

**Note:** Attempt any five questions.

1. (a) State sampling theorem. For any analog signal how the sampling rate is selected? Also discuss that if the sampling is performed at minimum sampling rate how reconstruction is done?

(b) Consider the analog signal:

$$X_a(t) = 3 \cos 100 \pi t$$

- Determine the minimum sampling rate required to avoid aliasing.
- Suppose that the signal is sampled at the rate  $F_s = 75$  Hz. What is the discrete time signal obtained after sampling?
- What is the frequency  $0 < F < F_s/2$  of a sinusoid that yields samples identical to these obtained in part (ii).

2. (a) State and prove the following properties of Z-transform:

- Time Shifting
- Differentiation in Z-domain

(b) Determine the Z-transform and the ROC of the signal:

$$X(n) = [3(2^n) - 4(3^n)] 4(n)$$

3. (a) Determine the inverse Z-transform of:

$$\frac{1}{1 - 1.5z^{-1} + 0.5z^{-2}}$$

When:

- ROC:  $|z| > 1$
- ROC:  $|z| < 0.5$

(b) Determine the system function and the unit sample response of the system described by the difference equation:

$$Y(n) = \frac{1}{2} y(n-1) + 2x(n)$$

4. (a) State and prove the following properties of DFT:

- Circular Convolution
- Time Reversal of a sequence

(b) A finite duration sequence of length L is given as:

$$x(n) = 1 \quad 0 \leq n \leq L-1$$

$$x(n) = 0 \quad \text{otherwise}$$

Determine the N point DFT of this sequence for  $N \geq L$ .

5. (a) Compare in detail the computational complexity for the direct computation of the DFT versus the FFT algorithm.  
(b) Draw and explain the flow graph of eight point decimation in time FFT algorithm.
6. (a) Discuss design of FIR digital filters using window method. Explain different types of windows used in the window design method.  
(b) Determine the order and the poles of a type I low pass Chebyshev filter that has a 1-dB ripple in the pass band a cutoff frequency  $\Omega_p = 1000\pi$ , a stop band frequency of  $2000\pi$  and an attenuation of 40 dB or more for  $\Omega \geq \Omega_s$ .
7. (a) How pipelining results in increased throughput of the DSP's ? Explain in detail.  
(b) Discuss in detail designing of programmable DSPs.
8. (a) Explain the effect of finite register length in FIR filter design.  
(b) Discuss design of IIR digital filters using Butterworth approximation. Draw and explain its frequency response characteristics.