



ENGINEERING & MANAGEMENT EXAMINATIONS, JUNE - 2009
DIGITAL SIGNAL PROCESSING
SEMESTER - 6

Time : 3 Hours]

[Full Marks : 70

GROUP - A**(Multiple Choice Type Questions)**

1. Choose the correct alternatives for any *ten* of the following : 10 × 1 = 10

i) Infinite memory system is also known as

- | | | |
|-------------------|-------------------|----------------------|
| a) FIR system | b) IIR system | |
| c) Digital system | d) Analog system. | <input type="text"/> |

ii) The z-transform of $u(-n)$ is

- | | | |
|-----------------------------|------------------------|----------------------|
| a) $\frac{1}{(1 - z^{-1})}$ | b) $\frac{z}{(1 - z)}$ | |
| c) $\frac{1}{(1 - z)}$ | d) $\frac{1}{(z - 1)}$ | <input type="text"/> |

iii) For rectangular window used for designing FIR filters, the peak amplitude of side lobe is

- | | | |
|------------|-------------|----------------------|
| a) - 40 dB | b) - 3 dB | |
| c) 0 dB | d) - 13 dB. | <input type="text"/> |

iv) The sequence $x(n) = (-1)^n$ is periodic with a period of

- | | | |
|--------------|--------------|----------------------|
| a) 6 samples | b) 4 samples | |
| c) 2 samples | d) 0 sample. | <input type="text"/> |

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v) Zero padding a signal

- a) reduces aliasing
- b) increases time resolution
- c) increases frequency resolution
- d) has no effect.

vi) If the Fourier transform of $x(n)$ is $X(\omega)$, then the Fourier transform of $nx(n)$ is

- a) $-j \frac{dX(\omega)}{d\omega}$
- b) $\frac{dX(\omega)}{d\omega}$
- c) $j \frac{dX(\omega)}{d\omega}$
- d) none of these.

vii) The digital system in $y(n) = x(n^2)$ is

- a) linear and causal
- b) linear and non-causal
- c) non-linear and causal
- d) non-linear and non-causal.

viii) If $x^*(n)$ is the complex conjugate of $x(n)$ then

- a) $|x(n)|^2 \neq |x^*(n)|^2$
- b) $|x(n)| = x(n) \cdot x^*(n)$
- c) $|x(n)|^2 = x(n) \cdot x^*(n)$
- d) none of these.

ix) If $X(k)$ represents the 8-point DFT of $x(n) = \{1, 1, 1, 1, 1, 1, 0, 0\}$, $X(0)$ is

- a) 3
- b) 1
- c) 6
- d) 0.



x) A discrete-time LTI system is known as causal system if its

- a) impulse response $h(n)$ is zero for $n < 0$
- b) impulse response $h(n)$ is zero for $n > 0$
- c) impulse response $h(n)$ is positive for $n < 0$
- d) none of these.

xi) $X(n)$ is an energy signal when

- a) $G = \sum_{-\infty}^{+\infty} |x(n)|^2$ is finite
- b) $G = \sum_{-\infty}^{+\infty} |x(n)|^2$ is infinite
- c) $P = \lim_{n \rightarrow \infty} \frac{1}{2N+1} \left\{ \sum_{-\infty}^{+\infty} |x(n)|^2 \right\}$ is finite
- d) none of these.

xii) The energy of constant amplitude complex valued exponential function $x(n) = A \exp(jn\omega)$ where A and ω are constants, is given by

- a) A^2
- b) $\frac{A^2}{2\omega}$
- c) $\frac{A^2}{2}$
- d) $\frac{A^2}{\omega}$

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following.

$3 \times 5 = 15$

2. a) State Parseval's energy theorem.
- b) Compute the convolution of the following signals :

$$x(n) = n/2 ; 0 \leq n \leq 5$$

$$h(n) = n/2 ; -3 \leq n \leq 5$$

$$= 0 ; \text{ otherwise}$$

$$= 0 ; \text{ otherwise.}$$

$$1 + 4$$

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3. Prove that the energy of a real valued energy signal is equal to the sum of the energies of its even and odd components i.e. $E_s = E_e + E_o$.
4. For the analog filter having transfer function $h(s) = \frac{1}{s(s+1)}$. Determine $H(z)$ using impulse invariance method.
5. Find out the relation between Fourier transform and Laplace transform with Z-transform.
6. For a causal LTI system, the output $y(n) = \frac{1}{4}y(n-1) + x(n)$. Calculate $y(n)$ while $x(n) = n^3 u(n+1)$.

GROUP - C

(Long Answer Type Questions)

Answer any three of the following.

3 × 15 = 45

7. a) Find the circular convolution of two sequences $x_1(n) = \{1, 1, 2, 2\}$ and $x_2(n) = \{1, 2, 3, 4, 5\}$. 7
- b) State and prove initial value theorem regarding z-transform. 3
- c) Compute DFT of the sequence $x(n) = \{1, 0, 0, 1\}$. 5
8. a) Discuss about design method of Low-pass filter. 4
- b) What do you mean by Windowing? 2
- c) What is rectangular window? 2
- d) How are rectangular windows used to design FIR filter? 4
- e) Determine the IDFT of $Y(k) = \{1, 0, 1, 0\}$. 3
9. a) Find the system function and impulse response of the system described by the difference equation $y(n) = x(n) + 2x(n-1) - 4x(n-2) + x(n-3)$. 5
- b) Find the inverse z-transform of $X(Z) = (z + 0.2) / (z + 0.5)(z - 1)$, $|z| > 1$. 5
- c) What are the properties of Region of convergence? Find the z-transform and ROC of the signal $x(n) = -b^n u(-n-1)$. 5

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10. a) Find the order of Butterworth filter that has a -2dB passband attenuation at a frequency of 20 rad/sec and -10dB stopband attenuation at 30 rad/sec. 5

b) Draw the following : 10

i) Direct form I

ii) Direct form II

iii) Cascade

iv) Parallel structures for the system described by the difference equation :

$$y(n) = \frac{3}{4}y(n-1) - \frac{1}{8}y(n-2) + x(n) + \frac{1}{3}x(n-1).$$

11. a) Find the convolution sum of the signals :

$$x(n) = 1 \quad \text{for } 3 \leq n \leq 6$$

$$= 0 \quad \text{otherwise}$$

$$h(n) = 1 \quad \text{for } -4 \leq n \leq 3$$

$$= 0 \quad \text{otherwise.}$$

5

b) What is zero padding ? What are its uses ? 3

c) A discrete-time system is represented by the following difference equation :

$$y(n) = 3y^2(n-1) - nx(n) + 4x(n-1) - 2x(n+1)$$

is the system

i) linear

ii) time-invariant

iii) causal.

Justify.

2 + 5

END