Total No. of Questions: 6 *Total No. of Printed Pages:3*

Enrollment No.....

Faculty of Engineering
End Sem Examination Dec-2023
EE3EL16 Digital Signal Processing

Programme: B.Tech. Branch/Specialisation: EE

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if necessary. Notations and symbols have their usual meaning.

Q.1 i. Let x(n) be the input signal, y(n) be the response, and h(n) be the unit sample response of the system. What is the relation given by $\sum_{k=-\infty}^{\infty} x(k)h(n-k)$ is known as- **1**

(a) Convolution difference (b) Convolution sum
(c) Convolution product (d) Convolution division

ii. One-sided Z-transform is also known as: **1**

(a) Unilateral Z-transform (b) Bilateral Z-transform
(c) Trilateral Z-transform (d) None of these

iii. Which of the following is true regarding the number of computations required to compute an N-point DFT? **1**

(a) N^2 complex multiplications and N(N-1) complex additions
(b) N^2 complex additions and N(N-1) complex multiplications
(c) N^2 complex multiplications and N(N+1) complex additions
(d) N^2 complex additions and N(N+1) complex multiplications

iv. The z-transform of the signal $a^n x(n)$ is- **1**

(a) $X(za)$ (b) $X(\frac{z}{a})$ (c) $X(\frac{z+a}{a})$ (d) None of these

v. What is the duration of the unit sample response of a digital filter? **1**

(a) Finite (b) Infinite
(c) Impulse (very small) (d) Zero

vi. In direct form for realisation of IIR filters, **1**

(a) Denominator coefficients are the multipliers in the feed forward paths
(b) Multipliers in the feedback paths are the positives of the denominator coefficients
(c) Numerator coefficients are the multipliers in the feed forward paths
(d) Multipliers in the feedback paths are the negatives of the denominator coefficients

vii. Which among the following assertions is an advantage of FIR Filter? 1
(a) Necessity of computational techniques for filter implementation
(b) Requirement of large storage
(c) Incapability of simulating prototype analog filters
(d) Presence of linear phase response

viii. FIR filters _____. **1**
I. are non-recursive
II. do not adopt any feedback
III. are recursive
IV. use feedback
(a) I & II (b) III & IV (c) I & IV (d) II & III

ix. The process of converting a signal from a given rate to a different rate is termed as- **1**
(a) Sampling (b) Normalizing
(c) Sampling rate conversion (d) None of these

x. In direct form realization for an interpolator, which among the following generates an intermediate signal? **1**
(a) Up-sampler (b) Down-sampler
(c) Anti-imaging filter (d) Anti-aliasing filter

Q.2 i. What do you understand by Memory-less system? Elaborate with an example. **2**

ii. Prove that the system defined by $y(n) = x^2(n)$ is shift invariant. **3**

iii. Given the sequence $x(n) = (6-n)[u(n) - u(n-6)]$, make a sketch of **5**
$y_1(n) = x(4-n)$ (b) $y_2(n) = x(2n-3)$.

OR iv. Find the z-transform of each of the following sequences- **5**
(a) $x(n) = 3\delta(n) + \delta(n-2) + \delta(n+2)$
(b) $x(n) = u(n) - u(n-10)$

Q.3 i. What do you understand by Discrete Fourier Transform (DFT)? Enlist important properties of DFT. **2**

ii. Compute the N-point DFT of the following sequences- **8**
$x_1(n) = \delta(n)$ (b) $x_2(n) = \delta(n-n_0)$ where $0 < n_0 < N$

OR iii. Determine how a $2N$-point DFT of a real valued sequence may be computed using an N-point FFT algorithm. **8**

Q.4 i. Explain impulse invariance procedure of designing an IIR filter from analog filter. **3**

ii. Differentiate between Butterworth and Chebyshev filters with reference to frequency response. **7**

OR iii. Use bilinear transformation to design a discrete time IIR low pass filter that satisfies the following frequency response constraint- **7**

$$1 - \delta_p \le \left|H(e^{j\omega})\right| \le 1 + \delta_p \quad 0 \le |\omega| \le \omega_p$$
$$\left|H(e^{j\omega})\right| \le \delta_s \quad \omega_s \le |\omega| \le \pi$$

Find the relationship between the parameters δ_p and δ_s for the discrete time filter and between the parameters ϵ and A for the continues time filter.

Q.5 i. What are the specifications to be considered to design a low pass filter with a cut-off frequency ω_c. **4**

ii. Provide an overview of design of linear phase FIR filter using commonly used windows like Rectangular, Hanning, Hamming and Blackmann with reference to Peak Side-lobe Amplitudes, Approximate Transition width and Stop-band Attenuation of an N-th order Low pass filter. **6**

OR iii. Design a FIR linear phase low pass filter according to the following specifications- **6**

$$0.99 \le \left|H(e^{j\omega})\right| \le 1.01 \quad 0 \le |\omega| \le 0.19\pi$$
$$\left|H(e^{j\omega})\right| \le 0.01 \quad 0.21\pi \le |\omega| \le$$

Q.6 Attempt any two:

i. Explain decimation and interpolation, the two basic operations in a multirate system. **5**

ii. How sampling-rate conversion is performed using multirate signal processing? **5**

iii. Write a short note on polyphase filters in multirate filtering operations. **5**

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