



K. K. Wagh Institute of Engineering Education & Research, Nashik
(An Autonomous Institute From A.Y. 2022-23)

| WINTER-2025 | |
|--|---------------------|
| Exam Seat No.: | |
| Academic Year:2025-2026 | Semester:V |
| Class:TY | Program:B.Tech |
| Branch Code:ELE | Pattern:2023 |
| Name of Course:Digital Signal Processing | Course Code:2306309 |
| Max. Marks:60 | Duration:2.30 Hrs. |

Instructions: Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 03 page(s).
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.

Marks CO

Question No. 1

1a) Solve the following questions with explanation (**any TWO**) (3Mx2=6M)

(6) 01

(i) Consider $x(t) = \cos 6\pi t + \sin(8\pi t)$, where t is in seconds. The Nyquist sampling rate (in samples/second) for the signal $y(t) = x(2t + 5)$ ____

(A) 8 (B) 12 (C) 16 (D) 32

(ii) A discrete time signal $x[n] = \sin \pi^2 n$ where n being integer

(A) periodic with period π (B) periodic with period π^2

(C) periodic with period $\frac{\pi}{2}$ (D) Non periodic

(iii) Consider two discrete time system T1 and T2 are defined as follow:

$$T1x[n] = x[0] + x[1] + \dots + x[n]$$

$$T2x[n] = x[0] + \frac{1}{2}x[1] + \dots + \frac{1}{2^n}x[n]$$

Which of the following statement is true?

(A) T1 and T2 are BIBO stable (B) T1 is BIBO is stable and T2 is non BIBO stable

(C) T1 and T2 are not BIBO stable (D) T1 is BIBO is not stable and T2 is BIBO stable

Question No. 2

2a) Solve the following questions with explanation (**any TWO**) (**3Mx2=6M**) (6) 02

(i) Consider a signal $f(t) = 1 + 2\cos\pi t + 3\sin\frac{2\pi}{3}t + 4\cos\frac{\pi}{2}t + \frac{\pi}{4}$, where t is in seconds. What is Its fundamental time period in second?

(ii) If the impulse response of a discrete time system is $h(n) = -5^n u(n-1)$. Then what is z-transform $H(z)$ of the system? Also comment on stability.

(iii) The z-transform of a sequence $x[n]$ is given as $X(z) = 2z + 4 - \frac{4}{z} + \frac{3}{z^2}$. If the $y[n]$ is the first difference of $x[n]$, then calculate $Y(z)$.

Question No. 3

3a) State and prove following properties of DFT (8) 01

(i) Linearity (ii) Circular time shifting

OR

3b) What discrete fourier transform? What is the difference between DFT and DTFT? (8) 01

3c) Obtain DFT of the sequence given below using DIT-FFT algorithm. (8) 03

$$x(n) = \frac{1^n}{4} \text{ for } 0 \leq n \leq 3$$

$$= 0 \quad \text{Otherwise}$$

OR

3d) Two discrete time signals are given by (8) 03

$$x(n) = \frac{1^n}{2} \text{ for } 0 \leq n \leq 2$$

$$= 0 \quad \text{Othewise}$$

$$\text{and } h(n) = \{1, 1\}$$

Find

(i) Circular convolution of these two sequences

(ii) Linear convolution of two sequences using circular convolution

Question No. 4

4a) What are the advantages of digital filter over analog filter? What are the limitations of digital filter? (6) 03

OR

4b) Compare IIR filter with FIR filter. (6) 03

- 4c) Design a digital low pass IIR digital filter using bilinear transformation with $T=0.5$ sec with following specifications. (10) 04

$$0.707 \leq |H(\omega)| \leq 1 \quad \text{for } 0 \leq \omega \leq 0.3\pi$$
$$|H(\omega)| \leq 0.2 \quad \text{for } 0.75\pi \leq \omega \leq \pi$$

OR

- 4d) A second order digital filter is described by (10) 04

$$H(s) = \frac{12}{s^2 + 7s + 12}$$

Find $H(z)$ using impulse variance method with (i) $T=1$ sec and (ii) $T=2$ sec.

Question No. 5

- 5a) Design an ideal FIR low pass filter with cut of frequency of 1 kHz and sampling frequency of 4 kHz (8) 04 with 11 samples using Fourier series method.

OR

- 5b) Design an ideal FIR high pass filter with cut-off frequency of 1.5kHz and sampling frequency of 7.5kHz with 9 samples using rectangular window. (8) 04

- 5c) Obtain the direct form and cascade structure of following FIR system. (8) 04

$$H(z) = 1 + \frac{5}{2}z^{-1} + 2z^{-2} + 2z^{-3}$$

OR

- 5d) Obtain direct form-I and direct form-II structure of following IIR system. (8) 04

$$y(n) = \frac{1}{4}y(n-1) - \frac{3}{5}y(n-3) + x(n) + \frac{1}{2}x(n-2)$$

..... End of question paper.....