BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

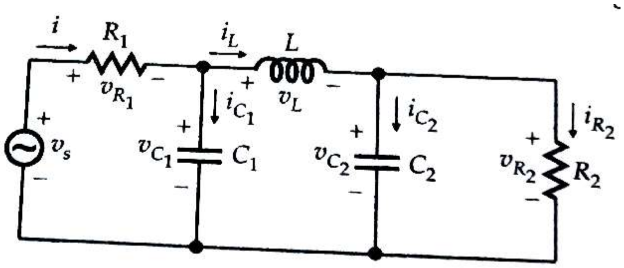
CLASS: BTECH — **SEMESTER : VII**
BRANCH: EEE — **SESSION : MO/2023**

SUBJECT: EE439 APPLIED CONTROL THEORY

TIME: 3 Hours — **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) A write the state equation for the network shown in the figure below, taking voltage across capacitor and current through the inductor as states. [5]



Q.1(b) Drow the state block diagram for the Transfer function [5]

$$\frac{Y(s)}{U(s)} = \frac{s+5}{s^2+10s+9}$$

Q.2(a) A system represented by following dynamic equation. [5]

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}\left[\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}\right] + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$$

$Y = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ Determine its transfer function

Q.2(b) A Linear time invariant system represented by following dynamic equation. [5]

$$\dot{x} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}\left[\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}\right] + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$$

Where U is a unit step function the initial condition is $X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

Obtain the solution of state equation.

PTO

Q.3(a) A linear time invariant system is described by the following differential equation. [5]

$\frac{dx_1}{dt}$ = -2 $x_1(t)$ + 4 $x_2(t)$

$\frac{dx_2}{dt}$ = -2 $x_1(t)$ - $x_2(t)$+U(t) Comment on controllability and stability

Q.3(b) A Linear time invariant system represented by following dynamic equation. [5]

$\dot{x}$ = $\begin{bmatrix} -1 & 2 \\ 1 & 3 \end{bmatrix} \left[\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}\right]$ + $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$ U

Determine the state feedback gain matrix that such the system poles are placed at s=-5 and s=-1

Q.4(a) Explain the significance of linearization. [5]

Q.4(b) Consider a system describe by its differential equation [5]

$\ddot{y}$ + 4$\dot{y}$ - 2.5 y^2 +5y = 0 , Drow the lairized phase portrait and comment on stability

Q.5(a) Determine the describing function of a relay with dead zone. [5]

Q.5(b) Find the extremal curve for the functional [5]

J(X)= $\int_0^1 \frac{1}{\dot{x}}$ dt

with boundary condition x(0) = 0, X(1)=1

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