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18EE54

Fifth 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. Distinguish between
   i) Even and Odd signals
   ii) Energy and power signals **(06 Marks)**

   b. Check whether the following signals are periodic or not. Determine their fundamental period.
   i) $x(t) = \cos(\sqrt{2}t) + \cos(t)$
   ii) $x(n) = 3e^{\frac{j3\pi}{5}\left(n + \frac{1}{2}\right)}$ **(06 Marks)**

   c. Sketch and find the energy of the following signals
   i) $x(t) = \begin{cases} t & ; & 0 < t < 1 \\ 2 - t & ; & 1 < t < 2 \\ 0 & ; & \text{otherwise} \end{cases}$

   ii) $x(n) = \begin{cases} 1 & ; & |n| \le 1 \\ 0 & ; & \text{otherwise} \end{cases}$ **(08 Marks)**

OR

2 a. Given the signal $x(n) = (6 - n)\{u(n) - u(n - 6)\}$ determine and sketch the following signals.
   i) $y_1(n) = x(4 - n)$
   ii) $y_2(n) = x(2n - 3)$ **(06 Marks)**

   b. A continuous time signal $x(t)$ and $g(t)$ is shown in Fig Q2(b) respectively. Express $x(t)$ interms of $g(t)$.
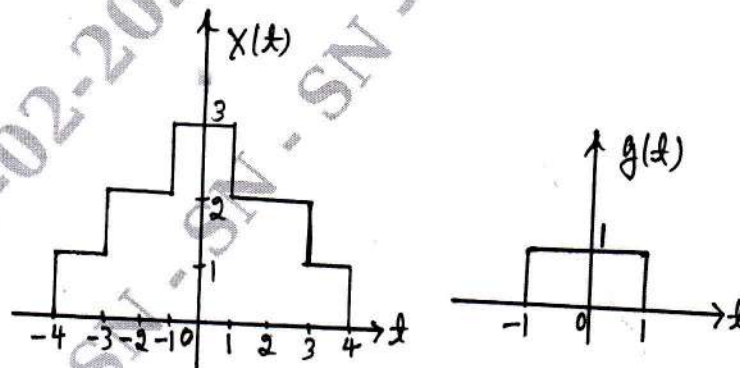

Fig Q2(b) **(04 Marks)**

   c. Determine whether the following systems are memoryless, causal, linear, Time invariant and stable i) $y(t) = x^2(t)$ ii) $y(n) = x(-n)$ **(10 Marks)**

Module-2

3 a. Evaluate the convolution sum of $x(n) = \beta^n u(n)$; $|\beta| < 1$ and $h(n) = \alpha^n u(n)$; $|\alpha| < 1$. **(08 Marks)**

   b. Determine whether the LTI system described by the following impulse responses are memoryless, causal and stable.

   i) $h(t) = e^{2t} u(t - 1)$

   ii) $h(n) = 2u(n) - 2u(n - 1)$ **(06 Marks)**

   c. Determine the forced response for the system given by, $5\dfrac{dy(t)}{dt} + 10y(t) = 2 \times (t)$ with input $x(t) = 2u(t)$. **(06 Marks)**

OR

4 a. Evaluate the convolution integral of $x(t) = u(t + 1)$ and $h(t) = u(t - 2)$. Also sketch the $y(t)$. **(06 Marks)**

   b. Determine the complete response of the system described by the difference equation:

   $y(n) - \dfrac{1}{9} y(n - 2) = x(n - 1)$ with $y(-1) = 1$, $y(-2) = 0$ and $x(n) = u(n)$. **(08 Marks)**

   c. Draw the direct form I and direct form II implementations for the difference equation

   $y(n) + \dfrac{1}{2} y(n - 1) - y(n - 3) = 3 \times (n - 1) + 2 \times (n - 2)$ **(06 Marks)**

Module-3

5 a. State and prove following properties of CTFT.

   i) Time differentiation   ii) Frequency shift **(08 Marks)**

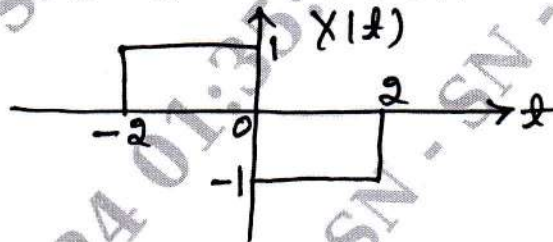   b. Determine the CTFT of the signal $x(t)$ is shown in Fig Q5(b)

Fig Q5(b) **(04 Marks)**

   c. Determine the frequency response and impulse response of the system having the input $x(t) = e^{-t} u(t)$ and output $y(t) = e^{-2t} u(t) + e^{3t} u(t)$. **(08 Marks)**

OR

6 a. State and prove the following properties of CTFT i) Modulation   ii) Time shift **(08 Marks)**

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

   c. Determine the frequency response and impulse response for system described the differential equation.

   $\dfrac{d^2 y(t)}{dt^2} + 5\dfrac{dy(t)}{dt} + 6y(t) = \dfrac{-dx(t)}{dt}$. **(06 Marks)**

Module-4

7 a. State and derive the following properties of DTFT.
   i) Time shift   ii) Convolution (08 Marks)

b. Determine the frequency response and the impulse response of the system having input.

$$x(n) = \left(\frac{1}{2}\right)^n u(n) \text{ and output } y(n) = \frac{1}{4}\left(\frac{1}{2}\right)^n u(n) + \left(\frac{1}{4}\right)^n u(n)$$ (08 Marks)

c. Using the appropriate properties, find DTFT of the following signal

$$x(n) = \left(\frac{1}{2}\right)^n u[n-2]$$ (04 Marks)

OR

8 a. State and derive the following properties of DTFT
   i) Frequency differentiation
   ii) Parseval's Theorem. (08 Marks)

b. Find the DTFT of the following signals
   i) $x(n) = \sigma(n)$
   ii) $x(n) = \alpha^n u(n)$; $|\alpha| < 1$. Draw the magnitude spectrum. (06 Marks)

c. Determine the frequency response and the impulse response of the system described by the difference equation. $y(n) + \frac{1}{2}y(n-1) = x(n) - 2x(n-1)$ (06 Marks)

Module-5

9 a. Define ROC. Describe the properties of ROC in Z-plane. (08 Marks)

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

c. A causal system has input $x(n) = \sigma(n) + \frac{1}{4}\sigma(n-1) - \frac{1}{8}\sigma(n-2)$

and output $y(n) = \sigma(n) - \frac{3}{4}\sigma(n-1)$. Find the impulse response of the system. (06 Marks)

OR

10 a. State and derive the following properties of 2 – transform
   i) Time Reversal
   ii) Convolution property. (08 Marks)

b. Determine the inverse z-transform if $x(z) = \dfrac{\frac{1}{4}z^{-1}}{\left(1-\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)}$ with ROC's

   i) $|z| > \frac{1}{2}$ ii) $|z| < \frac{1}{4}$ iii) $\frac{1}{4} < |z| < \frac{1}{2}$ (08 Marks)

c. Determine whether the system described below is causal and stable.

$$H(z) = \frac{2z+1}{z^2 + z - \frac{5}{16}}$$ (04 Marks)

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