December 2024
B.Tech (CE) - 5th Sem
Signals and Systems (ESC-501)

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

Instructions:

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

PART A (1.5 marks each)

Q1 (a) What are the different types for representing discrete time signals? (1.5)

(b) What are the basic operations on discrete time signals? (1.5)

(c) Distinguish between static and dynamic systems. (1.5)

(d) Prove that $\varphi(t) = e^{At}$ (1.5)

(e) What are the advantages of using state space representation? (1.5)

(f) What are Dirichlet conditions for the convergence of Fourier series? (1.5)

(g) What is the relationship between discrete time Fourier Transform and Z-transform? (1.5)

(h) Determine the Z transform of $u(n-1)$. (1.5)

(i) Give any two applications of DFT. (1.5)

(j) What is the relationship between the sampling frequency and the bandwidth of a signal for perfect reconstruction? (1.5)

PART B

Q2 (a) Check whether the following digital signals are BIBO stable or not. (6)

1. $y(n) = e^{-x(n)}$
2. $y(n) =$ maximum of $[x(n), x(n-1), x(n-2)]$

(b) Determine whether the following discrete time signals are periodic or not. If periodic, determine the fundamental period. (5)

1. cos $\left(\frac{n}{6}\right)$ cos $\left(\frac{n\pi}{6}\right)$
2. $1 + e^{j2\pi n/3} - e^{j4\pi n/7}$

(c) What is the system? Give common examples of the system. (4)

Q3 (a) Test the following systems for: Static or Dynamic, Linear or non-linear, Causal or non-causal, Time Invariant or Time Variant. (12)

1. $y(n) = \text{odd}[x(n)]$
2. $y(n) = x^2(n) + \frac{1}{x^2(n-1)}$

(b) Prove that if two systems are connected in parallel then the overall impulse response is equal to the sum of two impulse responses. (3)

Q4 (a) Find the convolution of the following sequences either using the direct method or using the graphical method: (8)

1. $x(n) = 3\delta(n+1) - 2\delta(n) + \delta(n-1) + 4\delta(n-2)$
2. $h(n) = 2\delta(n-1) + 5\delta(n-2) + 3\delta(n-3)$

(b) State and prove the Time Differentiation and Convolution properties of the Fourier Transform. (7)

Q5 (a) For the given system matrix, determine the state transition matrix $\Phi(t)$ (5)

$$A = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix}$$

(b) A periodic signal with a period of 4 seconds is described over one fundamental period by $x(t) = 3 - t$; $0 \leq t < 4$. Find the Exponential Fourier Series. Plot the amplitude and phase spectrum. (6)

(c) Compute the 3-point DFT of the sequence $x(n) = \{2, 1, 2\}$. (4)

Q6 (a) State and prove the Sampling Theorem used to reconstruct the original signal. (5)

(b) Using Laplace transform to determine the complete response of the system described by the equation, (6)
$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 4y(t) = \frac{dx(t)}{dt}$; $y(0) = 0$; $\left.\frac{dy(t)}{dt}\right|_{t=0} = 1$, for the input $x(t) = e^{-2t}u(t)$

(c) By using suitable Z-transform properties, find $X(z)$ of: (4)
$x(n) = (n-2)\left(\frac{1}{2}\right)^{n-2} u(n-2)$

Q7 (a) Find the inverse LT of $F(s) = \frac{s^2+2s+5}{(s+3)(s+5)^2}$ for the following conditions: (6)

I. $\sigma > -3$
II. $\sigma < -5$

(b) Find the inverse Z-transform of the following functions: (6)
$X(z) = \frac{z(z^2-4z+5)}{z^3-6z^2+11z-6}$

I. with ROC $|z| < 1$
II. with ROC $1 < |z| < 2$

(c) Enlist the applications of signals and systems in filtering. (3)