

BTECH
(SEM V) THEORY EXAMINATION 2022-23
DIGITAL SIGNAL PROCESSING

Time: 3 Hours

Total Marks: 100

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt all questions in brief. 2 x 10 = 20

- a. Determine the linear convolution of the sequences
 $x_1(n) = \{1, 2, 3, 4\}$ and $x_2(n) = \{1, 1, 2, 2\}$
- b. If $x(n) = \{4, -2, 4, -6\}$ find and sketch its odd and even parts with $-2 \leq n \leq 1$.
- c. Give the statement of Nyquist Sampling Theorem.
- d. With the help of block diagram illustrate the process of analog to digital conversion.
- e. Define the properties of convolution in an LTI system.
- f. Illustrate Twiddle factor and its two properties.
- g. Differentiate between FIR and IIR filters with example.
- h. Define frequency warping in Bilinear Transformation method for IIR filter.
- i. Illustrate the symmetry property and periodicity property of phase factor W_N used for FFT.
- j. Compute the DFTs of sequence $x(n) = \cos(n\pi/2)$, where $N=4$, using DIF FFT algorithm.

SECTION B

2. Attempt any three of the following: 10 x 3 = 30

- a. (i) Check whether the following discrete time system is static/dynamic, linear/Non-linear, Shift invariant/variant.
 $y(n) = e^{x(n)}$
 (ii) Check the stability of filter for $H(Z) = \frac{Z^2 - Z + 1}{Z^2 - Z + \frac{1}{2}}$
- b. Explain discrete time processing of continuous time signal with the help of block diagram.
- c. Determine the impulse response for the system given by following difference equation.
 $y(n) = x(n) + 3x(n-1) - 4x(n-2) + 2x(n-3)$
- d. Explain IIR filter design by bilinear transformation technique. Convert the analog filter into a digital filter whose system function is

$$H(s) = \frac{S + 0.2}{(S + 0.2)^2 + 9}$$
 Use the impulse invariant technique. Assume $T=1$ Sec.
- e. Differentiate between Wavelet Transform and Fourier Transform and also give the applications of Wavelet cosine transform.

SECTION C

3. Attempt any one part of the following: **10 x 1 = 10**

- a. (i) Consider a LTI system with unit sample response.

$$h(n) = \begin{cases} a^n & n \geq 0, \quad |a| < 1 \\ 0 & n < 0 \end{cases}$$

Find the response to an input of $x(n) = U(n) - U(n - N)$

- (ii) Check whether the following system is linear & time invariant.

$$F[x(n)] = a[x(n)]^2 + bx(n)$$

- b. Explain any two IIR filter realization methods with suitable example.

4. Attempt any one part of the following: **10 x 1 = 10**

- a. Derive the expression for sampling theorem and also explain Aliasing.
b. Explain multirate signal processing in detail.

5. Attempt any one part of the following: **10 x 1 = 10**

- a. Compute circular convolution of the following using graphical method and verify the result using DFT and IDFT.

$$x_1(n) = \begin{bmatrix} \underset{\uparrow}{1}, 2, 3, 4 \end{bmatrix} \quad x_2(n) = \begin{bmatrix} \underset{\uparrow}{1}, 1, 2, 2 \end{bmatrix}$$

- b. Determine the magnitude & phase responses for the system characterized by the difference equation

$$y(n) + \frac{1}{2}y(n-1) = x(n) - x(n-1)$$

6. Attempt any one part of the following: **10 x 1 = 10**

- a. A low pass filter is to be designed with following desired frequency response.

$$h_d(e^{j\omega}) = \begin{cases} e^{-j2\omega}, & -\frac{\pi}{4} \leq \omega \leq \frac{\pi}{4} \\ 0 & \frac{\pi}{4} < |\omega| \leq \pi \end{cases}$$

Determine the filter coefficients $h_d(n)$ if the window function is defined as.

$$w(n) = \begin{cases} 1 & 0 \leq n \leq 4 \\ 0 & \text{otherwise} \end{cases}$$

Also determine the frequency response $H(e^{j\omega})$ of the designed filter.

- b. Determine $H(z)$ for a Butterworth filter satisfying the following constraints

$$\begin{aligned} \sqrt{0.5} &\leq |H(e^{j\omega})| \leq 1 & 0 \leq \omega \leq \pi/2 \\ |H(e^{j\omega})| &\leq 0.2 & 3\pi/4 \leq \omega \leq \pi \end{aligned}$$

With $T=1$ sec. Apply impulse invariant transformation method.

7. Attempt any one part of the following: **10 x 1 = 10**

- a. Draw the flow graph for the implementation of 8-point DIT FFT of the following sequence
 $x(n) = \{1, 2, 3, 4, 4, 3, 2, 1\}$
b. Explain radix-2 DIT-FFT algorithm. Compare it with DIF-FFT algorithm.