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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) $y_1(t) = x(3t + 2)$
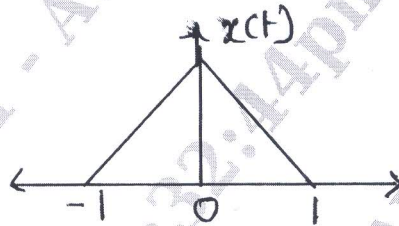   ii) $y_2(t) = x(-2t - 1)$
      iii) $y_3(t) = x(2t - 4)$.

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) $x(n) = 5\sin\left(\dfrac{6\pi n}{35}\right)$. **(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 :
   $h(n) = (½)^n u(n)$. **(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).
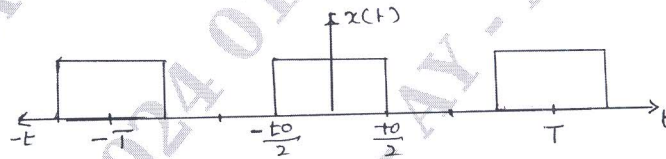

Fig.Q6(b) **(06 Marks)**

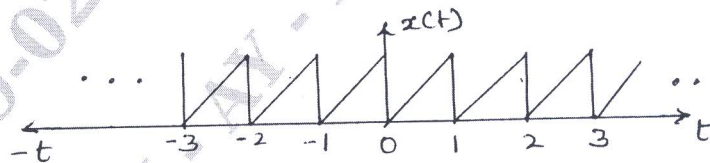   c. Find the complex Fourier coefficient for the periodic waveform shown in Fig.Q6(c).

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 $|\omega| \le 0.5$ 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)**

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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

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

   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

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

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