

**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 Sketch the frequency response and identify the following filters based on their pass band:

i).  $h(n) = \left\{1, -\frac{1}{2}\right\}$       ii).  $H(z) = \frac{z^{-1}-a}{1-az^{-1}}$

- b Find the IDIF-FFT for a given sequence  $X(k) = \{26, -2+2j, -2, -2-2j\}$ .  
 c Explain the effects of coefficient quantization in FIR filters.  
 d Explain frequency warping in bilinear transformation  
 e Compare IIM and BLT.

2 a Design FIR filter using frequency sampling technique for the following specifications: [10]

$$H(e^{j\omega}) = \begin{cases} e^{-j3\omega} & 0 \leq |\omega| \leq \frac{\pi}{2} \\ 0 & \text{otherwise} \end{cases}$$

b Design a Butterworth low pass filter using BLT for the following specifications [10]  
 (Assume  $T=1\text{sec}$ )

$$0.9 \leq |H(e^{j\omega})| \leq 1 \quad \text{for } 0 \leq \omega \leq \frac{\pi}{2}$$

$$|H(e^{j\omega})| \leq 0.1 \quad \text{for } \frac{3\pi}{4} \leq \omega \leq \pi$$

3 a If  $x(n) = \{1, 2, 3, 4, 5, 6, 7, 8\}$ , Find  $X(k)$  using DIT-FFT algorithm. Compare [10]  
 the computational complexity of above algorithm with DFT.

b The transfer function of digital causal system is given as follows: [10]

$$H(z) = \frac{1 - z^{-1}}{1 - 0.2z^{-1} - 0.15z^{-2}}$$

- (i) Find the difference equation.  
 (ii) Draw cascade form, parallel form realization.

4 a  $x(n) = \begin{cases} 1, & 0 \leq n \leq 3 \\ 0, & 4 \leq n \leq 7 \end{cases}$  [10]

i). Determine the DIF-FFT of the sequence  $x(n)$

ii). Also find the DFT of the following sequences using the result obtained in (i)

$$x_1(n) = \begin{cases} 1, & n = 0 \\ 0, & 1 \leq n \leq 4 \\ 1, & 5 \leq n \leq 7 \end{cases}$$

$$x_2(n) = \begin{cases} 0, & 0 \leq n \leq 1 \\ 1, & 2 \leq n \leq 5 \\ 0, & 6 \leq n \leq 7 \end{cases}$$

b Design a FIR filter using window method for following specification. [10]

$$H(e^{j\omega}) = \begin{cases} e^{-j2\omega} & \text{for } -\frac{\pi}{4} \leq \omega \leq \frac{\pi}{4} \\ 0 & \text{for } \frac{\pi}{4} \leq |\omega| \leq \pi \end{cases}$$

Determine the filter coefficient  $h(n)$  if the window function is defined as

$$w[n] = \begin{cases} 1 & 0 \leq n \leq 4 \\ 0 & \text{otherwise} \end{cases}$$

Also determine the frequency response of the designed filter.

5 a An analog filter has transfer function [10]

$$H(s) = \frac{s + 0.1}{(s + 0.1)^2 + 16}$$

Determine the transfer function of digital filter using bilinear transformation.

The digital filter should have specification  $\omega_r = \frac{\pi}{2}$

b The unit sample response of a system is  $h(n) = \{1, 2\}$  use overlap-save method [10]

of linear filtering to determine output sequence for the repeating input sequence,

$x(n) = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$ . Take  $N=5$

6 a Explain application of DSP in ECG and EEG signal analysis. [10]

b Obtain lattice realization for FIR filter given by [10]

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

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