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Paper Id: 233651 Roll No.

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

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

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.

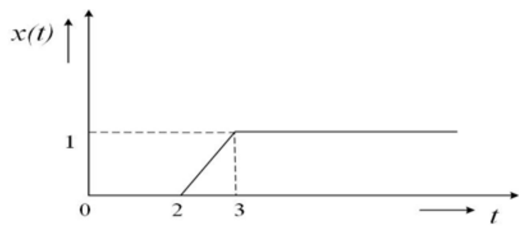

Fig. 1

(ii) Find the even and odd part of the signal; x(t)
$x(t) = \sin(t) + \cos(t) + \cos(t)\, sin\,(t)$.

(b) (i) Develop the electrical analogous circuit of the system shown in Fig. 2 using force-voltage analogy. Assuming wheels are frictionless (i.e. $D_1 = D_3 = 0$).

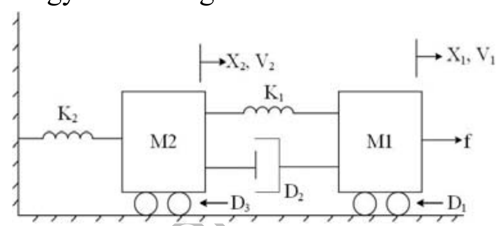

Fig. 2

(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

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

(i) Calculate the fundamental frequency ω_0 and the Fourier series coefficients a_k such that $x(t) = \sum_{k=-\infty}^{\infty} a_k e^{jk\omega_0 t}$.

(ii) Draw the magnitude and phase spectrum

(b) (i) Determine the time domain signals corresponding to the following Fourier Transforms $X(jw) = \dfrac{1}{(jw)^2 + 7(jw) + 12}$

(ii) For the system whose transfer function is given as
$$H(jw) = \frac{Y(jw)}{X(jw)} = \frac{1}{jw+1}$$
Find the system response for the input $x(t) = e^{-2t}$.

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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.

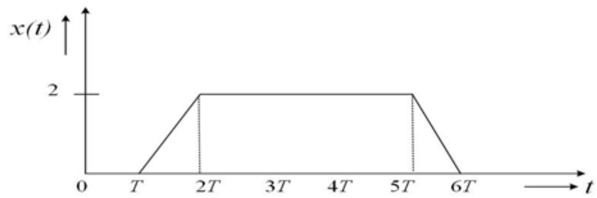

Fig. 3

(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.

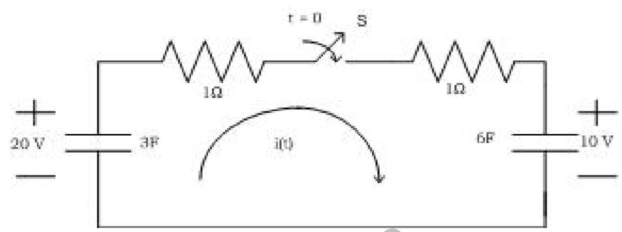

Fig.4

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
$\frac{d^3y(t)}{dt^3} + 2\frac{d^2y(t)}{dt^2} + 3y(t) = 6u(t)$, 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

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \; ; \qquad Itisgiventhat C = \begin{bmatrix} 1 & 0 \\ 1 & -1 \end{bmatrix} \text{ and}$$

$$x^T(0) = [1 \quad 1]$$