Sub Code: BEE-205

Roll No. 2024

B. Tech.
Year: II Semester: III
Minor Test Examination (2025-26)
Subject: Analysis of Linear Systems

Time: 2 Hr. **Max Marks: 30**

Note: Attempt ALL questions.

		Marks
Q1	**Attempt any three parts of the following.**	
a)	Express the signal shown in Fig.1 in terms of step signals. Hence, obtain its Laplace Transform.	4

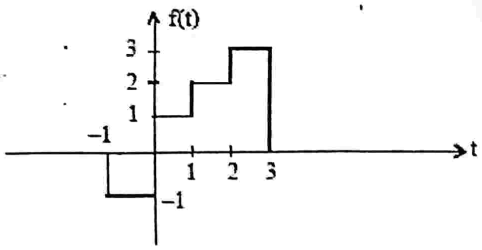


Fig.1

b)	A signal x(t) is given in the Fig.2. Draw with proper scale the following signals: $y(t) = x(t-4)$ *and* $y(t) = x(2t+3)$	4

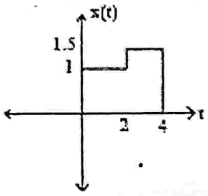


Fig.2

c)	An R-L series circuit is connected in with a switch and a voltage source of 50V. The value of the resistance and inductance are 5 ohm and 10 H respectively. Find the expression of current through the inductor and plot it v/s time. Also find initial and steady state value of the current.	4
d)	A unit impulse voltage is applied at t=0 to a series RC circuit. Find i(t) assuming the initial charge stored in the capacitor to be zero. Assume R=5 ohms and C=2F.	4
Q2	**Attempt any three parts of the following.**	
a)	Define a "Signal". Give mathematical representation and characteristics of unit step, unit impulse and unit ramp signal.	3
b)	Distinguish the following systems with examples. (i) Linear and non-linear systems (ii) Time varying and Time invariant systems	3
c)	Sketch the following signals. (i) $y(t) = u(t) - 2u(t) + 3u(t) - 4u(t) + 5u(t)$ (ii) $y(t) = u(t-2).u(5-t)$	3
d)	Check whether the following properties hold good for the system. $y(t) = 33.\sin(11t).x(t)$ (i) Linearity (ii) Causality (iii) Time invariance (iv) Stability	3

Q3 **Attempt any three parts of the following.**

a) A system is represented by differential equation as:

$$\frac{d^2x(t)}{dt^2} - x(t) = e^{-t}$$. Assuming zero initial conditions, find x(t) for t>0.

b) If $Lf(t) = F(s)$ where, L represents Laplace Transform. Then, prove the following:

(i) $L\frac{df(t)}{dt} = sF(s) - f(0^+)$

(ii) $L\int_0^t f(t)\,dt = \frac{F(s)}{s}$

c) Consider the circuit as shown in Fig.3. The switch is moved from position 1 to 2 at t = 0 after it remained in position 1 for a very long time. Find the expression for the inductor current i(t) for t > 0

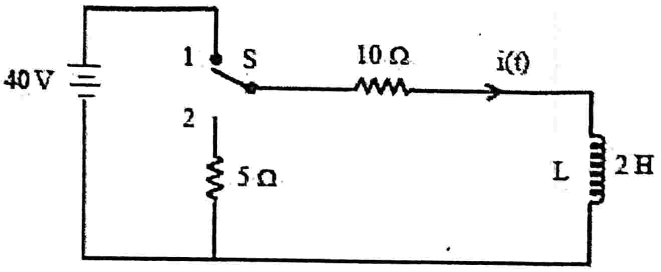


Fig.3.

d) An R-L-C series circuit is shown in Fig.4. The switch is moved from position 1 to 2 at t = 0 after it remained in position 1 for a long time. The initial current at (t = 0^-) in the inductor is 2 A and the voltage across the capacitor at that instant is 4 volts. Find the expression for the inductor current i(t) for t > 0 3

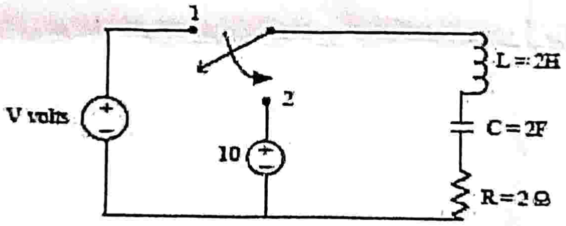


Fig.4

BEE-205

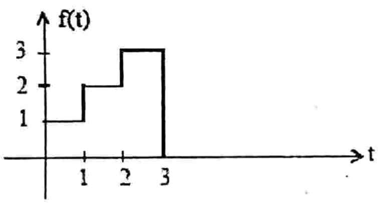
Roll No. 2024

B. Tech. (4 Credit Subject)
Year: 2nd, Semester: 3rd
Major Examination: 2025-26

Analysis of Linear System

Time: 3 Hrs. **Max. Marks: 50**

Note: Attempt ALL questions. ALL questions carry equal marks.

			Marks	CO	BL	PO	PI Code
1.		**Attempt any five parts of the following:**					
	(a)	Explain the importance of unit step, and gate signals in the signal synthesis?	2	1	1	1	1.3.1
	(b)	A signal f(t) is given in the Fig.1. Draw with proper scale the signal $g(t) = f(4t-4)$.  Fig.1	2	1	4	1	2.1.3
	(c)	Check whether the following system is: (a) static or dynamic (b) causal or non- causal $d^3y(t)/dt^3+2d^2y(t)/dt^2+4dy(t)/dt+3y^2(t)=x(t+1)$	2	1	4	1,2	2.1.3
	(d)	State the relationship of Step response and impulse response of an LTI system.	2	4	2	1	1.3.1
	(e)	The impulse response of a LTI system is given by e^{-4t}. If the input of the system is given by e^{-5t}, find the output of the system.	2	4	3	1,2	1.4.1
	(f)	Find the even and odd components of the following signals: $x(t) = (1+t+t^2+t^3)\ Sin^2(6t)$	2	5	2	1	1.3.1
	(g)	Find the inverse Laplace transform of the following: $X(s) = 1/(s+1)(s+2)$	2	6	2	1	1.2.1
2.		**Attempt any two parts of the following:**					
	(a)	Determine the Z-transform and ROC of the following signal. $x[n]=\left(\frac{1}{2}\right)^n\{u[n]-u[n-10]\}$	5	1	3	1,2	2.1.3
	(b)	Determine the Initial and final value of the discrete signal x(n) whose z-transform is given as $X(z) = z^2/(z-1).(z-0.2)$. State the theorem utilized.	5	1	4	1,2	1.4.1
	(c)	Compute the zero-state response for the following system	5	2	3	1,2	1.4.1

		h(n) with the input signal x(n) which are given as: $h[n]=\left(\frac{1}{3}\right)^n u[n],\quad x[n]=\left(\frac{1}{2}\right)^n\left(\cos\left(\frac{\pi}{3}n\right)\right)u[n],$					
3.		**Attempt any two parts of the following:**					
	(a)	Determine the inverse Z-transform of: $F(z)=\dfrac{1-\frac{1}{4}z^{-1}}{1-\frac{1}{6}z^{-1}-\frac{1}{6}z^{-2}}$, if (i) ROC: $\lvert z\rvert > 1/2$ (ii) ROC: $-1/3<\lvert z\rvert<1/2$ (iii) ROC: $\lvert z\rvert<-1/3$	5	3	2	1	1.3.1
	(b)	Compute the response of the system $y[n]=0.7y[n-1]-0.12y[n-2]+x(n-1)+x(n-2)$ to the input signal $x(n)=nu(n)$. Is the system stable	5	4	3	1,2	1.4.1
	(c)	State and prove the final value theorem in z-transform analysis.	5	3	5	1,2	1.4.1
4.		**Attempt any two parts of the following:**					
	(a)	Define: (a) State variables (b) State (c) State Vector (d) State-space	5	5	1	1	1.2.1
	(b)	The multivariable system is described by state equations: $\frac{d^2y_1(t)}{dt^2}+5\frac{dy_1(t)}{dt}-7y_2(t)=u_1(t)+9w(t)$ $\frac{dy_1(t)}{dt}+\frac{dy_2(t)}{dt}+y_1(t)+6y_2(t)=u_2(t)$. Obtain the state variable model of the system.	5	5	5	1,2	1.4.1
	(c)	Derive the expression for the transfer function of a system from its state model. Obtain the transfer function of the system, described by: $\dot{X}=\begin{bmatrix}-1 & -4 & -1\\ -1 & -6 & -2\\ -1 & -2 & -3\end{bmatrix}X+\begin{bmatrix}0\\ 1\\ 1\end{bmatrix}u;\quad y=\begin{bmatrix}1 & 1 & 1\end{bmatrix}X$	5	5	3	1	2.1.2
5.		**Attempt any two parts of the following:**					
	(a)	A linear time invariant system is characterised by the homogeneous state equation given by: $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-1/2 & 5/2\\ 1/2 & -7/2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$; *initial state is* $x(0)=\begin{bmatrix}1\\ 0\end{bmatrix}$ Find the resolvent matrix $\varphi(s)$, state transition matrix	5	6	5	1,2	1.4.1

		$\varphi(t), \varphi^{-1}(t)$ and the solution of the given system.					
	(b)	Solve the non-homogeneous state equation assuming the general representation of the state space model of a system. Write the expression of response also.	5	6	5	1,2	1.4.3
	(c)	A linear time-invariant system is characterised by the non-homogeneous state equation: $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u; \quad x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$ Compute the solution of non-homogeneous state equation assuming initial state vector $x(0)$ as given. u is the unit step input.	5	6	5	1,2	1.4.1

BL: Blooms Taxonomy Levels (1-Remembering 2-Understanding 3-Applying 4-Analysing 5-Evaluating 6-Creating)
CO: Course Outcomes
PO: Programme Outcomes
PI Code : Performance Indicator Code