

GUJARAT TECHNOLOGICAL UNIVERSITY

BACHELOR OF ENGINEERING – SEMESTER 7 – EXAMINATION – SUMMER 2026

Subject Code: 3171003

Date: 22/05/2026

Subject Name: Digital Signal Processing

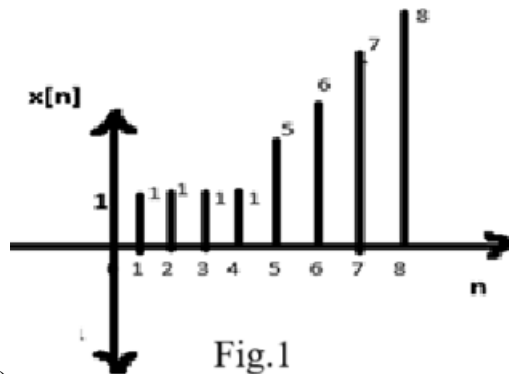
Time: 02:30 PM TO 05:00 PM

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

- Q.1**
- (a) Enlist the types of Discrete Time Signals, Systems and mathematical operations on Discrete time signals. 03
- (b) Discuss the difference between (i) Auto correlation vs Cross correlation. (ii) Circular Convolution vs Linear Convolution. 04
- (c) Do as directed. 07
- Draw (i) $x[n] = 4n-6$ for all n (1 Marks)
- (ii) If $x[n] = b^n$, $n \geq 0$, $0 < b < 1$, Sketch $x[n]$, $x[2n]$ and $x[n/2]$ (3marks)
- (iii) For fig. 1. Give mathematical expression in terms of elementary signals. (3



marks)

- Q.2**
- (a) Prove the Distributive Property of Linear Convolution. 03
- (b) Find out the output of an LTI system with given impulse response $a^n u[n]$, $|a| < 1$ when input is $u[n]$. 04
- (c) State and Prove (i) Time advancement property of DTFT. (ii) Compression in Time domain is equivalent to expansion in frequency domain. 07
- OR
- Q.2**
- (c) Prove that Convolution in Time Domain is equivalent to Multiplication in Z Domain. 07
- Q.3**
- (a) Find out one sided Z.T. of $x[n] = n a^{n-1}$ when it is causal. 03
- (b) Obtain the system transfer function of given system. 04
- $y[n] = 0.5 y[n-1] + x[n] - 1.5 x[n-1]$ when the input is unit step.
plot poles and zeros

- (c) For the given Z.T. , find out the poles . 07
 Obtain the sequence in Time Domain if ROC is hollow Ring in Z plane. Also draw the ROC.
 Make suitable comment on stability.

$$H(z) = \frac{1}{1 - 0.8z^{-1} + 0.12z^{-2}}$$

OR

- Q.3** (a) Compare (i) Laplace Transform vs Z.T. (ii) Z.T vs Fourier Transform 03
 (b) Obtain the impulse response of the given system with following T.F.H(z). 04

$$\frac{z^{-1} + 0.5z^{-2}}{1 - 0.6z^{-1} + 0.08z^{-2}}$$

- (c) Discuss Minimum phase, Maximum phase and Mixed phase systems with suitable examples. 07

- Q.4** (a) Explain various types of filters based on their frequency response. 03
 (b) Consider given LTI system. Draw the direct form and transposed direct form structures. 04

$$H(z) = 1 - (1/3) z^{-1} + (1/6) z^{-2} + z^{-3}$$

- (c) Identify the type of system (FIR/IIR). Obtain the Direct Form I and Direct Form II structures of the given system. 07

$$y[n] = -0.1 y[n-1] + 0.72 y[n-2] + 0.7 x[n] - 0.25 x[n-2]$$

OR

- Q.4** (a) Compare Recursive and Non recursive structures. 03
 (b) State the condition for Linear Phase. Obtain the Linear phase implementation of the given system. 04

$$H(z) = 1 + 0.5 z^{-1} + (1/3) z^{-2} + (1/6) z^{-3} + (1/3) z^{-4} + (1/2) z^{-5} + z^{-6}$$

- (c) Obtain the Cascade and Parallel form structures of the given system. 07

$$y[n] = -0.1 y[n-1] + 0.72 y[n-2] + 0.7 x[n] - 0.25 x[n-2]$$

- Q.5** (a) What is Twiddle factor ? give mathematical definition. What is its significance ? Enlist its Properties. 03

- (b) What is Quantization in general? What is Co-efficient quantization ? Explain the effects of Co-efficient quantization in filters with suitable example. 04

- (c) Design a First Order Digital Low Pass Filter with 3dB cutoff frequency of $\omega_c = 0.25\pi$ by applying bilinear Transformation to the given analog Butterworth filter. 07

$$H(s) = \frac{1}{1 + \frac{s}{\Omega_c}}$$

Here Ω_c is the 3 dB cutoff frequency of the analog filter.

OR

- Q.5** (a) Explain the circular shift property of the DFT. 03
 (b) Explain various Windowing Techniques in brief. 04
 (c) Compute 4 point DFT using DIT FFT for sequence $\{x[0], x[1], x[2], x[3]\}$. Also draw the butterfly diagram. 07
