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18EC45

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 Signal. List the various classifications of signals with suitable expressions/diagrams. **(06 Marks)**

b. Sketch the even and odd components of the following signals
i) $x(n) = u(n) - u(-n-1)$
ii) $x(t) = r(t) - 2r(t-1) + r(t-2)$ where $r(t) = t \cdot u(t)$. **(08 Marks)**

c. Determine whether the following signals are energy or power signals. Also determine their average power/total energy
i) $x(n) = \alpha^n u(n)$ ii) $x(t) = 5ws\,(\pi t)$. **(06 Marks)**

OR

2 a. List all the continuous time elementary signals with necessary expressions and suitable diagrams. **(06 Marks)**

b. Determine whether the following signals are periodic or not. If periodic, determine their fundamental period
i) $x(n) = \text{Cos}\left(\frac{\pi}{2}n\right) \cdot \text{Cos}\left(\frac{\pi}{4}n\right)$
ii) $x(t) = 2\text{Cos}\,t + 3\text{Cos}(\pi t)$ **(06 Marks)**

c. For signals x(t) and y(t) as given in Fig Q2(c), sketch the following
i) $x(2t) \cdot y\left(\frac{1}{2}t+1\right)$ ii) $x(t+1)(2-1)$.

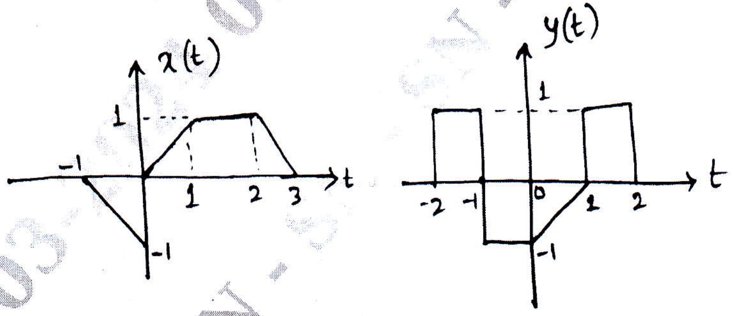

Fig Q2(c) **(08 Marks)**

Module-2

3 a. List all the basic system properties with respect to continuous time systems, with definition, necessary expressions and example. **(08 Marks)**

b. Convolute $x(n) = \{1, 2, -\underset{\uparrow}{1}, 1\}$ and $h(n) = \{1, \underset{\uparrow}{0}, 1\}$ using graphical method. **(04 Marks)**

c. For an LTI system characterized by impulse response $h(n) = \beta^n u(n)$, $0 < \beta < 1$, find the output of the system for input x(n) given by $x(n) = \alpha^n [u(n) - u(n-10)]$. **(08 Marks)**

OR

4 a. Determine whether the systems given by the following input output are causal, linear, time – invariant, stable. Justify (08 Marks)
i) $y(n) = (n + 1)\,x(n)$ ii) $y(t) = x(t) + 10$

b. Derive the equation for convolution sum. (04 Marks)

c. Convolute the signals $x_1(t) = \{u(t + 2) - u(t - 1)\}$ and $x_2(t) = u(2 - t)$. (08 Marks)

Module-3

5 a. State and prove the associative property of convolution integral. (04 Marks)

b. Given the impulse response, determine whether each of the following systems are stable, memoryless, causal. Justify your answer with suitable explanation. (08 Marks)
i) $h(n) = (0.8)^n\,u(n + 2)$
ii) $h(t) = e^{-6t}u(3 - t)$

c. Obtain the Fourier series representation for the signal $x(t) = \text{Sin}(2\pi t) + \text{Cos}(3\pi t)$. Sketch the magnitude and phase spectra. (08 Marks)

OR

6 a. Evaluate the step response for the systems with impulse response as given below.
i) $h(t) = e^{-|t|}$
ii) $h(n) = \left(\frac{1}{2}\right)^n u(n)$ (10 Marks)

b. Find the Fourier series of the signal shown in Fig Q6(b)

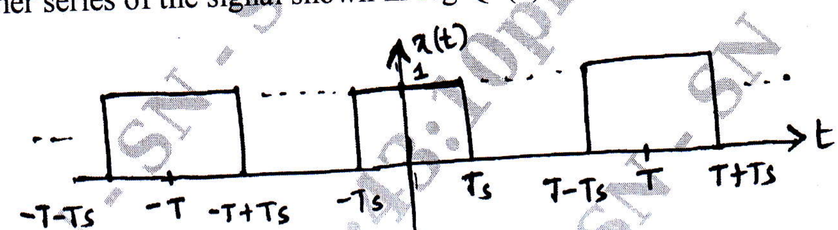

Fig Q6(b) (10 Marks)

Module-4

7 a. State and prove the time shift property of Discrete Time Fourier Transform. (04 Marks)

b. Evaluate the Fourier transform of the following signals. Also draw spectrum. (08 Marks)
i) $x(t) = e^{-at} \cdot u(t), a > 0$
ii) $x(t) = \delta(t)$

c. Evaluate the DTFT for the signal x(n) shown in Fig Q7(c)

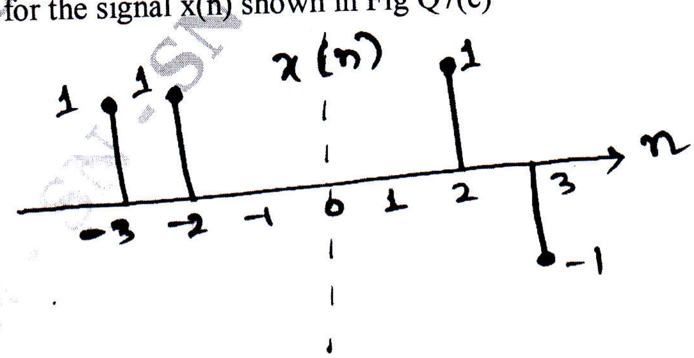

Fig Q7(c) (08 Marks)

OR

8 a. Using appropriate properties, find the DTFT of the signal $x(n) = \text{Sin}\left(\frac{\pi}{4}n\right)\left(\frac{1}{4}\right)^n u(n-1)$. **(08 Marks)**

b. Determine the inverse Fourier transform of the following signals

i) $x(jw) = \frac{5jw + 12}{(jw)^2 + 5jw + 6}$

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

c. State and prove time differentiation property of Fourier transform. **(04 Marks)**

Module-5

9 a. List all the properties of Region of convergence (ROC). **(04 Marks)**

b. Determine the Z-transform, the ROC and the locations of poles and zeros of x(z) for the following signals

i) $x(n) = -\left(\frac{3}{4}\right)^n u(-n-1) + \left(\frac{-1}{3}\right)^n u(n)$

ii) $x(n) = n \cdot \text{Sin}\left(\frac{\pi}{2}n\right)u(-n)$ **(08 Marks)**

c. Find the inverse z-transform of $x(z) = \frac{1 - z^{-1} + z^{-2}}{\left(1 - \frac{1}{2}z^{-1}\right)(1 - 2z^{-1})(1 - z^{-1})}$ with following ROCs

i) $1 < |z| < 2$

ii) $\frac{1}{2} < |z| < 1$. **(08 Marks)**

OR

10 a. Determine the z-transform and ROC for the signal $x(n) = \left(\frac{1}{2}\right)^n \{u(n) - u(n-10)\}$. **(04 Marks)**

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

i) $x(z) = \text{Cos}(z^{-2})$ ROC $|z| > 0$

ii) $x(z) = \frac{1}{1 - \left(\frac{1}{4}\right)z^{-2}}$ ROC $|z| > \frac{1}{4}$. **(08 Marks)**

c. Find the transfer function and the impulse response of a causal LTI system if the input to the system is $x(n) = \left(-\frac{1}{3}\right)^n u(n)$ and the output is $y(n) = 3(-1)^n u(n) + \left(\frac{1}{3}\right)^n u(n)$. **(08 Marks)**

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