

CBCS SCHEME

15EC44

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Fourth Semester B.E. Degree Examination, Jan./Feb. 2021 Signals and Systems

Time: 3 hrs.

Max. Marks: 80

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

Module-1

- 1 a. For the trapezoidal pulse $x(t)$ shown in Fig Q1(a), find the energy of $x(t)$ also energy of signal $y(t) = \frac{dx(t)}{dt}$.

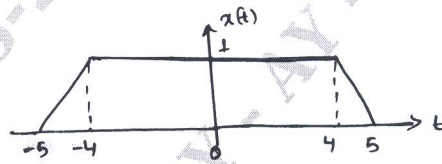


Fig Q1(a)

(04 Marks)

- b. For $x(t)$ and $y(t)$ given in Fig Q1(b) – i) and ii), respectively carefully sketch.
i) $x(t)y(-1-t)$ ii) $x(4-t) \cdot y(t)$

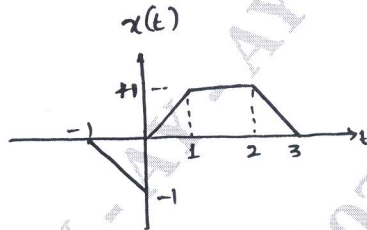


Fig Q1(b) – i)

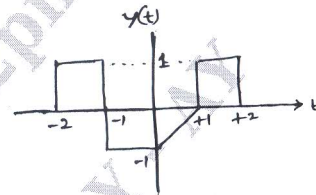


Fig Q1(b) – ii)

(06 Marks)

- c. For the following systems described by the input output relation, determine whether the system is linear, time invariant, causal and stable.
(i) $y(n) = x(n) + u(n+1)$ (ii) $y(t) = e^{-t} u(t)$

(06 Marks)

OR

- 2 a. List the elementary continuous time signals with suitable expression and diagram for each. (06 Marks)
b. Determine whether the following signals are periodic, if they are periodic, find the fundamental period.

(i) $x(t) = \cos(2\pi t) + \sin(3t)$ (ii) $x(n) = \cos\left(\frac{1}{5}\pi n\right) \cdot \sin\left(\frac{1}{3}\pi n\right)$ (04 Marks)

- c. Sketch the even and odd components of the signals depicted in Fig Q2(c) i) and ii)

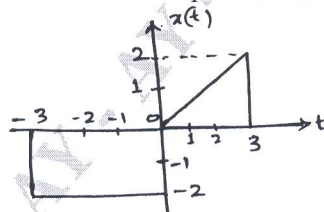


Fig Q2(c) – i)

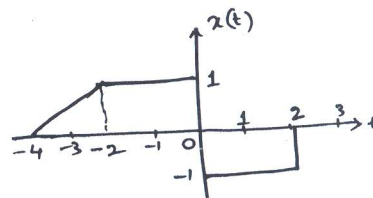


Fig Q2(c) – ii)

(06 Marks)

Module-2

- 3 a. Suppose the input $x(t)$ and impulse response $h(t)$ of a LTI system are given by
 (i) $x(t) = 2u(t-1) - 2u(t-3)$
 (ii) $h(t) = u(t+1) - 2u(t-1) + u(t-3)$
 Find the output of this system. (10 Marks)
- b. State and prove the commutative and distributive properties of the convolution sum. (06 Marks)

OR

- 4 a. A LTI system has impulse response given by $h(n) = u(n) - u(n-10)$
 Determine the output of this system when the input $x(n)$ is defined by
 $x(n) = u(n-2) - u(n-7)$. (08 Marks)
- b. State and prove the associative property of convolution integral. (04 Marks)
- c. A continuous time LTI system has impulse response as shown in Fig Q4(c)

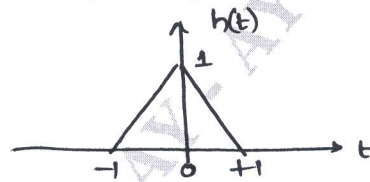


Fig Q4(c)

Find its output, if the input is $x(t) = \delta(t-1) + \delta(t-2) + \delta(t-3)$. (04 Marks)

Module-3

- 5 a. The following are the impulse responses of LTI systems. Determine whether each system is memoryless, causal and stable
 i) $h(t) = e^t u(-1-t)$
 ii) $h(n) = \cos(n)u(n)$
 iii) $h(t) = u(t+1) - 2u(t-1)$. (06 Marks)
- b. Determine the spectra of the signal $x(n) = \cos\left(\frac{\pi}{3}n\right)$. (05 Marks)
- c. Determine and sketch the magnitude and phase spectra of the signal
 $x(n) = (-1)^n$; $-\infty < n < \infty$ (05 Marks)

OR

- 6 a. Evaluate the step response for the LTI systems represented by the following impulse responses. i) $h(t) = t \cdot u(t)$ ii) $h(t) = e^{-|t|}$ (06 Marks)
- b. Evaluate the Fourier series representation for the signal $x(t) = \sin(2\pi t) + \cos(3\pi t)$. (07 Marks)
- c. Define continuous Time Fourier Series. State any 4 properties of CTFS. (03 Marks)

Module-4

- 7 a. State and prove Parseval's theorem for continuous Time Fourier Transform. (04Marks)
- b. Find the DTFT for the signals
 i) $x(n) = 2^n u(-n)$ ii) $x(n) = a^{|n|}$; $|a| < 1$ (06 Marks)
- c. Find the Fourier Transform of the signal
 $x(t) = \sin(\pi t)e^{-2t} \cdot u(t)$ (06 Marks)

OR

- 8 a. Evaluate the Fourier transform for the signal $x(t) = e^{-3t} u(t-1)$. Sketch the magnitude and phase spectra. (06 Marks)
- b. Determine the signal $x(n)$ if its DTFT is as shown in Fig Q8(b).

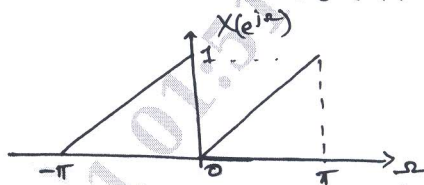


Fig Q8(b)

- c. State sampling theorem. Determine the Nyquist rate corresponding to the following signals. (05 Marks)
- i) $x_1(t) = \cos(150\pi t) \cdot \sin(100\pi t)$ ii) $x_2(t) = \cos^3(200\pi t)$.

Module-5

- 9 a. State and prove the convolution property of Z transform. (04 Marks)
- b. Find the Z-transform of the signal

$$x(n) = \left\{ n \left(\frac{-1}{2} \right)^n \cdot u(n) \right\} * \left(\frac{1}{4} \right)^{-n} u(-n) \quad (06 \text{ Marks})$$

- c. Using power series expansion method, determine the inverse Z-transform of

(i) $X(z) = e^{z^2}$, with ROC all z except $|z| = \infty$

(ii) $X(z) = \frac{1}{1 + \frac{1}{2}z^{-1}}$ with ROC $|z| > \frac{1}{2}$. (06 Marks)

OR

- 10 a. Find the time domain signal corresponding to the Z-transform

$$X(z) = \frac{\frac{1}{4}z^{-1}}{\left(1 - \frac{1}{2}z^{-1}\right)\left(1 - \frac{1}{4}z^{-1}\right)} \quad \text{given the following cases of ROC}$$

i) ROC ; $|z| > \frac{1}{2}$ ii) ROC ; $|z| < \frac{1}{4}$ iii) ROC $\frac{1}{4} < |z| < \frac{1}{2}$ (05 Marks)

- b. A causal system has input $x(n]$ and output $y(n]$. Determine transfer function and impulse response of this system.

$$x(n) = (-3)^n \cdot u(n) \quad y(n) = 4(2)^n u(n) - \left(\frac{1}{2}\right)^n u(n) \quad (05 \text{ Marks})$$

- c. A LTI discrete time system is given by the system function $H(z) = \frac{3 - 4z^{-1}}{1 - 3.5z^{-1} + 1.5z^{-2}}$

Specify the ROC of $H(z)$ and determine $h(n)$ for the following conditions.

- i) The system is stable ii) The system is causal. (06 Marks)
