CBCS SCHEME

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15EC52

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

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Module-1

1 a. Evaluate 8-point DFT of the sequence :

$$x(n) = \begin{cases} \left(\frac{1}{2}\right)^{n+1}; & -2 \le n \le 2 \\ 0 \quad ; & 3 \le n \le 5 \end{cases}$$

Also draw the magnitude and phase plots. **(12 Marks)**

b. Given $x_1(n) = \delta(n-1) - \delta(n-3)$ and $x_2(n) = \cos\left(\frac{2\pi n}{4}\right)$; $0 \le n \le 3$ perform $x_1(n) \circledast_4 x_2(n)$ using DFT – IDFT method. **(04 Marks)**

OR

2 a. Find the DFT of the sequence (N = 4) $x(n) = \{\underset{\uparrow}{0}.5, 0, 0.5, 0\}$ using Z- transforms. **(04 Marks)**

b. The first five samples of 8-point DFT X(K) are given by X(0) = 6, X(1) = –0.7071 – j1.7071, X(2) = 1 – j, X(3) = 0.7071 + j0.2929, X(4) = 0. Find the remaining samples of X(K) and hence find its time domain sequence x(n). **(10 Marks)**

c. Bring out the differences between linear convolution and circular convolution. **(02 Marks)**

Module-2

3 a. Let x(n) be a finite length sequence with $X(K) = \{\underset{\uparrow}{0}, 1+j, 1, 1-j\}$, using the properties of DFT find the DFT's of the following sequences.

i) $x_1(n) = e^{j\frac{\pi}{2}n} x(n)$

ii) $x_2(n) = \cos\{(\pi/2)n\} x(n)$

iii) $x_3(n) = x(4-n)$. **(06 Marks)**

b. Find the output of a FIR filter with impulse response $h(n) = \{\underset{\uparrow}{3}, 2, 1, 1\}$ and the input $x(n) = \{1, 2, 3, 3, 2, 1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1\}$. Use overlap add method using 7 point circular convolution. **(10 Marks)**

OR

4 a. Prove the periodicity and symmetric properties of twiddle factor. **(04 Marks)**

b. Evaluate the function $\sum_{K=0}^{15} e^{\frac{-j4\pi K}{8}} X(K)$ without computing DFT for a given 16-point sequence $x(n) = \{\underset{\uparrow}{3}, 2, 1, 0, 0, 4, -1, -2, -4, 1, 3, 2, -1, 5, 1, 4\}$. **(06 Marks)**

c. State and prove Parsaval's theorem as applied to DFT. **(06 Marks)**

Module-3

5 a. What are the total number of complex additions and multiplications required for 32-point DFT by using direct computation of DFT and by FFT methods? Also find the number of stages required, memory requirement and speed improvement factor by considering multiplication. **(07 Marks)**

b. Find the IDFT of the sequence :

$$X(K) = \{\underset{\uparrow}{36}, -4 + j9.7, -4 + j4, -4 + j1.7, -4, -4 - j1.7, -4 - j4, -4 - j9.7\}$$

Using radix -2 DIF – FFT algorithm. **(09 Marks)**

OR

6 a. Derive radix – 2 DIT –FFT algorithm and draw the complete signal flow graph for $N = 8$. **(08 Marks)**

b. Explain Goertizel algorithm and obtain the direct from II realization. **(08 Marks)**

Module-4

7 a. A digital filter has input $x(n) = \delta(n) + \frac{1}{4}\delta(n-1) - \frac{1}{8}\delta(n-2)$ and the output $y(n) = \delta(n) - \frac{3}{4}\delta(n-1)$. Realize the filter in direct form – I, direct form – II, cascade and parallel form. **(10 Marks)**

b. Given that $|H(e^{j\Omega})|^2 = \frac{1}{1 + 64\Omega^6}$, determine the analog Butterworth low pass filter transfer function. **(06 Marks)**

OR

8 a. Compare Butterworth filter with Chebychev filters. **(04Marks)**

b. Design a digital filter H(Z) that when used in an A/D – H(z) – D/A structures given an equivalent analog filter with the following specifications :

Pass band ripple : ≤ 3.01dB
Pass band edge : 500Hz
Stop band edge : 750Hz
Stop band attenuation : ≥ 15dB

Sample rate f_s = 2KHz and T = 1sec. Use bilinear transformation to design the filter on an analog system. Also obtain the difference equation. **(12Marks)**

Module-5

9 a. Determine the impulse response of a FIR filter with reflection coefficients $K_1 = 0.6$, $K_2 = 0.3$, $K_3 = 0.5$ and $K_4 = 0.9$, also draw the direct form structure. **(12 Marks)**

b. List the advantages of FIR filter over IIR filters. **(04 Marks)**

OR

10 a. Design a FIR lowpass filter with a desired frequency response

$$H_d(e^{j\omega}) = e^{-j3\omega}; \quad \frac{-3\pi}{4} \leq \omega \leq \frac{3\pi}{4}$$
$$= 0 ; \quad \frac{3\pi}{4} |\omega| < \pi$$

Use Hamming window with m = 7, also obtain the frequency response. **(10 Marks)**

b. Explain the following :
i) Rectangular window
ii) Hamming window
iii) Bartlett window. **(06 Marks)**

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