Graphic Era HILL UNIVERSITY
Established by an Act of the State Legislature of Uttarakhand (Adhiniyam Sankhya 12 of 2011)
University under section 2(f) of UGC Act, 1956

End Term (Odd) Semester Examination November 2025

Roll no.....

Name of the Program and semester: **B.Tech. V Semester**
Name of the Course: **Digital Signal Processing**
Course Code: **TEC 502**

Time: 3 hour Maximum Marks: 100

Note:

(i) All the questions are compulsory.
(ii) Answer any two sub questions from a, b and c in each main question.
(iii) Total marks for each question is 20 (twenty).
(iv) Each sub-question carries 10 marks.

Q1. **CO1** (2X10=20 Marks)

a. i) Prove the "Circular Time Shifting" and Circular Time Reversal Property" of DFT
ii) Explain the "Associative" and "Distributive" property of the LTI systems. Determine the impulse response for the cascade of LTI systems having impulse responses:

$$h_1(n)=\left(\frac{1}{2}\right)^n u(n) \quad and \quad h_2(n)=\left(\frac{1}{4}\right)^n u(n)$$

b. Prove the "Convolution Property" of DTFT. Determine the DTFT and Energy Density Spectrum of the sequence:

$$x(n)=\begin{cases} A; & 0 \le n \le L-1 \\ 0; & Otherwise \end{cases}$$

c. State and proof the "Sampling Theorem".

Q2. **CO2** (2X10=20 Marks)

a. Explain and proof the efficient computation of the DFT of two real sequences. Also compute 4- point DFT of the sequence x(n) = {1,2, 3, 4}; using DITFFT Algorithm.

b. Prove Decimation- in-Frequency Radix -2 FFT (DIFFFT) algorithm and draw its flow graph for 8-point. Also explain how it has less computational complexity than direct method.

c. Compute the Inverse DFT for the following using FFT algorithm:
X(k)={ 20, -5.828-j2.414, 0, -0.172-j0.414,0, -0.172+j0.414, 0, -5.828+j2.414}
↑

Q3. **CO3** (2X10=20 Marks)

a. Proof the "Lattice Structure" for FIR digital filter.

b. Determine the Direct Form I & II realization of the following systems:

$$I.\ H(z)=\frac{0.28z^2+0.319z+0.04}{0.5z^3+0.3z^2+0.17z-0.2}$$

II. y(n) = -0.1y(n-1) + 0.2y(n-2) + 3x(n) + 3.6x(n-1) + 0.6x(n-2)

c.Prove and draw the structure for linear phase FIR Filter for M Odd. Determine and draw the Cascade and

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linear phase realization of FIR filter, whose system function is:

$$H(z) = (1 + 0.5\,z^{-1} + z^{-2})(1 + 0.25z^{-1} + z^{-2})$$

Q4. **CO4** (2X10=20 Marks)

a. Prove the 'Impulse Invariant Transformation Technique' for design of IIR Filter.

b. The desired response of low- pass filter is

$$H_d(e^{j\omega}) = e^{-j3\omega}; -3\pi/4 < \omega < 3\pi/4$$
$$= 0; \textit{otherwise}$$

Determine $H(e^{j\omega})$ for M = 7; if window function is Hamming window

c. Explain the design steps of "Chebyshev filter".

Q5. **CO4/CO5** (2X10=20 Marks)

a. What are the advantages of 'multirate signal processing'? Explain with proof the 'Decimation' process of the signal. Explain the application of DSP in audio signal.

b. Use the bilinear transformation to convert analog filter with system function

$$H(s) = \frac{s+0.1}{(s+0.1)^2+9}$$

into digital IIR filter. The digital filter should have a resonant frequency of $\omega_r = \pi/4$.

c. What is "Gibbs phenomenon"? Why this phenomenon is developed in rectangular window and it is eliminated or reduced? Compare the merits and demerits of rectangle window with other windows.