CBCS SCHEME

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17EC52

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Digital Signal Processing

Time: 3 hrs. Max. Marks: 100

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

Module-1

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

b. Compute circular convolution of two sequences, $x_1(n) = \{1, 2, 3, 4\}$ and $x_2(n) = \{1, -1, 3, 2\}$, using DFT-IDFT method. **(06 Marks)**

c. Compute 16-point DFT of the sequence $x(n) = 8,\ 0 \le n \le 15$. **(04 Marks)**

OR

2 a. Compute N-point DFT of the sequence $x(n) = \sin\left(\frac{2\pi K_0 \eta}{N}\right),\ 0 \le n \le N-1$. **(08 Marks)**

b. Compute DFT of the sequence $x(n) = \sin\left(\frac{3\pi n}{4}\right) + \cos\left(\frac{\pi n}{4}\right),\ 0 \le n \le 3$, using linearity property of DFT. **(06 Marks)**

c. Derive the relationship between DFT and DTFS coefficients. **(06 Marks)**

Module-2

3 a. The 4-point DFT of a length-4 sequence x(n) is given by X(k) = {8, -1+j, -2, -1-j}. Obtain y(k), the 4-point DFT of the sequence $y(n) = e^{\frac{-j\pi n}{2}} x((n-1))_4$. **(05 Marks)**

b. Given a sequence x(n) = {1, -1, 2, -2}, determine DFT{DFT{DFT{DFT{x(n)}}}}, using complex conjugate properties of DFT. **(07 Marks)**

c. Determine the filter output y(n), whose impulse response h(n) = {1, -1, 2} and input x(n) = {1, 4, 3, 2, 1, -1, 2, 1, 5, 3, 2, 4}, using overlap-save method. Consider 8-point circular convolution approach. **(08 Marks)**

OR

4 a. The 4-point DFT of a sequence x(n) is given by x(k) = {16, -4+j4, -4, -4-j4}. Determine the energy of x(n) using Parseval's theorem. **(04 Marks)**

b. The IDFT {x(k)} is given by x(n) = {1, 2, 3, 4}. Determine IDFT of the following sequences: i) x(4-k) ii) j^k x(k) iii) Re{x(k)} iv) Im {x(k)} **(10 Marks)**

c. Discuss the need of FFT algorithms for computation of DFT. **(06 Marks)**

Module-3

5 a. Compute 8-point DFT of the sequence x(n) = {0.707, 0, -0.707, -1, -0.707, 0, 0.707, 1} using DIT-FFT algorithm. **(08 Marks)**

b. Starting from the expression of Z-transform of an N-point sequence x(n), derive chirp z-transform algorithm. **(08 Marks)**

c. Mention the similarities and differences between DIT-FFT and DIF-FFT algorithm. **(04 Marks)**

OR

6 a. Develop the radix-2 DIF-FFT algorithm for N = 8 and draw the signal flow graph. **(10 Marks)**

b. Given x(n) = {1, 2, 3, -1}, obtain x(1) using Goertzel algorithm and also explain Goertzel Algorithm. **(10 Marks)**

Module-4

7 a. Obtain a parallel realization for the transfer function H(z) given below:

$$H(z) = \frac{8z^3 - 4z^2 + 11z - 2}{\left(z - \frac{1}{4}\right)\left(z^2 - z + \frac{1}{2}\right)}$$ **(06 Marks)**

b. Derive an expression for order and cut-off frequency of low-pass Butterworth filter. **(08 Marks)**

c. Transform the analog filter,

$$H_a(s) = \frac{s+1}{s^2 + 5s + 6}$$

into digital filter, H(z) using impulse invariant transformation. Consider T = 0.1 sec. **(06 Marks)**

OR

8 a. Design a digital filter H(z) that when used in A/D – H(z) – D/A structure gives an equivalent analog filter with the following specifications: Passband attenuation ≤ 3.01dB, Passband edge frequency = 500Hz, Stopband attenuation ≥15dB, Stopband edge frequency = 750Hz and sampling rate = 2kHz. The filter is to be designed by performing bilinear transformation on Butterworth analog filter. **(12 Marks)**

b. A linear time-invariant digital IIR filter is specified by the transfer function,

$$H(z) = \frac{(z^2 - 1)(z^2 - 2z)}{\left(z^2 + \frac{1}{16}\right)\left(z^2 - z + \frac{1}{2}\right)}$$

Obtain direct form-I and direct form-II realizations of the system. **(08 Marks)**

Module-5

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

$$H_d(w) = \begin{cases} 0, & |w| < \pi/4 \\ e^{-j2w}, & \pi/4 < |w| < \pi \end{cases}$$

Find the frequency response of the FIR filter designed using rectangular window. **(10 Marks)**

b. Given the FIR filter with the following difference equation:

y(n) = x(n) + 3.1x(n-1) + 5.5x(n-2) + 4.2x(n-3) + 2.3x(n-4)

Sketch the lattice realization of the filter. **(10 Marks)**

OR

10 a. The frequency response of an ideal band pass filter is given by;

$$H_d(w) = \begin{cases} e^{-j3w}, & 1 < |w| < 2 \\ 0, & |w| < 1 \text{ or } 2 < |w| < \pi \end{cases}$$

Design an FIR bandpass filter which approximates the above filter, using Hamming window. **(10 Marks)**

b. Realize the linear-phase FIR filter having the following impulse response:

$$h(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2) + \frac{1}{4}\delta(n-3) + \delta(n-4)$$ **(05 Marks)**

c. Realize an FIR filter with impulse response h(n) given by, $h(n) = \left(\frac{1}{2}\right)^n [u(n) - u(n-4)]$, using direct form-I. **(05 Marks)**