CBCS SCHEME

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15EC52

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Digital Signal Processing

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Describe the process of frequency domain sampling and reconstruction of discrete time signals. **(10 Marks)**

b. Using linearity property find the DFT of the sequence $x(n) = \cos\left(\frac{\pi n}{4}\right) + \sin\left(\frac{\pi}{2}n\right)$ consider N =4. **(06 Marks)**

OR

2 a. State and prove the i) circular time shift ii) circular time reversal properties of DFT. **(08 Marks)**

b. Solve by concentric circle or graphical method to find circular convolution $x(n) = \{1, 3, 5, 3\}$ and $h(n) = \{2, 3, 1, 1\}$. **(04 Marks)**

c. Derive the expression for the relationship of DFT with Z – transforms. **(04 Marks)**

Module-2

3 a. State and prove the following properties of phase factor ω_N.
i) periodicity
ii) symmetry. **(04 Marks)**

b. Find the output y(n) of a filter whose impulse suppose $h(n) = \{1, 2, 3, 4\}$ and input signal to the filter is $x(n) = \{1, 2, 1, -1, 3, 0, 5, 6, 2, -2, -5, -6, 7, 1, 2, 0, 1\}$ using overlap – add method with 6-point circular convolution. **(12 Marks)**

OR

4 a. In the direct computation of N-point DFT of x(n), how many :
i) Complex additions
ii) Complex multiplications
iii) Real multiplication
iv) Real additions
v) Trigonometric functions

Evaluations are required? **(06 Marks)**

b. Explain the linear filtering of long data sequences using overlap – save method. **(10 Marks)**

Module-3

5 a. Find the DFT of the sequence using decimation in time FFT algorithm and draw the flow graph indicating the intermediate values in the flow graph.
$x(n) = \{1, -1, -1, -1, 1, 1, 1, -1\}$. **(08 Marks)**

b. Derive the computational arrangement of 8-point DFT using radix – 2 DIF-FFT algorithm. **(08 Marks)**

OR

6 a. What is Goertzel algorithm? Obtain direct form–II realization of second order goertzel filter. **(08 Marks)**

b. Find the IDFT of the sequence using DIF-FFT algorithm :
$X(k) = \{0, 2\sqrt{2}(1-j), 0, 0, 0, 0, 2\sqrt{2}(1+j)$. **(08 Marks)**

Module-4

7 a. Obtain the direct form I, direct form II, cascade and parallel form realization for the following system. $y(n) = 0.75y(n-1) - 0.125y(n-2) + 6x(n) + 7x(n-1) + x(n-2)$. **(08 Marks)**

b. Realize the system given by the difference equation :
$y(n) = -0.1y(n-1) + 0.72y(n-2) + 0.7x(n) - 0.252\,x(n-2)$
Use parallel form. Is this system stable? Determine its impulse response. **(08 Marks)**

OR

8 a. Design an IIR digital filter that when used in the prefilter A/D – H(z) – D/A structure will SATISFY the following equivalent along specifications. **(10 Marks)**
i) LPF with –1dB cutoff at 100π rad/sec
ii) Stopband attenuation of 35dB or greater at 1000π rad/sec.
iii) Monotonic stop band and pass band
iv) Sampling rate of 2000 samples/sec.

b. Obtain H(z) using impulse invariance method for the following analog filter 5Hz sampling frequency $H_a(S) = \dfrac{2}{(S+1)(s+2)}$. **(06 Marks)**

Module-5

9 a. A linear time – invariant digital IIR filter is specified by the following transfer function :

$$H(z) = \frac{(z-1)(z-2)(z+1)z}{\left[z-\left(\tfrac{1}{2}+\tfrac{1}{2}j\right)\right]\left[z-\left(\tfrac{1}{2}-j\tfrac{1}{2}\right)\right]\left[z-j\tfrac{1}{4}\right]\left[z+j\tfrac{1}{4}\right]}$$

Realize the system in the following forms : i) direct form – I ii) Direct form –II. **(12 Marks)**

b. Obtain a cascade realization for the system function given below :

$$H(z) = \frac{\left(1+z^{-1}\right)^3}{\left(1-\tfrac{1}{4}z^{-1}\right)\left(1-z^{-1}+\tfrac{1}{2}z^{-2}\right)}.$$ **(04 Marks)**

OR

10 a. Explain the following terms :
i) Rectangular window
ii) Bartlett window
iii) Hamming window. **(08 Marks)**

b. A filter is to be designed with the following desired frequency response :

$$H_d(\omega) = \begin{cases} 0, & -\tfrac{\pi}{4} < \omega < \tfrac{\pi}{4} \\ e^{-j2\omega}, & \tfrac{\pi}{4} < |\omega| < \pi \end{cases}$$

Find the frequency response of the FIR filter designed using rectangular window defined below :

$$\omega_R(n) = \begin{cases} 1, & 0 \le n \le 4 \\ 0, & \text{otherwise} \end{cases}.$$ **(08 Marks)**

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