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

CLASS: BTECH **SEMESTER : VII**
BRANCH: EEE **SESSION : MO/2025**

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.

			CO	BL
Q.1(a)	The state variable description is $[\dot{x}] = \begin{bmatrix}2 & 0\\ 0 & 2\end{bmatrix}$ x + $\begin{bmatrix}1\\1\end{bmatrix}$u	[5]		
Q.1(b)	Determine state transition matrix of the system assuming all initial condition is zero $\dot{x} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix} + \begin{bmatrix}0\\1\end{bmatrix}$ U Y = $[1 \quad 0]\begin{bmatrix}x_1\\x_2\end{bmatrix}$ Find the Unforce response of the system.	[5]		
Q.2(a)	A system is represented by $\dot{x} = \begin{bmatrix}-1 & 3\\ 0 & -2\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix} + \begin{bmatrix}1\\1\end{bmatrix}u$ $y = [1 \quad 0]\begin{bmatrix}x_1\\x_2\end{bmatrix}$ Designee a state feedback controller for the given system such that the close loop pole are at -5 and -6.	[5]		
Q.2(b)	For the system given below, an observer is to be designed to estimate the state variables. Select the observer gain and write the equations describing the observer dynamics. $\dot{x} = \begin{bmatrix}-4 & -4\\ 1 & -2\end{bmatrix}x + \begin{bmatrix}0\\2\end{bmatrix}u$ $y = \begin{bmatrix}1 & 0\end{bmatrix}x$ Observer eigen value should be (-10,-10).	[5]		
Q.3(a)	Consider a nonlinear system defined as $\dot{x}_1 = x_2$ $\dot{x}_2 = -\frac{n}{m}{x_2}^2 + \frac{1}{m}u$ Where m and n are constant. Linearize the state equation.	[5]		
Q.3(b)	Define describing Function and explain its significance in the analysis of nonlinear system. Derive the describing function of an Idel Relay.	[5]		
Q.4(a)	Consider the system describe as $\ddot{y} + \dot{y} + y - y^2$ Draw the Phase trajectory of the system.	[5]		
Q.4(b)	Drow the shape of the phase portrait for the following singular point 1) Node, 2) Focus, 3) Center,4) Saddle.	[5]		
Q.5(a)	Explain the different type of optimal control problem.	[5]		
Q.5(b)	Find the extremal curve for the functional J(x)= $\int_0^1 \frac{1}{\dot{x}}dt$ The boundary condition are given x(0)=0, x(1)= 1	[5]		

::::::19/11/2025::::::M