**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]

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

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

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

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

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

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

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

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

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

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

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

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

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 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 [10]

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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