

(3 Hours)

[Total Marks : 100

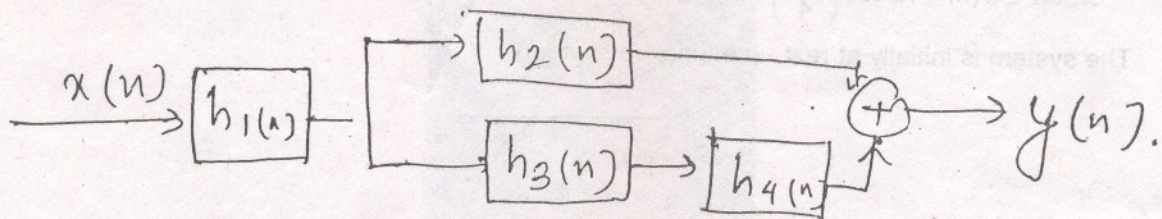
- N.B.** (1) Question No. 1 is compulsory.
 (2) Attempt any four questions out of remaining six questions.
 (3) **Figures to right** indicate full marks.
 (4) Assume suitable data if necessary.

1. (a) Find Z-transform of — 5
 $x(n) = a^n(n+1)u(n)$.
 (b) Test linearity, causality and time invariance of following systems — 6
 (i) $y(n) = e^{x(n)}$
 (ii) $y(n) = ax(n) + b$.
 (c) Prove Parseval's Energy relation. Use DFT and IDFT. 4
 (d) Compare IIR filter with FIR filter. 5
2. (a) Consider the interconnection of LTI system as shown in figure. 12
 (i) Express the overall impulse response of system in term of $h_1(n)$, $h_2(n)$, $h_3(n)$ and $h_4(n)$.
 (ii) Determine $h(n)$ when —

$$h_1(n) = \left\{ \frac{1}{2}, \frac{1}{4}, \frac{1}{2} \right\}$$

$$h_2(n) = h_3(n) = (n+1)u(n)$$

$$h_4(n) = \delta(n-2)$$



- (b) Derive the relationship of DFT to Fourier transform and Z-transforms. 8
3. (a) An FIR LTI system has an impulse response $h(n)$, which is real value, even and has finite duration of $(2N+1)$. Show that if $Z_1 = re^{j\omega_0}$ is zero of system, then $Z_1 = \left(\frac{1}{r}\right)e^{j\omega_0}$ is also a zero. 8
- (b) Draw a phase response of following filter to prove that it is a linear phase filter. 4
 (c) Explain in detail bilinear transformation technique while designing a digital filter. 8
4. (a) Show that the power of a real valued signal is equal to sum of the power of its even and odd signals. 6
 (b) An analog signal —
 $x_a(t) = \sin(480\pi t) + 3\sin(720\pi t)$ is sampled 600 times/second.
 (i) Determine the Nyquist rate for $x_a(t)$. 2
 (ii) Determine the folding frequency. 2
 (iii) What are the frequencies, in radian, in the resulting discrete time signals? 2
 (iv) If $x(n)$ is passed through ideal D/A converter, what is reconstructed signal $y_a(t)$? 2
 (v) What is the resolution Δ ? 2
 (c) Determine whether, following sign is periodic — 4
 (i) $\cos(0.01\pi u)$
 (ii) $\sin(3n)$.

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5. (a) Obtain direct form I, Direct form II, Cascade and parallel realization for —

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

- (b) Design a Butterworth filter using BLT with following specifications :—

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$$A_p = 3 \text{ db}$$

$$W_p = 0.5 \pi$$

$$A_s = 15 \text{ dp}$$

$$W_s = 0.75 \pi$$

Use sampling frequency = 1 Hz.

6. Write short notes on :—

- Hilbert transform
- Goertzel algorithm
- Effect of finite word length
- Chirp Z-algorithms.

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7. (a) Explain in detail impulse invariance technique for designing digital IIR filter from analog IIR filter.

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- (b) Find Z-transform of $x(n) = n^2(-1)^n u(n)$.

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- (c) Determine the transient and steady-state response of system characterized by difference equation as —

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$$y(n) = 0.5 y(n-1) + x(n)$$

$$\text{when } x(n) = 10 \cos\left(\frac{\pi n}{4}\right) u(n).$$

The system is initially at rest. (i.e. relaxed system).