CBCS SCHEME

USN

17EC52

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
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. Compute the N point DFT of the given sequence.

$x(n) = \frac{\cos 2\pi}{N} K_o n \quad 0 \le n \le N-1.$ **(05 Marks)**

b. State and prove the circular frequency shift property of DFT. **(05 Marks)**

c. G(k) and H(k) are the 6 point DFTs of sequence g(n) and h(n) respectively. The DFT G(k) is given as

$G(k) = \{1 + j, -2.1 + j3.2, -1.2 - j2.4, 0, 0.9 + j3.1, -0.3 + j1.1\}$

The sequence g(n) and h(n) are related by the circular time shift as $h(n) = g((n-4))_6$. Determine H(k), without computing the DFT. **(10 Marks)**

OR

2 a. Let x(n) be the sequence, $x(n) = \delta(n) + 2\delta(n-2) + \delta(n-3)$.

i) Find the 4 point DFT of x(n).

ii) If y(n) is the 4-point circular convolution of x(n) with it self, find y(n) and four point DFT Y(K). **(10 Marks)**

b. Given the sequence $x_1(n) = \{1, 2, 3, 1\}$ and $x_2(n) = \{4, 3, 2, 2\}$. Find y(n) such that $Y(K) = X_1(K) . X_2(K)$. **(05 Marks)**

c. The even samples of the 11-point DFT of length – 11 real sequence are given by X(0) = 4, X(2) = -1 + j3, X(4) = 2 + j5, X(6) = 9 – j6, X(8) = -5 – j8 and X(10) = $\sqrt{3}$ - j2. Determine the missing odd samples of the DFT. **(05 Marks)**

Module-2

3 a. Compute y(n) of the filter whose impulse response is h(n) = (3, 2, 1, 1) and input is given by x(n) = {1, 2, 3, 3, 2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1}. Use overlap save method. Assume the length of the block is 9. **(10 Marks)**

b. Let X(K) be a 14-point DFT of a length 14 real sequence x(n). The first 8 samples of X(K) are given by

X(0) = 12, X(1) = -1 + j3, X(2) = 3 + j4, X(3) = 1 – j5, X(4) = -2 + j2, X(5) = 6 + j3, X(6) = -2 – j3, X(7) = 10. Determine the remaining samples of X(K). Also evaluate the following functions without computing the IDFT.

i) x(0) ii) x(7) iii) $\sum_{n=0}^{13} x(n)$ iv) $\sum_{n=0}^{13} |x(n)|^2$. **(10 Marks)**

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.

OR

4 a. Compute the speed improvement factor in calculating 64 point DFT of a sequence using direct computations and FFT algorithms. **(05 Marks)**

b. Find the 4 point DFT of the sequence x(n) = {2 + j2, -3 + j1, 2 + j1, -1 + j3}. Make use of this result compute the DFT of the sequence.
y(n) = {1, -1.5, 1, -0.5} and z(n) = {j4, j2, +j2, j6}. **(10 Marks)**

c. List and prove the 2 property which improves the efficiency of computation of DFT using FFT algorithm. **(05 Marks)**

Module-3

5 a. Given x(n) = n + 1 for $0 \le n \le 7$. Compute the X(K) using DIF FFT algorithm. **(12 Marks)**

b. Illustrate Chirp Z transform concept with contours for different values of r, R θ and ϕ. **(08 Marks)**

OR

6 a. If $x_1(n) = \{1, 2, 0, 1\}$ and $x_2(n) = \{1, 3, 3, 1\}$. Obtain 4-point circular convolution by using DIT-FFT algorithm. **(10 Marks)**

b. Discuss the Goertzel algorithm in computation of sparse DFT and list its advantages. **(10 Marks)**

Module-4

7 a. A digital filter is given by

$$H(z) = \frac{1 - \frac{1}{2}z^{-1}}{\left(1 - \frac{1}{3}z^{-1}\right)\left(1 - \frac{1}{4}z^{-1}\right)}$$

Obtain the parallel form structure. **(06 Marks)**

b. Design an IIR – digital filter that when used in the pre filter A/D – H(Z) – D/A structure will satisfy the following equivalent analog specifications. Use BLT.

i) LPF with -1db cut off at 100π rad/sec.
ii) Stopband attenuation of 35db or greater at 1000π rad/sec.
iii) Monotonic stopband and passband.
iv) Sampling rate of 2000 samples/sec. **(14 Marks)**

OR

8 a. Convert the following second order analog filter with system transfer function $H(S) = \frac{s+a}{(s+a)^2 + b^2}$ into a digital filter with impulse response by the use of impulse invariance mapping technique. **(08 Marks)**

b. Consider the first order LPF with passband edge frequency Ω_p having its transfer function $H_a(s) = \frac{\Omega_p}{s + \Omega_p}$. Transfer the filter to

i) LPI with passband edge frequency Ω_1.
ii) HPF with cutoff frequency Ω_2. **(06 Marks)**

c. Determine the order and magnitude squared function of the chebyshev filter for the following specifications:

i) Maximum passband ripple is 1db.
ii) Stopband attenuation is 40db for $\Omega \ge 4$ rad/sec. **(06 Marks)**

Module-5

9 a. Realize the linear phase FIR filter with the following impulse response. Give the necessary equation. $h(n) = \delta(n) + \frac{1}{2}\delta(n-1) - \frac{1}{4}\delta(n-2) + \delta(n-4) + \frac{1}{2}\delta(n-3)$. **(06 Marks)**

b. Obtain the lattice structure corresponding to the FIR filter described by the system function $H(z) = 1 + 2z^{-1} + \frac{1}{3}z^{-2}$. **(06 Marks)**

c. Design the symmetric FIR lowpass filter whose desired frequency response is $H_d(w) = \begin{cases} e^{-jw\tau} & \text{for } |w| \le W_c \\ 0 & \text{otherwise} \end{cases}$. The length of the filter should be 7 and W_c = /rad/sample. Use rectangular window. **(08 Marks)**

OR

10 a. Derive the steps involved in design of an FIR filter using window function. Also list the advantage of FIR filter. **(10 Marks)**

b. The desired frequency response of a LPF is

$$H_d(e^{jw}) = e^{-j3w} \quad \frac{-3\pi}{4} \le w \le \frac{3\pi}{4}$$
$$= 0 \quad \frac{3\pi}{4} < |w| \le \pi$$

Design it using Hamming window (N = 7). Also obtain its frequency response. **(10 Marks)**

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