BG/K/TX

Reg. No: [redacted]

VIT
Vellore Institute of Technology

# Final Assessment Test – November 2024

Course: BEVD203L - Signal Processing

Class NBR(s): 4058 Slot: B1+TB1

Time: Three Hours Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

**Answer ALL Questions**

**(10 X 10 = 100 Marks)**

1. A continuous-time signal *x(t)* is shown in Fig.1.

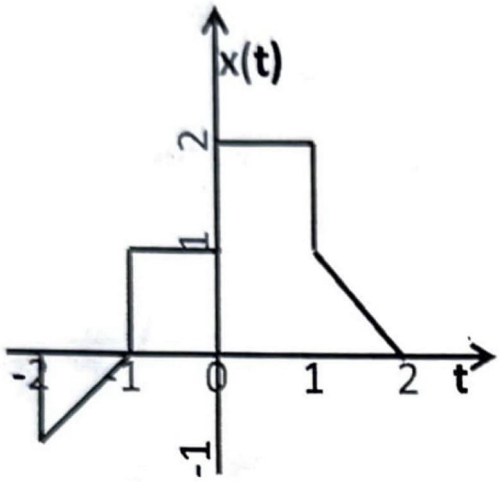



**Fig.1**

Sketch and label carefully each of the following signals.

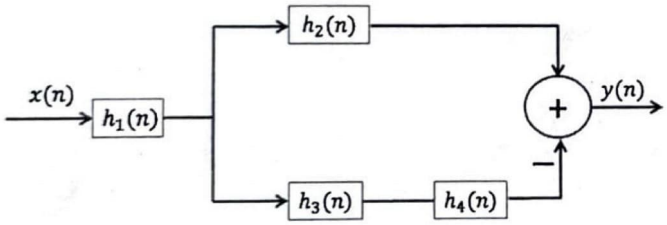
a) $x(t-1)$

b) $x(2-t)$

c) $x(t)\left[\delta\left(t+\frac{3}{2}\right)-\delta\left(t-\frac{3}{2}\right)\right]$

d) $x(2t+1)$

2. Consider the interconnection of LTI systems as shown in the below figure




a) Express the overall impulse response in terms of $h_1(n), h_2(n), h_3(n)$ and $h_4(n)$.

b) Determine $h(n)$ when

$$h_1(n)=\left\{\frac{1}{2},\frac{1}{4},\frac{1}{2}\right\}; h_2(n)=h_3(n)=(n+1)u(n);\ h_4(n)=\delta(n-2)$$

3. Compute the response of the system
$y(n) = 0.7y(n-1) - 0.12y(n-2) + x(n-1) + x(n-2)$ to the input
$x(n) = n\,u(n)$ using z-transform method. Is the system stable?

4. Compute the eight-point DFT of the sequence

$$x(n) = \begin{cases} 1, & 0 \le n \le 3 \\ 0, & 4 \le n \le 7 \end{cases}$$

Determine the DFT $x_1(k)$ of the new sequence

$$x_1(n) = \begin{cases} 0, & 0 \le n \le 1 \\ 1, & 2 \le n \le 5 \\ 0, & 6 \le n \le 7 \end{cases}$$

using $x(k)$ and DFT properties. Do not evaluate $x_1(k)$ directly.

5. Design a FIR filter with

$$H_d(e^{j\omega}) = \begin{cases} e^{-j3\omega} & \text{for } \frac{-\pi}{4} \le \omega \le \frac{\pi}{4} \\ 0 & \text{for } \frac{\pi}{4} \le |\omega| \le \pi \end{cases}$$

using a Hamming window with $N$=7.

6. Design a digital Butterworth filter satisfying the constraints

$$0.707 \le |H(e^{j\omega})| \le 1 \text{ for } 0 \le \omega \le \frac{\pi}{2}$$

$$|H(e^{j\omega})| \le 0.2 \text{ for } \frac{3\pi}{4} \le \omega \le \pi$$

with $T$ = 1sec, using Bilinear Transformation.

7. An IIR digital low-pass filter is required to meet the following specifications:

Pass band ripple ≤ 0.5 dB

Pass band edge: 1.2 KHz

Stop band attenuation ≥ 40 dB

Stop band edge: 2.0 KHz

Sample rate: 8.0 KHz

Determine the required filter order for

(i) A digital Butterworth filter

(ii) A digital Chebyshev filter.

8. Realize the lattice-ladder structure for the transfer function:

$$H(z) = \frac{1 + 2z^{-1} + 2z^{-2} + z^{-3}}{1 - 0.8z^{-1} + 0.49z^{-2} - 0.57z^{-3}}$$

9.(a) Explain in detail about finite word length effects in digital filters.

**OR**

9.(b) (i) Express the decimal fractions 4.5, 6.5 and 1.5 in binary floating point format. **[7]**

(ii) Briefly explain floating point representation. **[3]**

10.(a) Determine $x(n)$ for the given 8-point Fourier sequence $X(k) = \{7, -0.7071 + 0.7071i, i, 0.7071 + 0.7071i, 1, 0.7071 - 0.7071i, -i, -0.7071 - 0.7071i\}$ using the DIF-FFT algorithm

**OR**

10.(b) Compute the eight-point DFT of the sequence

$$x(n) = \begin{cases} 1, & 0 \le n \le 7 \\ 0, & \text{otherwise} \end{cases}$$

using the radix-2 Decimation In Frequency- FFT algorithm.

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