

- N.B. (1) Question No. 1 is compulsory.
 (2) Answer any four questions out of remaining six questions.
 (3) Assume suitable data if required.

1. (a) The analog signal $x(t)$ is given below : 20

$$x(t) = 2 \cos 2000 \pi t + 3 \sin 6000 \pi t + 8 \cos 12000 \pi t$$

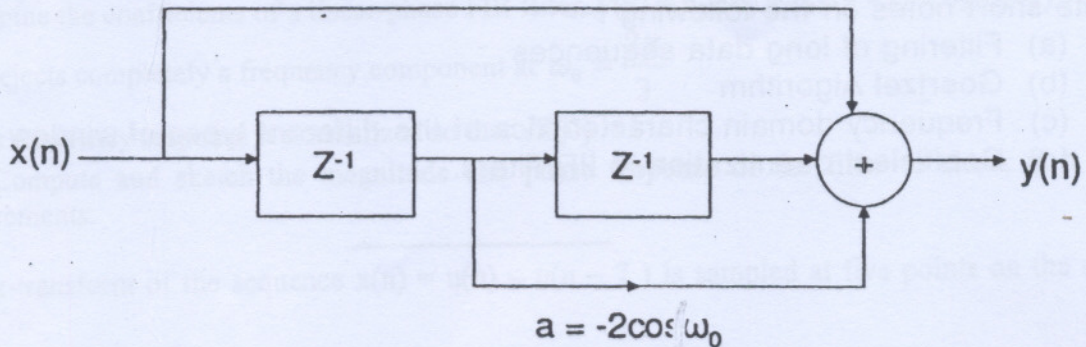
Calculate :

- (i) Nyquist sampling rate.
 - (ii) If the given $x(t)$ is sampled at the rate $F_s = 5000$ Hz. What is the discrete time signal obtained after sampling ?
 - (iii) What is the analog signal $y(t)$ we can reconstruct from the samples if ideal interpolation is used ?
- (b) Determine the causal and stable inverse of the system with impulse response

$$h(n) = \delta(n) - \frac{1}{2} \delta(n-1).$$

- (c) Suppose that $H(z)$ and $G(z)$ are rational and have minimum phase. Which of the following filters have minimum phase ?
- (i) $H(z) G(z)$
 - (ii) $H(z) + G(z)$.

2. (a) Consider the digital filter shown in Figure :— 10



- (i) Determine the input-output relation and the impulse response $h(n)$
- (ii) Determine and sketch the magnitude $|H(\omega)|$ and the phase response $\angle H(\omega)$ of the filter and find which frequencies are completely blocked by the filter.
- (iii) When $\omega_0 = \pi/2$, determine the output $y(n)$ to the input

$$x(n) = 3 \cos \left(\frac{\pi}{3} n + 30^\circ \right) \quad -\infty < n < \infty.$$

(b) For a continuous time signal with equation, $x(t) = \sin [2 \pi 1000 t] + 0.5 \sin [2 \pi 2000 t]$ 10
 Sample the given signal at 8000 samples/sec and find out 8 point DFT. Plot magnitude and phase response.

3. (a) Given $x(n) = \{ 1, 2, 2, 1 \}$. Find corresponding DFT $X(k)$ using DIT FFT. 10
 (b) Explain energy compaction capability of DCT. 10

4. (a) What is a linear phase filter ? What conditions are to be satisfied by the impulse response of an FIR system in order to have a linear phase ? Plot and justify compulsory zero locations for symmetric even antisymmetric even and antisymmetric odd FIR filters. 10
- (b) Design the second order low pass digital Butterworth filter whose cut off frequency is 1 KHz at sampling frequency 10^4 samples per second. (Use BLT method.) 10

5. (a) Design an FIR low pass digital filter with specifications — 10

$$H_d(e^{j\omega}) = \begin{cases} e^{-j^3\omega} & -3\pi/4 \leq \omega \leq 3\pi/4 \\ 0 & 3\pi/4 \leq |\omega| \leq \pi \end{cases}$$

- (b) A linear shift-invariant system has a unit sample response given by 8
 $h(n) = \{ -0.01, 0.02, -0.10, 0.40, -0.10, 0.02, -0.01 \}$
- (i) Draw a signal flow graph for this system that requires the minimum number of multiplications.
- (ii) If the input to this system is bounded with $|x(n)| < 1$ for all n , what is the maximum value that the output $y(n)$ can attain ?
- (c) Define phase delay and group delay. 2

6. (a) Implement the all pass filter using a lattice filter structure 8

$$H(z) = \frac{-0.512 + 0.64z^{-1} - 0.8z^{-2} + z^{-3}}{1 - 0.8z^{-1} + 0.64z^{-2} - 0.512z^{-3}}$$

- (b) With the help of block diagram, explain architecture of TMS 32 C 5X series of processors. 8
- (c) Compare Impulse Invariant and Bilinear transformation. 4

7. Write short notes on the following :— 20

- (a) Filtering of long data sequences
- (b) Goertzel Algorithm
- (c) Frequency domain characteristics of the different types of window functions
- (d) Coefficient quantization in IIR filters. .