**Sr. No. -** 015406

**May 2024**

**B.Tech. – IV SEMESTER**

Theory of Signal System (ECP-406)

**Time: 3 Hours** **Max. Marks:75**

***Instructions:***

1. *It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.*
2. *Answer any four questions from Part -B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

## PART -A

Q1 (a) What is the condition of causality of continuous time LTI system? (1.5)

(b) Why ROC cannot contain any poles? (1.5)

(c) Find the system function for given causal LTI system as described by the difference equation y(n) = y(n-1) + y(n-2) + x(n-1) where x(n) is the input and y(n) is the output. (1.5)

(d) Find the output of the continuous time system , whose input and impulse response are x(t) = $\delta$(t) , h(t) = $e^{-at}u(t)$. (1.5)

(e) Compare energy and power signals. (1.5)

(f) What is eigen function of discrete time LTI system? (1.5)

(g) State the need for sampling. (1.5)

(h) What is the significance of Parseval's relation? (1.5)

(i) How is unit step response related to impulse response? (1.5)

(j) State initial value theorem. Find x(∞) if X(s) = $\frac{s-2}{s(s+4)}$ (1.5)

## PART -B

Q2 (a) State and prove differentiation in the frequency domain property of DTFT. Using properties of DTFT, find the DTFT of the following signal x(n) = n $3^{-n}$u(-n). (7.5)

(b) Find the 4- point DFT of the sequence x(n) = 6 + sin $\left(\frac{2\pi n}{N}\right)$; n = 0,1,……….N-1 (7.5)

Q3 (a) If two systems $h_1(t) = e^{-2t}u(t)$ and $h_2(t) = \delta(t) - \delta(t-1)$ are connected in parallel and overall response h(t) of $h_1(t)$ & $h_2(t)$ is connected in cascade with third system $h_3(t) = \delta(t)$ then find the overall response $h_o(t)$ of h(t) & $h_3(t)$. Draw the block diagram of interconnected system and also find the output of it for the input x(t) = u(t) using convolution integral. (7.5)

(b) State and prove sampling theorem. Determine the Nyquist rate and Nyquist interval of signal x(t) = $\left[\frac{\sin(4000\pi t)}{\pi t}\right]^2$ (7.5)

Q4 (a) Plot the signal x(t) = r(-t + 2). Check the linearity , causality and time invariance of system y(t) = x(t-3) + (3-t). Also test the stability of the system $h(t) = (2 + e^{-3t})\, u(t)$. (7.5)

(b) Discuss properties of LTI systems. Perform convolution of the two sequences $x_1(n) = \{ \underset{\uparrow}{1}, 2, 0.5, 1\}$ and $x_2(n) = \{ 1, \underset{\uparrow}{2}, 1, -1\}$.

Q5 (a) Derive the relation between Laplace transform and Fourier transform. Find the Laplace transform of $\cosh \Omega_0 t\, u(t)$. (7.5)

(b) A system is characterized by the differential equation (7.5)

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6\, y(t) = x(t)$$

Solve for y(t) for $t \geq 0$ when $x(t) = u(t)$, $\frac{dy(0^-)}{dt} = 12$, $y(0^-) = 2$

Q6 (a) State and prove convolution property of Z- transform. Find the Z-transform and plot the ROC for the given signal (7.5)

$$x(n) = -b^n u(-n-1) + (0.5)^n u(n)$$

(b) Using the power series expansion technique, find the inverse z -transform of the following $X(z) = \frac{z}{2z^2-3z+1}$ for the cases when ROC : $|z| < \frac{1}{2}$ and ROC : $|z| > 1$ (7.5)

Q7 (a) Find the circular convolution of the two sequences $x_1(n) = \{ 1,2,2,1\}$ and $x_2(n) = \{ 1,2,3,1\}$ using graphical method and matrix method. (7.5)

(b) Distinguish between CTFT and DTFT. Find the Fourier transform of the signal $x(t) = e^{-t}\sin 5t\, u(t)$. (7.5)

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