MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

EC-303

SIGNALS AND SYSTEMS

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.
All symbols are of usual significance.

GROUP A
(Multiple Choice Type Questions)

1. Answer any *ten* questions. 10×1 = 10

(i) If a signal f(t) has energy E, the energy of the signal f(2t) is equal to

(A) E (B) E/2 (C) 2E (D) 4E

(ii) The time period of the signal $x(t) = \cos 2\pi t + \sin 5\pi t$ is

(A) 1 sec (B) 2/5 sec (C) 2 sec (D) 5 sec

(iii) The system y(n+2) + y(n+1) = x(n+2) is

(A) casual and memory less (B) causal and has memory
(C) is causal (D) is non-causal

(iv) The trigonometric Fourier series of an even function of time does not have the

(A) dc term (B) cosine terms
(C) sine terms (D) odd harmonic terms

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(v) If an input signal is applied to two LTI system with impulse responses h(t) and 2h(t – 2), then the response of the second system is the response of the first with

(A) amplitude scaled by 2 and delayed by 2
(B) amplitude scaled by 2 and advanced by 2
(C) delayed by 2
(D) amplitude scaled by 2

(vi) If x (t) is odd, then its Fourier series coefficients must be

(A) real and odd (B) imaginary and odd
(C) real and even (D) imaginary and even

(vii) The Laplace transform of i(t) is given by $I(S) = \frac{2}{s(1+s)}$

As $t \to \infty$, the value of i(t) tends to

(A) 0 (B) 1 (C) 2 (D) ∞

(viii) Flat-top sampling of low-pass signals

(A) give rise to aperture effect (B) implies oversampling
(C) leads to aliasing (D) introduced delay distortion

(ix) The Nyquist sampling rate for the signal $g(t) = 10 \cos(50\pi) \cos^2(150\pi t)$ where t is in seconds is

(A) 150 samples /sec (B) 200 samples /sec
(C) 300 samples /sec (D) 350 samples /sec

(x) If the output of discrete-time LTI system is always identical to the input signal, then the unit-impulse response h(n) is

(A) unit step (B) unit impulse (C) all ones (D) ramp

(xi) The signal x(n) = cos2n is

(A) periodic with period π (B) periodic with period 2
(C) periodic with period 4π (D) aperiodic

(xii) The odd and even components of signal u(t) are

(A) cos t, sin t (B) sin t, – cos t
(C) cos t, j sin t (D) cos t, - j sin t

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GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5 = 15

2. Whether the following system is linear and causal. Justify your answer. 3+2
$y(t) = x^2(t-1) + 2$.

3. Find the Fourier transform of the signal $e^{-a|t|}$, for a > 0. 5

4. Find the Z-transform and ROC of the signal, 5
$x(n) = a^n u(n) - b^n u(-n-1)$; for $|b| > |a|$.

5. If $X(s)$ is the Laplace transform of $x(t)$, then show that $L[x(at)] = \frac{1}{|a|} X\left(\frac{s}{a}\right)$. 5

6. Define ergodic process. Explain the difference between power spectral density and Energy Spectral Density. 3+2

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. 3×15 = 45

7. (a) Prove that an LTI system is BIBO stable if the ROC of system function includes the unit circle. 5+5+5

(b) Using z–transformation find the convolution of two sequence:
$x_1(n) = \{1, 2, -1, -1, 3\}$ and $x_2(n) = \{1, 2, -1, 3\}$.

(c) Find the inverse Z-transform of $X(z) = \frac{z(z^2 - 4z + 5)}{(z-1)(z-2)(z-3)}$

For ROC: (i) $2 < |z| < 3$ (ii) $|z| < 1$.

8. (a) State and prove convolution theorem for CTFT. 5+5+5

(b) Find out Fourier Transform of $x(t) = \cos(\omega_0 t)$.

(c) The input and output of a causal LTI system are related by differential equation: $\frac{d^2y(t)}{dt^2} + 6\frac{dy(t)}{dt} + 8y(t) = 2x(t)$. Find the impulse response of the system.

9. (a) Find the Laplace transform of $x(t) = e^{5t}[u(t) - u(t-5)]$. 5+5+5

(b) State and prove the initial and final values theorems of Laplace transform.

(c) Find the impulse response of the system function,
$H(s) = \frac{(s+2)}{s^2 + 5s + 4}$.

10. (a) State and explain Parseval's theorem for DTFT. 4+2+4+5

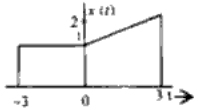
(b) What is the relationship between DTFT and z-transform?

(c) State and prove frequency differentiation property of the CTFT.

(d) Determine the inverse discrete time Fourier transform of the following expression
$X(e^{j\omega}) = \begin{cases} 1; & |\omega| \le W \text{ or } -W \le \omega \le W \\ 0; & W < |\omega| \le \pi \end{cases}$

Also draw the waveform for inverse DTFT of $X(e^{j\omega})$.

11. (a) Consider the signal shown below. Draw the even and odd part of the signal. [5+(1+4)+5]



(b) Define Z-transform. State the properties of ROC for z-transform.

(c) The impulse response of linear time invariant system is $h(n) = \{1, 2, 1, 1\}$.
Determine the response of the system to the input signal $x(n) = \{1, 2, 3, 1\}$.

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

(a) Auto-correlation and Cross-correlation

(b) Discrete LTI system

(c) Mapping of s-plane into z-plane

(d) Causal and Non-causal system

(e) Linear convolution.