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 If $x(n) = \{2,3,4,5\}$
i) Find DFT of $x(n)$using DIT-FFT
ii) If $y(n) = x(n-1)$Find DFT of $y(n)$ using property not otherwise.

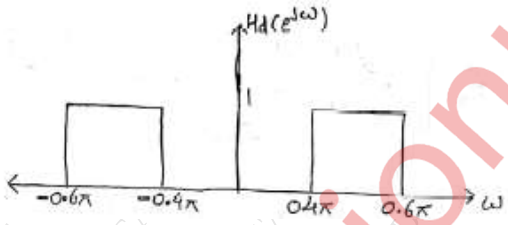
b A digital filter is described by the following difference equation
$$y(n) = 0.9y(n-1) + bx(n)$$
i) Determine b such that $|H(0)| = 1$
ii) Identify the filter type based on pass band.

c Obtain computational complexity of FFT algorithm.

d Define group delay and phase delay.

e Explain the frequency warping in bilinear transformation.

2 a Design digital FIR filter for the following specification. Use hanning window and assume M = 7. **[10]**



b Compute circular convolution of the following sequence using DITFFT-IFFT **[10]**
x1 (n) = {1, 2, 1, 2} and x2 (n) = {1, 2, 1}.

3 a Compute the DFT of the sequence x (n) = {1, 2, 3, 4, 4, 3, 2, 1} using DIF-FFT algorithm. Compare the computational complexity of the above algorithm with DFT. **[10]**

b For the second order IIR filter **[10]**
$$H(z) = \frac{1}{(1-0.5z^{-1})(1-0.45z^{-1})}$$
Study the effect of shift in pole location with a 3-bit coefficient.

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

b Write a note on frequency sampling realization of FIR filer. **[10]**

5 a Design a digital Butterworth low pass filter that satisfies the following constraint using impulse invariant transformation method. Assume $T = 1\ sec$ **[10]**

$$0.707 \leq |H(w)| \leq 1 \quad ; \qquad for \quad 0 < \omega < 0.3\pi$$
$$|H(w)| \leq 0.2 \quad ; \qquad for \quad 0.75\pi < \omega < \pi$$

b Explain overlap and save method for data filtering. Using this method find output of a system with impulse response h(n) = {1, 2, 1} and input x(n) = {3, -1, 0, 1, 3, 2, 0, 1, 2, 1} **[10]**

6 a Explain application of DSP for Echo cancellation. **[10]**

b The transfer function of discrete time causal system is given by **[10]**

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

Draw cascade and parallel realization.