CBCS SCHEME

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17EC42

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Signals and Systems

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Define signals and systems. Give the relevant examples. **(05 Marks)**

b. Find the even and odd components of each of the following signals :

i) $x(t) = \cos(t) + \sin(t) + \sin(t)\cos(t)$

ii) $x(t) = 1 + t + 3t^2 + 5t^3 + 9t^4$

iii) $x(t) = 1 + \cos(t) + t^2\sin(t) + t^3\sin(t)\cos(t)$. **(09 Marks)**

c. A triangular pulse signal x(t) is dipicted in Fig.Q1(c). Sketch each of the following signals derived from x(t).

i) $y_1(t) = x(3t+2)$

ii) $y_2(t) = x(-2t-1)$

iii) $y_3(t) = x(2t-4)$.

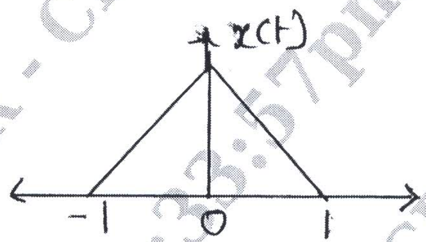

Fig.Q1(c) **(06 Marks)**

OR

2 a. Explain the following properties of systems with suitable example :

i) Time – invariance

ii) Stability

iii) Linearity

iv) Causality. **(08 Marks)**

b. Consider the following sinusoidal signals. Determine whether each x(n) is periodic and if it is find its fundamental period.

i) $x(n) = 10\sin(2n)$

ii) $x(n) = 15\cos(0\cdot 2\pi n)$

iii) $x(n) = 5\sin\left(\frac{6\pi n}{35}\right)$. **(06 Marks)**

c. A discrete time system is given by y(n) = n x(n). Determine its properties. **(06 Marks)**

Module-2

3 a. Derive the expression for convolution sum. **(05 Marks)**

b. Find y(n) = x(n) * h(n). where $x(n) = \left\{3, 5, -\underset{\uparrow}{2}, 4\right\}$ and $h(n) = \left\{\underset{\uparrow}{3}, 1, 3\right\}$. **(05 Marks)**

c. Evaluate the convolution integral for a system with input x(t) and impulse response h(t), respectively given by x(t) = u(t) – u(t – 4) and h(t) = u(t) – u(t – 2). **(10 Marks)**

OR

4 a. Prove the following properties of convolution integral :
i) Commutative
ii) Associative
iii) Distributive. **(10 Marks)**

b. Investigate :
i) Causality
ii) Stability of the following systems :
i) $h(n) = 2^n u(n-1)$
ii) $h(n) = (0.5)^{|n|}$. **(10 Marks)**

Module-3

5 a. Find the step response of an LTI system represented by the impulse response :
$h(n) = (\frac{1}{2})^n u(n)$. **(07 Marks)**

b. Find the step response of an LTI system whose impulse response is given by $h(t) = t^2 u(t)$. **(07 Marks)**

c. Consider the periodic waveform :
$x(t) = 4 + 2\cos 3t + 3\sin 4t$
i) What is the value of T?
ii) What is the total average power?
iii) Find the complex Fourier co-efficient. **(06 Marks)**

OR

6 a. Find the Fourier coefficients for x(t)
$$x(t) = \cos\left(\frac{2\pi t}{3}\right) + 2\cos\left(\frac{5\pi t}{3}\right).$$ **(08 Marks)**

b. Consider the rectangular pulse train shown in Fig.Q6(b). Using the derivative property. Find x(k).

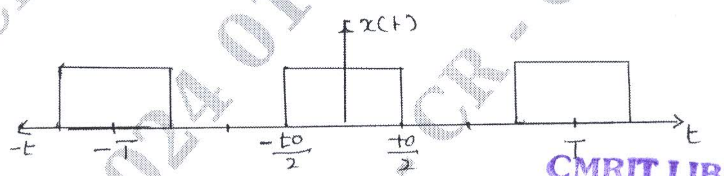

Fig.Q6(b)

(06 Marks)

c. Find the complex Fourier coefficient for the periodic waveform shown in Fig.Q6(c).

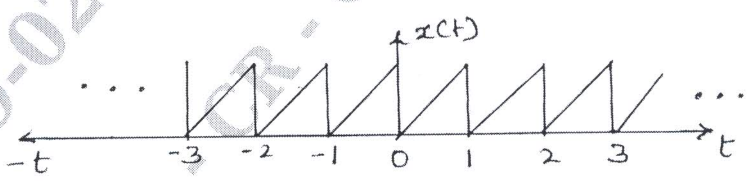

Fig.Q6(c) **(06 Marks)**

Module-4

7 a. Find the Fourier transform of the signal $x(t) = \delta(t + 0.5) - \delta(t - 0.5)$. **(06 Marks)**

b. What is the energy of the signal $x(t) = e^{-\alpha t} u(t)$ and what is its energy in the frequency band $|\omega| \leq 0.5$ rad/sec? **(07 Marks)**

c. Find the Fourier transform of a rectangular pulse described as
$$x(t) = \begin{cases} 1, & 1+1 < a \\ 0, & 1+1 > a \end{cases}.$$ **(07 Marks)**

OR

8 a. Find the DTFT of the sequence $x(n) = \alpha^n u(t)$. Also sketch the magnitude and phase spectrum. **(08 Marks)**

b. Find the Fourier transform of $x(t) = e^{-\alpha t} u(t)$. Also sketch the magnitude and phase spectrum. **(06 Marks)**

c. State and prove the following properties of Fourier transform :
   i) Time shift
   ii) Frequency shift. **(06 Marks)**

Module-5

9 a. Describe the properties of region of convergence and sketch the ROC of two sided sequence, right sided sequence and left sided sequence. **(10 Marks)**

b. Find the z – transform of the following and indicate the region of convergence.
   i) $x(n) = a^n \cos \Omega_0 u(n)$
   ii) $x(n) = n\, a^n u(n)$. **(10 Marks)**

OR

10 a. Find the inverse Z –transform of the sequence

$$x(z) = \frac{z}{3z^2 - 4z + 1},$$ for the following ROCs

   i) $|z| > 1$
   ii) $|z| < \frac{1}{3}$
   iii) $\frac{1}{3} < |z| < 1$

   using partial fraction expansion method. **(08 Marks)**

b. Using power series expansion technique. Find the inverse z – transform of

$$x(z) = \frac{z}{2z^2 - 3z + 1}$$ for the following ROCs.

   i) $|z| < \frac{1}{2}$ ii) $|z| > I$. **(06 Marks)**

c. The output of a discrete time LTI system is found to be $y(n) = 2(\frac{1}{3})^n u(n)$, when the input $x(n)$ is $u(n)$. Find the impulse response $h(n)$ of the system. **(06 Marks)**

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