}$.
9. Determine the IDFT of $X(k) = \{3, (2 + j), 1, (2 - j)\}$.
10. Distinguish between linear and circular convolutions of two sequences.
11. Compute (a) linear and (b) circular periodic convolutions of the two sequences $x_1(n) = \{1, 1, 2, 2\}$ and $x_2(n) = \{1, 2, 3, 4\}$. (c) Also find circular convolution using the DFT and IDFT
12. Perform the circular convolution of the following two sequences:
$$x_1(n) = \{\underset{\uparrow}{2}, 1, 2, 1\}$$
$$x_2(n) = \{\underset{\uparrow}{1}, 2, 3, 4\}$$
13. Use the four-point DFT and IDFT to determine the sequence : $x_3(n) = x_1(n) \textcircled{N} x_2(n)$, where $x_1(n)$ and $x_2(n)$ are the sequence given in Problem 12.
14. The first five points of the eight-point DFT of a real-valued sequence are $\{0.25, 0.125 - j0.3018, 0, 0.125 - j0.0518, 0\}$. Determine the remaining three points.
15. Given $x(n) = \{1, 2, 3, 4, 4, 3, 21\}$, find $X(k)$ using DIT FFT algorithm.
16. Given $x(n) = \{0, 1, 2, 3, 4, 5, 6, 7\}$, find $X(k)$ using DIT FFT algorithm.
17. Given $x(n) = \{0, 1, 2, 3\}$, find $X(k)$ using DIT FFT algorithm.
18. Given $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$, find $X(k)$ using DIF FFT algorithm.
19. Given $x(n) = 2^n$ and $N = 8$, find $X(k)$ using DIF FFT algorithm.
20. Use the 4−point inverse FFT and verify the DFT results $\{6, -2 + j2, -2, -2 - j2\}$ obtained for the given input sequence $\{0, 1, 2, 3\}$.
21. Given $X(k) = \{20, -5.828 - j2.414, 0, -0.172 - j0.414, 0, -0.172 + j0.414, 0, -5.828 + j2.414\}$, find $x(n)$.
22. Draw the butterfly line diagram for 8-point FFT calculation and briefly explain. Use decimation-in-time.

23. Draw the butterfly line diagram for 8-point FFT calculation and briefly explain. Use decimation-in-frequency.

24. Compute the eight-point DFT of the sequence

$$x(n) = \begin{cases} 1 & \text{for} \quad 0 \leq n \leq 7 \\ 0 & \text{otherwise} \end{cases}$$

by using the decimation-in-frequency FFT algorithm.

25. Derive the signal flow graph for the $N = 16-$point, radix-4 decimation-in-time FFT algorithm in which the input sequence is in normal order and the computations are done in place.

26. Compute the eight-point DFT of the sequence$x(n) = \{\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, 0, 0, 0, 0\}$ using the in-place radix-2 decimation-in-time and radix-2 decimation-in-frequency algorithms. Follow exactly the corresponding signal flow graphs and keep track of all the intermediate quantities by putting them on the diagrams.

27. Compute the 16$-$point DFT of the sequence $x(n) = cos\frac{\pi}{2}n, 0 \leq n \leq 15$ using the radix-4 decimation-in-time algorithm.

28. Find the DTFT of a sequence $x(n) = a^n u(n)$

29. Distinguish between DIT and DIF-FFT algorithm.

30. If $H(k)$ is the $N-$point DFT of a sequence $h(n)$, Prove that $H(K)$ and $H(N-k)$ are complex conjugates.