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15EC52

Fifth Semester B.E. Degree Examination, June/July 2018

Digital Signal Processing

Time: 3 hrs.

Max. Marks: 80

- Note:** 1. Answer FIVE full questions, choosing one full question from each module.
 2. Use of filter table is not permitted.

Module-1

- 1 a. Compute N-point DFT of a sequence $x(n) = \frac{1}{2} + \frac{1}{2} \cos\left(\frac{2\pi}{N}\left(n - \frac{N}{2}\right)\right)$. (08 Marks)
- b. Compute 4-point circular convolution of the sequences using time domain and frequency domain.
 $x(n) = \{2, 1, 2, 1\}$ and $h(n) = \{1, 2, 3, 4\}$ (08 Marks)

OR

- 2 a. Obtain the relationship between DFT and z-transform. (08 Marks)
- b. Let $x(n)$ be a real sequence of length N and its N-point DFT is $X(K)$, show that
 (i) $X(N-K) = X^*(K)$
 (ii) $X(0)$ is real.
 (iii) If N is even, then $X\left(\frac{N}{2}\right)$ is real. (08 Marks)

Module-2

- 3 a. Let $x(n)$ be a finite length sequence with $X(K) = \{0, 1-j, 4, 1+j\}$, using properties of DFT, find the DFT of the followings:
 (i) $x_1(n) = e^{j\frac{\pi}{2}n} x(n)$
 (ii) $x_2(n) = \left\{ \cos \frac{\pi}{2} n \right\} x(n)$ (08 Marks)
- b. Find the response of an LTI system with an impulse response $h(n) = \{3, 2, 1\}$ for the input $x(n) = \{2, -1, -1, -2, -3, 5, 6, -1, 2, 0, 2, 1\}$, using overlap add method. Use 8-point circular convolution. (08 Marks)

OR

- 4 a. State and prove the,
 (i) Modulation property. (ii) Circular time shift property. (08 Marks)
- b. Consider a finite duration sequence $x(n) = \{0, 1, 2, 3, 4, 5\}$
 (i) Find the sequence, $y(n)$ with 6 point DFT is $y(K) = W_2^K X(K)$.
 (ii) Determine the sequence $y(n)$ with 6-point DFT $y(K) = \text{Real}[X(K)]$. (08 Marks)

Module-3

- 5 a. Develop the radix - 2 Decimation in frequency FFT algorithm for $N = 8$ and draw the signal flow graph. (10 Marks)
- b. What is Goertzel algorithm and obtain the direct form - II realization? (06 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

- 6 a. Let $x(n)$ be the 8-point sequence of $x(n) = \left\{ \frac{1}{\sqrt{2}}, 1, \frac{1}{\sqrt{2}}, 0, \frac{-1}{\sqrt{2}}, -1, \frac{-1}{\sqrt{2}}, 0 \right\}$. Compute the DFT of the sequence using DIT FFT algorithm. (06 Marks)
- b. What is Chirp-Signals and mention the applications of Chirp-Z-transform? (04 Marks)
- c. A designer is having a number of 8-point FFT chips. Show explicitly how he should interconnect three chips in order to compute a 24-point DFT. (06 Marks)

Module-4

- 7 a. Design a digital low pass Butterworth Filter using bilinear transformation to meet the following specifications:
 $-3 \text{ dB} \leq |H(e^{j\omega})| \leq -1 \text{ dB}$ for $0 \leq \omega \leq 0.5\pi$
 $|H(e^{j\omega})| \leq -10 \text{ dB}$ for $0.7\pi \leq \omega \leq \pi$ (10 Marks)
- b. Obtain the parallel form of realization of a system difference equation,
 $y(n) = 0.75y(n-1) - 0.125y(n-2) + 6x(n) + 7x(n-1) + x(n-2)$ (06 Marks)

OR

- 8 a. Convert the analog filter with system function,
 $H_a(s) = \frac{s+0.1}{(s+0.1)^2 + 9}$ into a digital IIR filter by means of the impulse invariance method. (08 Marks)

- b. Obtain the DF-I and cascade form of realization of the system function,

$$H(z) = \frac{1 + \frac{1}{3}z^{-1}}{\left(1 - \frac{1}{5}z^{-1}\right)\left(1 - \frac{3}{4}z^{-1} + \frac{1}{8}z^{-2}\right)}$$
 (08 Marks)

Module-5

- 9 a. Obtain the linear phase realization of FIR filter with impulse response,
 $h(n) = \delta(n) - \frac{1}{2}\delta(n-1) + \frac{1}{4}\delta(n-2) + \frac{1}{4}\delta(n-3) - \frac{1}{2}\delta(n-4) + \delta(n-5)$. (06 Marks)
- b. What are the advantages and disadvantages of the window technique for designing FIR filter? (04 Marks)
- c. A low pass filter is to be designed with the following desired frequency response:

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

Determine the filter coefficients $h_d(n)$ and $h(n)$ if $\omega(n)$ is a rectangular window defined as,

$$\omega_R(n) = \begin{cases} 1, & 0 \leq n \leq 4 \\ 0, & \text{Otherwise} \end{cases}$$
 (06 Marks)

OR

- 10 a. The desired frequency response of a low pass filter is given by,

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega}, & |\omega| < \frac{3\pi}{4} \\ 0, & \frac{3\pi}{4} < |\omega| < \pi \end{cases}$$
 . Determine the frequency response of the FIR filter if

Hamming window is used with $N = 7$. (10 Marks)

- b. 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. (06 Marks)