

Duration: 3hrs

[Max Marks:80]

- N.B.: (1) Question No 1 is Compulsory.
 (2) Attempt any three questions out of the remaining five.
 (3) All questions carry equal marks.
 (4) Assume suitable data, if required and state it clearly.

1 Attempt any FOUR [20]

a Obtain the linear phase realization of the system function

$$H(z) = \frac{1}{2} + \frac{1}{3}z^{-1} + z^{-2} + \frac{1}{4}z^{-3} + z^{-4} + \frac{1}{3}z^{-5} + \frac{1}{2}z^{-6}$$

b Discuss the properties of Butterworth and type-I Chebyshev filter

c Given $H(Z)$, compute the truncated $H'(z)$ with coefficients represented by 4-bit

word length. $H(z) = \frac{1}{z-0.752352}$

d Find the IDIF-FFT for a given sequence $X(k) = \{26, -2+2j, -2, -2-2j\}$.

e State the condition for stability and causality of analog and digital filter.

2 a Design a lowpass filter for the following specification [10]

Cutoff frequency=500 Hz ; sampling frequency = 2000 Hz; order of the filter N=10. Use Hamming window to get the impulse response.

b Determine the output response $\bar{y}(n)$ if $h(n) = (1,1,1)$, $x(n) = (1,2,3,1)$ by using linear convolution, circular convolution & circular convolution with zero padding. [10]

3 a Find the DFT of the sequence $x[n] = \{1, 2, 3, 4, 4, 3, 2, 1\}$ using radix-2 decimation in time FFT algorithm. [10]

b For the analog transfer function $(s) = \frac{2}{s^2+3s+2}$. Determine $H(z)$ using impulse invariant transformation if (a) $T=1$ second and (b) $T=0.1$ second. [10]

- 4 a Determine the impulse response $h(n)$ of a filter having desired response=7, use frequency sampling approach [10]

$$Hd(w) = \begin{cases} e^{-j3\omega} & 0 \leq |\omega| \leq \frac{\pi}{2} \\ 0 & \frac{\pi}{2} \leq |\omega| \leq \pi \end{cases}$$

- b Derive the equation for steady state noise power due to input quantization. [10]

- 5 a Design a digital Butterworth low pass filter that satisfies the following constraint using BLT. Assume $T = 1 \text{ sec}$ [10]

$$\begin{aligned} 0.707 \leq |H(w)| \leq 1 & ; \quad \text{for } 0 \leq \omega \leq 0.5\pi \\ |H(w)| \leq 0.2 & ; \quad \text{for } 0.75\pi \leq \omega \leq \pi \end{aligned}$$

- b Determine the zeros of the following FIR systems and identify whether the following system is minimum phase, maximum phase, mixed phase. Also comment on stability. [10]

(i) $H_1(z) = 6 + z^{-1} + 6z^{-2}$

(ii) $H_2(z) = 1 - z^{-1} - 6z^{-2}$

(iii) $H_3(z) = 1 - \frac{5}{2}z^{-1} - \frac{3}{2}z^{-2}$

(iv) $H_4(z) = 1 - \frac{5}{2}z^{-1} - \frac{2}{3}z^{-2}$

- 6 a Describe echo cancellation and sub-band coding of speech signal. [10]

- b Obtain the cascade and parallel form realization of the system [10]

$$Y(n) = -0.1y(n-1) + 0.2y(n-2) + 3x(n) + 3.6x(n-1) + 0.6x(n-2)$$