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Paper Code : EE-605A

DIGITAL SIGNAL PROCESSING

Time Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

   i) Integration of a Unit Impulse Function $\delta(t)$ results in

   a) Unit Step Function

   b) Unit Impulse Function

   c) Unit Ramp Function

   d) none of these.

ii) z-transform of discrete-time Unit Step signal is equal to

a) z b) $z - 1$

c) $\frac{z}{z-1}$ d) $\frac{z+1}{z-1}$.

iii) If $X(z)$ is the z-transform of $x(n)$, then z-transform of $x(n - n_0)$ equals

a) 1 b) z

c) $z^{-n0} X(z)$ d) $z^{n0} X(z)$.

iv) If W_N denotes the twiddle factor, the value of W_N^{kn} ($kn = 3$ and $N = 4$) is equal to

a) 0 b) 1

c) $+j$ d) $-j$.

v) IIR filters

a) use feedback

b) are sometimes called recursive filters

c) can oscillate if not properly designed

d) all of these.

vi) A Blackman window can eliminate ripple in FIR Filters. The trade-off is

a) larger transition bandwidth

b) smaller transition bandwidth

c) a non-linear phase response

d) possible instability.

vii) The output of two digital filters can be added, Or, the same effect can be achieved by

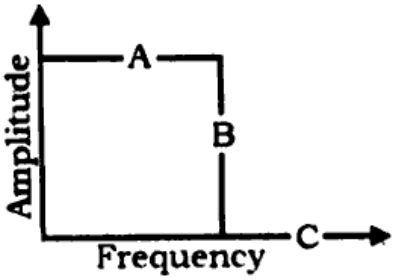
a) adding their coefficients

b) subtracting their coefficients

c) convolving their coefficients

d) averaging their coefficients.

viii) The letter *A* below indicates the filter



a) stopband b) transition band

c) passband d) ripple.

ix) A quantizer operates at a sampling frequency of 16 kHz. What is its Nyquist limit ?

a) 4 b) 8

c) 16 d) 32.

x) A DSP convolves each discrete sample with four coefficients and they are all equal to 0.25. This must be a/an

a) IIR Filter b) FIR Filter

c) Nyquist Filter d) All of these.

xi) Which of the following is used to alter FIR Filter co-efficients such that they smoothly approach zero at both ends ?

a) Rectangular window b) Blackman window

c) Laplace window d) Hilbert window.

xii) The basic process that's going on inside a DSP Chip is

a) Quantization

b) MAC

c) Logarithmic Transformation

d) Vector calculations.

GROUP – B
(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. If $u(n)$ denotes a Unit Step signal, obtain the z-transform of $u(-n)$.

3. Obtain the convolution sum of the two discrete-time signals given below :

$$x(n) = e^{-n2}$$

$$h(n) = 3n^2, \text{ for all } n.$$

4. Determine $x(n)$ by using convolution for,

$$X(z) = \frac{1}{\left(1-\frac{1}{2z}\right)\left(1+\frac{2}{4z}\right)}$$

5. A discrete-time system is characterized by the following difference equation :

$$y(n) = x(n) + e^{a}\, y(n-1)$$

Check this system for BIBO stability.

6. If $X(z)$ denotes the z-transform of $x(n)$, prove that

$$nx(n) = -z\frac{d}{dz}X(z).$$

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Differentiate between Causal and Non-Causal systems.

b) What do you mean by BIBO stability of LTI systems ? What is the condition for checking the BIBO stability ?

c) Show that the signal given by $x(t) = t^{-1/4}.u(t-1)$ is neither an Energy nor a Power Signal.

d) Determine the energy of the following sequence :

$x(n) = (1/2)^n$ for $n \geq 0$ and 0 for $n < 0$.

$2 + 3 + 5 + 5$

8. a) In what condition z-transform reduces to Fourier Transform ?

b) What do you mean by Region of Convergence (ROC) of z-transform ? What are the properties of ROC ?

c) Find the z-transform and the region of convergence (ROC) of the discrete time signal given as :

$x(n) = 2^n\ u(n)$ where $u(n)$ denotes a Unit step signal.

d) Obtain the convolution of the given discrete-time signal using the convolution property of z-transform :

$$x(n) = n(1/2)^n u(n) * (1/4)^{-n} u(-n)$$

where * denotes convolution. 2 + 4 + 4 + 5

9. a) Obtain the Discrete Fourier Transform (DFT) of delayed unit impulse $\delta(n - n_0)$.

b) Explain the condition when the results of both Circular and Linear Convolution will be the same.

c) Determine the circular convolution of the following sequences and compare the results with linear convolution :

$$x(n) = [\,1, 0.5, 1, 0.5, 1, 0.5, 1, 0.5\,]$$

$$h(n) = [\,0, 1, 2, 3\,]$$

d) Determine the DFT of the four point sequence

$$x(n) = [\,2, 4, 1, 3\,].$$ 3 + 2 + 5 + 5

10. a) Determine the 8-point DFT of the following sequence :

$$x(n) = [\,0.5, 0, 0.5, 0, 0.5, 0, 0.5, 0\,]$$

Use in place radix-2 decimation in time FFT algorithm.

b) What are the various FIR Filter design methods ? Which window is most commonly used for FIR Filter design and why ?

c) Design the symmetric FIR lowpass filter for which desired frequency response is expressed as :

$H_d(\omega) = e^{-j\omega\tau}$ for $\omega \leq \omega_c$ and 0 elsewhere.

The length of the filter should be 7 and $\omega_c = 1$ radians/sample. Make use of Rectangular Window.

6 + 3 + 6

11. Write short notes on any *three* of the following : 3 × 5

a) Sampling Theorem

b) Butterfly Structure of FFT

c) Gibbs Phenomenon

d) Hilbert Transformer

e) Window Method of Filter Design.