CBCS SCHEME

USN

15EC44

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.*

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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 $y(t) = \frac{d\,x(t)}{dt}$.

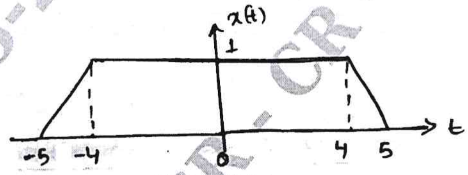

Fig Q1(a) **(04 Marks)**

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) $x(4-t)\cdot y(t)$

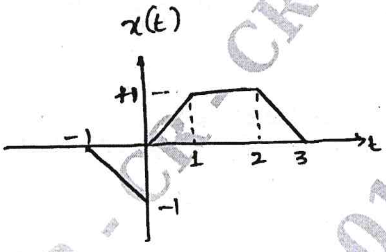

Fig Q1(b) – i)

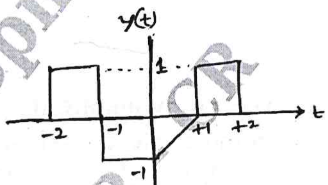

Fig Q1(b) – ii) **(06 Marks)**

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)

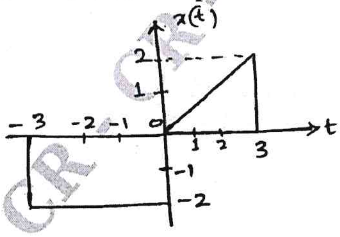

Fig Q2(c) – i)

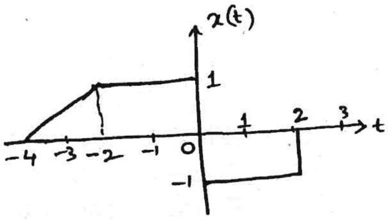

Fig Q2(c) – ii) **(06 Marks)**

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)

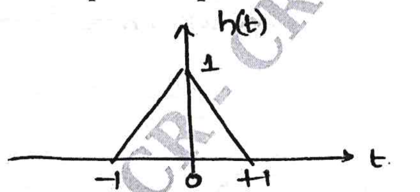

Fig Q4(c)

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).

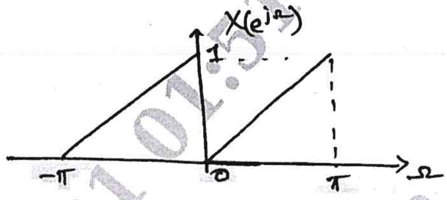

Fig Q8(b) **(05 Marks)**

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

Module-5

9 a. State and prove the convolution property of Z transform. **(04 Marks)**

b. Find the Z-transform of the signal

$$x(n) = \left\{ n\left(\frac{-1}{2}\right)^n \cdot u(n) \right\} * \left(\frac{1}{4}\right)^{-n} u(-n)$$ **(06 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) $X(z) = \dfrac{1}{1+\frac{1}{2}z^{-1}}$ with ROC $|z| > \dfrac{1}{2}$. **(06 Marks)**

OR

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

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

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

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

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

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

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)**

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