

B.TECH
(SEM III) THEORY EXAMINATION 2022-23
BASIC SIGNALS & SYSTEMS

Time: 3 Hours

Total Marks: 100

Note: Attempt all Sections. In the case of any missing data; assume suitably.

SECTION A

1. Attempt all questions in brief.

2 x 10 = 20

- (a) Differentiate between an energy signal and power signal, give an example for both.
- (b) What are standard signals? Give the relations between unit step and unit ramp signals.
- (c) State and prove time Shifting of Fourier Transform.
- (d) Find the Fourier Transform of the signal, $x(t) = e^{-3t}u(t-2)$
- (e) What is meant by Region of Convergence in Laplace Transform?
- (f) Define transfer function of a system.
- (g) Find the Z-Transform of the sequence given as:
 $x[n] = [0,5,3,2,5,2,3,1]$
- (h) What will be the location of the poles in the case of stable system, in z-domain?
- (i) Discuss the advantages of state space analysis in comparison with the transfer function approach.
- (j) List the properties of state transition matrix.

SECTION B

2. Attempt any three of the following:

10x3=30

- (a) Differentiate between the following with suitable examples
 - (i) Linear system and non-linear system
 - (ii) Causal and non-causal system
- (b) (i) What are the conditions to be satisfied for the existence of Fourier series of a periodic signal?
(ii) Derive the Fourier coefficients of the trigonometric Fourier series.
- (c) (i) State and prove initial value theorem for Laplace Transform.
(ii) Consider the transfer function of a network given by:
$$Z(s) = \frac{s^3 + s^2 + 5s + 25}{s^4 + 5s^3 + 4s^2 + 9s + 5}$$
. Find the initial and final value of the function.
- (d) Discuss the properties of Region of Convergence (ROC) of z-transform
- (e) A network is characterized by the following state space equations

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 1 \\ -2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, \quad y = [1 \quad 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Obtain (i) Transfer Function of the system, $\frac{Y(s)}{X(s)}$

(iii) State Transition Matrix

SECTION C

3. Attempt any *one* part of the following:

10x1=10

- (a) (i) Express the signal $x(t)$ shown in Fig. 1 in terms of unit ramp and unit step function.

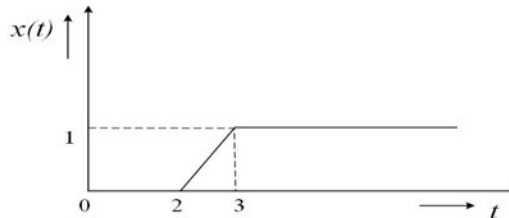


Fig. 1

- (ii) Find the even and odd part of the signal; $x(t)$
- $x(t) = \sin t \quad \cos t \quad \cos t \quad \sin t$.
- (b) (i) Develop the electrical analogous circuit of the system shown in Fig. 2 using force-voltage analogy. Assuming wheels are frictionless (i.e. $D = D = 0$).

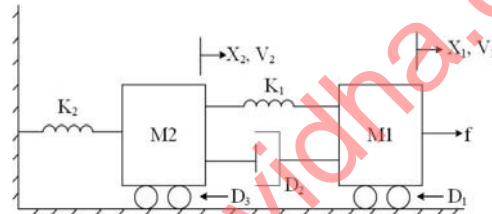


Fig. 2

- (ii) Write down the differential equations of the dynamic system.

4. Attempt any *one* part of the following:

10x1=10

- (a) A continuous time periodic signal is given as

$$x(t) = 2 \cos \frac{2\pi}{3}t + 4 \sin \frac{5\pi}{3}t$$

- (i) Calculate the fundamental frequency ω and the Fourier series coefficients a_n such that $x(t) = \sum a_n e^{jn\omega t}$.
- (ii) Draw the magnitude and phase spectrum
- (b) (i) Determine the time domain signals corresponding to the following Fourier Transforms

$$X(j\omega) = \frac{1}{(j\omega)^2 + 7(j\omega) + 12}$$

- (ii) For the system whose transfer function is given as

$$H(j\omega) = \frac{Y(j\omega)}{X(j\omega)} = \frac{1}{j\omega + 1}$$

Find the system response for the input $x(t) = e^{-2t}$.

5. Attempt any *one* part of the following:

10x1=10

- (a) (i) Derive the relation between Continuous Time Fourier Transform (CTFT) and Laplace Transform.
 (ii) Find the unilateral Laplace transform of the signal shown in Fig. 3.

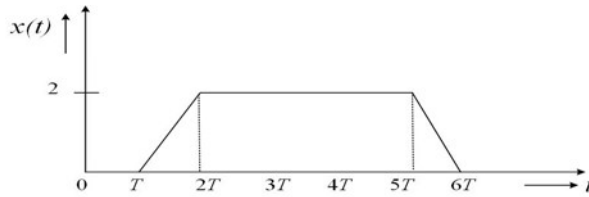


Fig. 3

- (b) Solve for $i(t)$ in circuit in Fig.4 which 3F capacitor is initially charged to 20V, the 6 F capacitor to 10V, and the switch is closed at $t=0$. Also draw the transformed circuit.

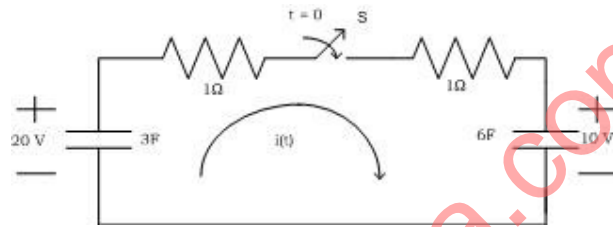


Fig.4

6. Attempt any *one* part of the following:

10x1=10

- (a) Using long division method, determine the inverse z-transform of the function

$$X(z) = \frac{1}{\left(1 - \frac{3}{4}z^{-1} + \frac{1}{8}z^{-2}\right)} \text{ with ROC: } |z| > \frac{1}{2}$$

- (b) Determine the impulse response of the Discrete Time system:

$$y[n] = 3y[n-1] - 2y[n-2] + x[n] - 3x[n-1] + 2x[n-2]$$

7. Attempt any *one* part of the following:

10x1=10

- (a) A system is described by $\ddot{y} + 2\dot{y} + 3y = 6u$, Represent the system in state space, in phase variable form.

- (b) Obtain output response, $y(t)$ of the system described by the state equations if the input is unit step function

$$\begin{cases} \dot{x}_1 = 0x_1 + 1x_2 + 0u \\ \dot{x}_2 = 2x_1 + 3x_2 + 1u \end{cases}; \quad \text{It is given that } C = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \text{ and } x^T(0) = [1 \quad 1]$$