

(Following Paper ID and Roll No. to be filled in your Answer Book)

**PAPER ID : 2488**

Roll No.

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**B.Tech.****(SEMESTER-VI) THEORY EXAMINATION, 2012-13****DIGITAL SIGNAL PROCESSING****Time : 3 Hours ]****[ Total Marks : 100****SECTION – A**

1. Attempt all question parts :

**10 × 2 = 20**

- (a) Determine the direct form realization of the linear phase filter given by  $h(n) = \{1, 2, 3, 4, 3, 2, 1\}$ .
- (b) Find whether the digital filter given by the impulse response  $h(n) = \{1 -2 0 2 -1\}$  is linear phase or not. Prove your answer.
- (c) "A stable system is always causal". Justify the statement.
- (d) Compute the N-point DFT of the signal  $x(n) = a^n$  for  $0 \leq n \leq N - 1$
- (e) Compare between linear convolution and circular convolution.
- (f) If  $x(n) = \delta(n) + \delta(n - 1) + \delta(n - 2)$ , determine  $X(e^{j\omega})$ .
- (g) Discuss the properties of Chebyshev polynomial.
- (h) Explain the term "Group delay" with respect to filters.
- (i) Draw the butterfly diagram for  $N = 8$ .
- (j) State the condition for design of stable digital filter from stable analog filter.

**SECTION – B**

2. Attempt any three question parts :

**3 × 10 = 30**

- (a) Consider an FIR filter described by the system function  $H(z) = 1 + 2.88z^{-1} + 3.4048z^{-2} + 1.74z^{-3} + 0.4z^{-4}$ 
  - (i) Sketch the lattice realization of the filter.
  - (ii) Is the system minimum phase



- (b) Find the linear convolution of sequences using the overlap add method  
 $x(n) = \{1, 2, 0, 3, 4, 1, 0, 1, 2, 3, 2, 1\}$  and  $h(n) = \{4, 1, 2\}$
- (c) Convert the analog filter with the system function  

$$H_a(s) = \frac{s + 0.2}{(s + 0.2)^2 + 9}$$
into a digital IIR filter using impulse invariant technique. Assume  $T = 1$  s.
- (d) Determine the cascade and parallel form realization for an LTI system described by the difference equation  

$$y(n) = \frac{1}{4} y(n-2) + x(n)$$
- (e) Given that  $x(n) = \{2, 2, 2, 2, 1, 1, 1, 1\}$ . Compute 8 point FFT using decimation-in-time method.

### SECTION - C

Attempt all questions :

**5 × 10 = 50**

3. Attempt any two parts :

**2 × 5 = 10**

- (a) An FIR filter is described by the difference equation  $y(n) = x(n) - x(n-10)$ . Compute and sketch its Fourier Transform magnitude and phase spectrum.
- (b) Define Discrete Time Fourier Transform (DTFT) of a sequence  $x(n)$ . Determine DTFT for  $\cos \omega_0 n$  and  $\sin \omega_0 n$ .
- (c) Obtain the direct form II structure for the system given by the transfer function  

$$y(n) = \frac{3}{4} y(n-1) - \frac{1}{8} y(n-2) + x(n) + \frac{1}{3} x(n-1)$$

4. Attempt any one part :

**1 × 10 = 10**

- (a) The desired frequency response of a low pass filter is given by

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

Design the filter using hamming window.

- (b) Given an 8 point sequence  $x(n) = n + 1$  where  $n = 0, 1, 2, \dots, 7$ . Develop an FFT algorithm using decimation-in-frequency (DIF) approach. Discuss its advantages in terms of savings in complex additions and multiplication.

5. Attempt any one part :

1 × 10 = 10

- (a) The frequency response of an ideal bandpass filter is given by

$$H(\omega) = \begin{cases} 0 & |\omega| \leq \frac{\pi}{8} \\ 1 & \frac{\pi}{8} < |\omega| < \frac{3\pi}{8} \\ 0 & \frac{3\pi}{8} \leq |\omega| \leq \pi \end{cases}$$

Determine its impulse response.

- (b) Perform the convolution of the following two sequences  $h(n)$  and  $x(n)$

$$h(n) = \begin{cases} \left(\frac{1}{2}\right)^n & 0 \leq n \leq 2 \\ 0 & \text{otherwise} \end{cases} \quad \text{and}$$

$$x(n) = \delta(n) + \delta(n-1) + 4\delta(n-2)$$

6. Attempt any one part :

1 × 10 = 10

- (a) Derive the condition of an FIR filter to give linear phase response. Also, find the frequency response of a given FIR filter, if the number of samples,  $N$ , in its impulse response  $h(n)$  is odd.
- (b) Using bilinear transformation, design a Butterworth low pass filter to meet the following specifications :

$$0.8 \leq |H(e^{j\omega})| \leq 1 \quad 0 \leq |\omega| \leq 0.2\pi$$

$$|H(e^{j\omega})| \leq 0.2 \quad 0.6\pi \leq |\omega| \leq \pi$$

7. Attempt any two parts :

2 × 5 = 10

- (a) Derive the frequency transformation for converting a prototype digital low pass filter into a digital highpass filter.
- (b) Show that the zeros of a linear phase FIR filter occurs at reciprocal location.
- (c) Show that the output data is in bit reversed order for the decimation in frequency algorithm for  $N = 8$ .