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CS/B.TECH(ECE-N)/SEM-3/EC-303/2012-13

2012

SIGNALS & SYSTEMS

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) The fundamental period of the sequence $x[n] = \sin\left(\frac{2\pi n}{3}\right)$ is

a) 1 b) 2

c) 3 d) 6.

ii) A signal is a power signal if

a) $E < \infty$, $P = 0$ b) $P < \infty$, $E = 0$

c) $P < \infty$, $E = \infty$ d) $P = \infty$, $E = 0$

iii) If a signal $x(t)$ has half wave symmetry, then the Fourier series will have only

a) Odd harmonics of sine terms

b) Constant term and even harmonics of cosine terms

c) Even harmonics of sine and cosine terms

d) Odd harmonics of sine and cosine terms.

iv) The system described by $y[n] = nx[n]$ is

a) Linear, time varying and stable

b) Non-Linear, time invariant and unstable

c) Non-linear, time varying and stable

d) Linear, time varying and unstable.

v) A signal is given by the equation $\left(\frac{1}{3}\right)^n u(n)$. The signal is

a) an energy signal

b) a power signal

c) both energy and power signal

d) netither energy nor power signal.

vi) The signal $x(n) = e^{j\frac{3}{5}\left(n+\frac{1}{2}\right)}$

a) is periodic with period $\frac{3}{5}$

b) is periodic with period $\frac{1}{2}$

c) is non-periodic

d) none of these.

vii) The Fourier series coefficient b_n contains

a) only cosine terms

b) only sine terms

c) only dc and cosine terms

d) only dc and sine terms.

viii) The z-transform of a sequence $x(n)$ is $X(z)$. The z-transform of $nx(n)$ is

a) $z\frac{d}{dx}X(z)$ b) $\frac{d}{dz}X(z)$

c) $-z\frac{d}{dz}X(z)$ d) None of these.

ix) The minimum sampling frequency associated with a signal of bandwidth B Hz is

a) 2B Hz b) 4B Hz

c) B Hz d) 3B Hz.

x) The ROC of the signal

$x(n) = \left(\frac{1}{2}\right)^n u(n) + \left(\frac{1}{3}\right)^n u(-n-1)$ is

a) $\frac{1}{3} < |z| < \frac{1}{2}$

b) $\frac{1}{2} < |z| < \frac{1}{3}$

c) $\frac{1}{3} = |z| < \frac{1}{2}$

d) The z-transform of the signal does not exist.

xi) The z transform of $\delta(n-m)$ is

a) z^{-m} b) z^{-m-n}

c) z^{n-m} d) z^{m-n}.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Define energy and power signal.

Calculate the power of signal sequence given by,

$x[n] = e^{j\left(\frac{\pi n}{2}+\frac{\pi}{4}\right)}$ 2 + 3

3. Find the system function and impulse response of the system described by the difference equation

$Y(n) = X(n) + 5X(n-2) - 3X(n-3) + X(n-4)$.

4. Find the compact trigonometric Fourier series for the exponential $e^{-t/2}$ over the interval $0 \le t \le \pi$.

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

6. Find the Laplace transform of the signal $\frac{t^{n-1}}{(n-1)!} e^{-at}$.

7. Determine the z-transform of the following sequence and find its ROC :

$x(n) = \{ 2, -1, 3, 2, 1 \uparrow, 0, 2, 3, -1 \}$

GROUP – C

(Long Answer Type Questions)

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

8. a) Write various forms of Fourier series representation for continuous time periodic signal.

b) How do we get the frequency representation of aperiodic signal ?

c) State the condition required for existence of Fourier Transform.

d) State and prove Parseval's theorem for energy signal.

e) State the F.T. of the signal $x(t) = e^{-at} u(t)$. Hence find out F.T. of the signal

$x(t - t_0) = e^{-(t - t_0)}. u(t - t_0)$. $3 + 2 + 2 + 3 + 5$

9. a) What is the relationship between DTFT and Z-transform ?

b) State and prove convolution theorem of Z-transform.

c) Find z-transform and ROC of

$x(n) = [3(3)^n - 4(2)^n] u(n)$.

d) Find the inverse z-transform using Residue method

$X(z) = (1 - \frac{1}{4} z^{-1}) / (1 - \frac{1}{9} z^{-1})$, ROC : $|z| > 1/3$.

$2 + 3 + 5 + 5$

10. a) State and prove time convolution theorem for CTFT.

b) Find out Fourier Transform of

i) $\cos \omega_0 t$

ii) $e^{-at} u(t)$.

c) The input and the output of a causal LTI system are related by differential equation

$$\frac{d^2 y(t)}{dt^2} + 6 \frac{dy(t)}{dt} + 8y(t) = 2x(t)$$

Find the impulse response of the system. $5 + 5 + 5$

11. a) State and prove Sampling theorem.

b) What is aliasing effect ? How can we overcome from this effect ?

c) Two signals $x_1(t)$ and $x_2(t)$ are multiplied together and the product is sampled by a periodic impulse train $p(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT)$. If the signal $x_1(t)$ and $x_2(t)$ are band limited to Ω_1 and Ω_2 respectively. That is

$X_1(j\Omega) = 0$ for $|\Omega| > \Omega_1$

$X_2(j\Omega) = 0$ for $|\Omega| > \Omega_2$

Determine the maximum sampling interval T that recovers the signal form its sampling. 5 + 5 + 5

12. Write short note on any *three* of the following : 5 + 5 + 5

a) Probability Density Function

b) Stability of a system

c) Power Spectral Density and Energy Spectral Density

d) Significance of ROC.