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Roll No.

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 $H(Z)=\dfrac{Z^2-Z+1}{Z^2-Z+\frac{1}{2}}$

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.

$$h(n) = a^n \quad n \geq 0, \quad |a| < 1$$
$$0 \quad n < 0$$

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.

$$x_1(n) = \left[\underset{\uparrow}{1}, 2, 3, 4\right] \qquad x_2(n) = \left[\underset{\uparrow}{1}, 1, 2, 2\right]$$

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.

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

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

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

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.