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15EC44

Fourth Semester B.E. Degree Examination, July/August 2021
Signals and Systems

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions.***

1 a. Check whether the following system is i) linear or nonlinear ii) Time invariant or time variant iv) Stable or unstable v) invertible or non invertible $y(n) = \log(x(n))$ **(06 Marks)**

b. Sketch the following signals and determine their even and odd components
$x(n) = u(n + 2) - 3\,u(n - 1) = 2u(n - 5)$ **(06 Marks)**

c. Represent the given signal x(t) shown in Fig Q1(c) using basic signals.

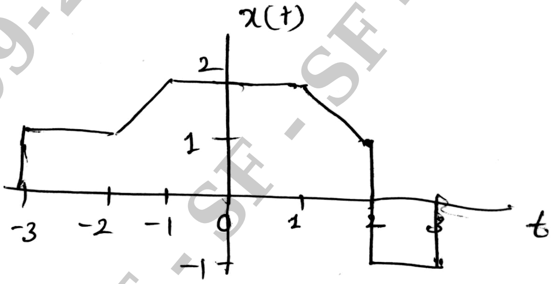

Fig Q1(c) **(04 Marks)**

2 a. Check whether the following signal are periodic or not. If periodic, determine the fundamental period :

i) $x(n) = \mathrm{Cos}\left(\frac{\pi n}{7}\right)\mathrm{Sin}\left(\frac{\pi n}{3}\right)$ ii) $x(t) = \left[2\mathrm{Cos}^2\left(\frac{\pi t}{2}\right) - 1\right]\mathrm{Cos}(\pi t)\,\mathrm{Sin}(\pi t)$ **(06 Marks)**

b. A rectangular pulse $x(t) = \begin{cases} A, & \text{for } 0 \le t \le T \\ 0, & \text{Elsewhere} \end{cases}$ in applied to an integrator circuit, find the total energy of the output y(t) of the integrator. **(05 Marks)**

c. A staircase signal x(t) that may be viewed as a superposition of four rectangular pulses. Starting with rectangular pulse shown in Fig Q2(c), constant and express x(t) in forms of g(t)

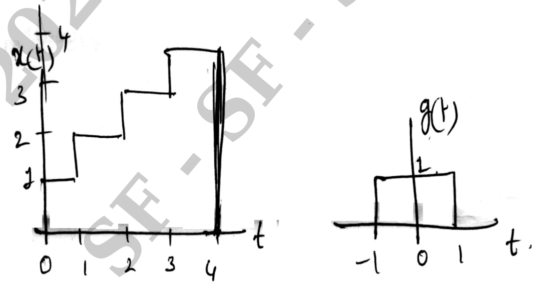

Fig Q2(c)

(05 Marks)

3 a. Find the overall impulse response of a cascade of two systems having identical impulse responses, $h(t) = 2[u(t) - u(t - 1)]$. **(08 Marks)**

b. Find the discrete time convolution sum given below.
$y(n) = \beta^n u(n) \times \alpha^n u(n)$; $|\beta| < 1$; $|\alpha| < 1$. **(08 Marks)**

4 a. A LTI system has impulse response $h(t) = t\,u(t) + (10 - 2t)\,u(t - 5) - (10 - t)\,u(t - 10)$. Determine the output for the following input $x(t) = \delta(t + 2) + \delta(t - 5)$. **(05 Marks)**

b. Evaluate the discrete time convolution sum given below $y(n) = u(n) \times u(n - 3)$. **(08 Marks)**

c. State three properties of discrete time convolution. **(03 Marks)**

5 a. Find the step response of a system whose impulse response is given by $h(t) = u(t + 1) - u(t - 1)$. **(04 Marks)**

b. A system consists of several subsystem connected as shown in Fig Q5(b). Find the operator H relating x(t) and y(t) for the following subsystem operators.

$H_1 : y_1(t) = x_1(t)\,x_1(t - 1)$

$H_2 : y_2(t) = |\,x_2(t)\,|$

$H_3 : y_3(t) = 1 + 2x_3(t)$

$H_4 : y_4(t) = \text{Cos}\,(y_3(t))$

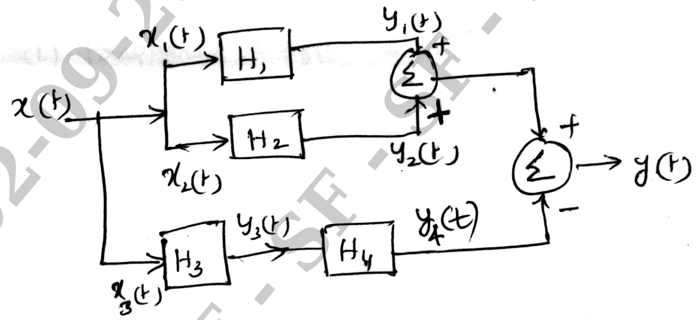

Fig Q5(b) **(05 Marks)**

c. Obtain the DTFS coefficient of $x(n) = \text{Cos}\left(\frac{6\pi}{13}n + \frac{\pi}{6}\right)$.

Draw : i) Magnitude spectrum ii) Phase spectrum. **(07 Marks)**

6 a. State the following properties of DTFS.

i) Linearity ii) Time shift iii) frequency shift iv) Parseval's Relationship v) Convolution vi) Modulation. **(06Marks)**

b. Evaluate the FS representation for the signal, $x(t) = \text{Sin}\,(2\pi t) + \text{Cos}\,(3\pi t)$. Sketch the magnitude and phase spectra. **(07 Marks)**

c. For the impulse response h(n) given below determine whether the corresponding system is i) memoryless ii) causal iii) stable.

$h(n) = 2u(n) - 2u(n - 1)$. **(03 Marks)**

7 a. Compute the DTFT of the signal

$$x(n) = \left(\frac{1}{2}\right)^n \{u(n+3) - u(n-2)\}$$ **(06 Marks)**

b. State and prove the following properties of Fourier Transform.

i) Frequency differentiation ii) Linearity. **(06 Marks)**

c. State Sampling theorem. **(04 Marks)**

8 a. Specify the Nyquist rate and Nyquist intervals for the following signals.

i) $g(t) = \text{Sin c}\,(200t)$ ii) $g_2(t) = \text{Sinc}^2\,(200t)$. **(04 Marks)**

b. Obtain the Fourier transform of the signal $x(t) = e^{-at}\,u(t)$; $a > 0$. Draw its magnitude and phase spectra. **(06 Marks)**

c. State and explain the significance of following terms under DTFT

i) Parseval's relation ii) Convolution iii) Time shift. **(06 Marks)**

9 a. Explain the properties of ROC. **(04 Marks)**

b. Determine the z-transform of $x(n) = -u(-n-1) + \left(\frac{1}{2}\right)^n u(n)$. Find the ROC and pole-zero locations of x(z) in the Z-plane. **(06 Marks)**

c. A causal system has input x(n) and output y(n). Find the impulse response of the system, if

$$x(n) = \delta(n) + \frac{1}{4}\delta(n-1) + \frac{1}{8}\delta(n-2)$$

$$y(n) = \delta(n) - \frac{3}{4}\delta(n-1)$$ **(06 Marks)**

10 a. State and prove the following properties Z-transform i) Initial value theorem ii) Time reversal property. **(06 Marks)**

b. Find the inverse Z-transform of $x(z) = \dfrac{z^{-1}}{-2z^{-2} - z^{-1} + 1}$ ROC : $| < |z| < 2$. **(06 Marks)**

c. Determine whether the system is causal and stable $H(z) = \dfrac{2z+1}{z^2 + z - 5/16}$. **(04 Marks)**

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