CBCS SCHEME

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15EC44

Fourth Semester B.E. Degree Examination, Feb./Mar. 2022
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. Find and sketch the even and odd component of the signal

$x(t) = 1 \quad -1 \le t \le 1$
$= 2 \quad 1 \le t \le 2$
$= 0 \quad \text{Otherwise}$ **(06 Marks)**

b. Determine whether the signal $x(n) = \left(\frac{1}{2}\right)^n u(n)$ is Energy signal or power signal and also find the energy or power. **(04 Marks)**

c. The continuous time signal x(t) shown in Fig.Q1(c). Sketch the following signal.
(i) $x(t)\,u(1-t)$ (ii) $x(t)\,[u(t)-u(t-1)]$ (iii) $x(t)\,[u(t+1)-u(t)]$ **(06 Marks)**

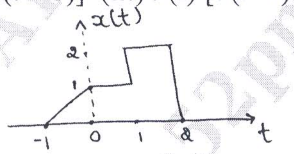

Fig.Q1(c)

OR

2 a. Determine whether the signal $x(n) = \cos\left(\frac{n\pi}{8}\right)\sin\left(\frac{n\pi}{4}\right)$ is periodic or non periodic. If periodic, find the fundamental period. **(04 Marks)**

b. Fig.Q2(b) shows a staircase line signal x(t) that may be viewed as the superposition of three rectangular pulses. Starting with a template of the rectangular pulse g(t) shown in Fig.Q2(b). Construct the waveform of x(t) and express x(t) in terms of g(t).

Fig.Q2(b) **(08 Marks)**

c. The output of a discrete-time system is related to its input x[n] as follows :
$y[n] = 2x(n+2) + 3x(n) + x(n-1)$
Determine whether it is (i) Memoryless (ii) Stable (iii) Causal (iv) Time Invariant **(04 Marks)**

Module-2

3 a. Derive the expression for convolution sum. **(04 Marks)**

b. Evaluate the discrete-time convolution sum
$Y[n] = 2[u(n+2) - u(n-4)] * \{u[n+1] - u[n-4]\}$ **(10 Marks)**

c. State and prove the commutative property of convolution sum. **(02 Marks)**

OR

4 a. An LTI system has the impulse response $h(t) = e^{-2t}\,u(t+2)$. Determine the system output $y(t)$ if the input signal $x(t) = e^{-3t}\,u(t-1)$. **(10 Marks)**

b. State and prove the associative and distributive properties of Convolution Integral. **(06 Marks)**

Module-3

5 a. Consider the interconnection of Four LTI system, as depicted in Fig.Q5(a). The impulse responses of the systems are $h_1(n) = u[n]$, $h_2[n] = u[n+2] - u[n]$ and $h_3(n) = \delta(n-2)$, $h_4[n] = \alpha^n\,u[n]$. Find the impulse response $h[n]$ of the overall system. **(06 Marks)**

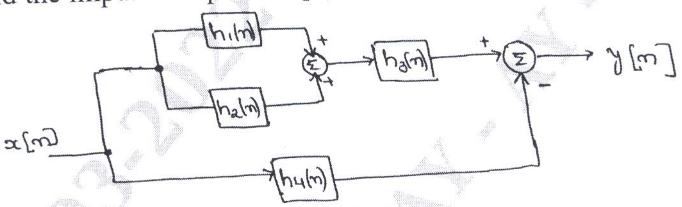

Fig.Q5(a)

b. For each of the following impulse responses, determine whether corresponding system is (i) Memoryless (ii) Causal (iii) Stable. Justify your answers.

$h(t) = u(t+1) - u(t-1)$

$h(n) = 2^n\,u[-n]$ **(06 Marks)**

c. Evaluate the step responses for the LT1 systems represented by the following impulse responses:

(i) $h(n) = \left(\frac{1}{2}\right)^n u[n]$ (ii) $h(t) = e^{-|t|}$ **(04 Marks)**

OR

6 a. Determine the DTFS coefficients of the periodic signal depicted in Fig.Q6(a).

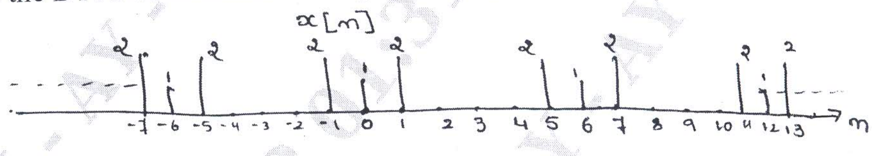

Fig.Q6(a) **(08 Marks)**

b. Determine the Fourier series representation of

$x(t) = 2\sin(2\pi t - 3) + \sin(6\pi t)$ **(08 Marks)**

Module-4

7 a. Use the linearity property to determine the Fourier representation of the signal

$x(t) = 2e^{-t}\,u(t) - 3e^{-2t}\,u(t)$ **(04 Marks)**

b. State and prove differentiation in time domain property of CTFT. **(04 Marks)**

c. Determine the time-domain signal $x(t)$ corresponding to the frequency domain signal

$$x(jw) = \frac{-jw}{(jw)^2 + 3jw + 2}$$ **(08 Marks)**

OR

8 a. Find DTFT of the signal $x[n] = \left(\frac{1}{3}\right)^n u[n+2]$ **(04 Marks)**

b. Suppose $x(t) = 3\sin(2\pi t) + \cos(\pi t) + \sin(4\pi t)$.
Determine the condition on the sampling interval T_s so that each $x(t)$ is uniquely represented by the discrete-time sequence $x(n) = x(nT_s)$. **(03 Marks)**

c. Find the Inverse DTFT of $X(e^{j\Omega}) = \dfrac{\frac{5}{6}e^{-j\Omega} + 5}{1 + \frac{1}{6}e^{-j\Omega} - \frac{1}{6}e^{-j2\Omega}}$. (09 Marks)

Module-5

9 a. Define ROC. Explain properties of ROC with example. (06 Marks)

b. Find the Z-transform of the signal

$$x(n) = \left(n\left(-\frac{1}{2}\right)^n u[n]\right) * \left(\frac{1}{4}\right)^{-n} u[-n]$$ (10 Marks)

OR

10 a. Determine the transfer function and impulse response for the causal LTI system described by the difference equation $y[n] - \frac{1}{4}y(n-1) - \left(\frac{3}{8}\right)y(n-2) = -x[n] + 2x[n-1]$ (10 Marks)

b. Find the inverse Z-transform of $X(z) = e^{z^2}$, with ROC all z except $|z| = \infty$. (06 Marks)

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