CBCS SCHEME

USN

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) $x(t) = \text{Cos}\,(\sqrt{2}t) + \text{Cos}\,(t)$
   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) $x(t) = \begin{cases} t & ; \quad 0 < t < 1 \\ 2-t & ; \quad 1 < t < 2 \\ 0 & ; \quad \text{otherwise} \end{cases}$
   ii) $x(n) = \begin{cases} 1 & ; \quad |n| \le 1 \\ 0 & ; \quad \text{otherwise} \end{cases}$ **(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).

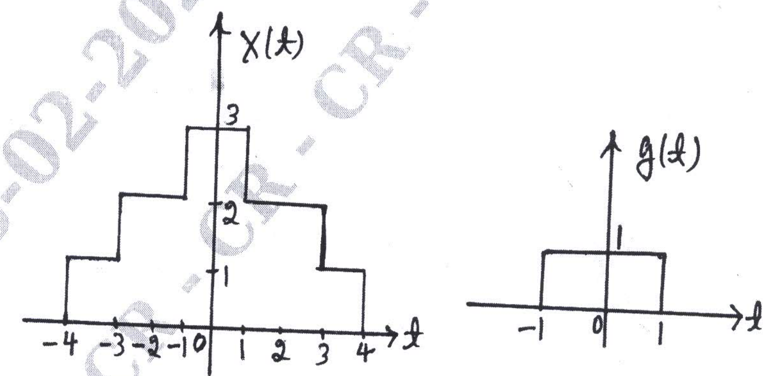

Fig Q2(b) **(04 Marks)**

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)

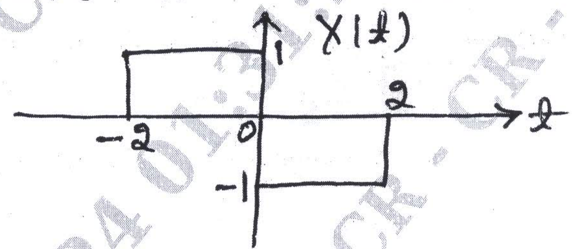

Fig Q5(b) (04 Marks)

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.

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = \frac{-dx(t)}{dt}.$$ (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.
$x(n) = \left(\frac{1}{2}\right)^n u(n)$ 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.
$H(z) = \dfrac{2z+1}{z^2 + z - \frac{5}{16}}$ **(04 Marks)**

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