

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER- VI EXAMINATION – SUMMER 2020****Subject Code: 2161707****Date: 27/10/2020****Subject Name: Control System Design****Time: 10:30 AM TO 01:00 PM****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

		MARKS
Q.1	(a) Explain state, state variable and state vector with reference to state space.	03
	(b) Compare lead and lag compensation techniques in frequency domain.	04
	(c) Find state space model for RLC series circuit. Consider voltage across capacitor as an output with $R = 1K$, $C=5F$ and $L=2H$.	07
Q.2	(a) Explain diagonal canonical form in state space.	03
	(b) Find controllable and observable canonical form for the system with transfer function $\frac{2}{s(s+1)}$.	04
	(c) Derive condition for complete state controllability of the system. Also find controllability for the system $\dot{x} = Ax + Bu$ and $y = cx$ with $A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ and $C = [0 \quad 1]$.	07
	OR	
	(c) Derive condition for complete state observability of the system. Also find observability for the system $\dot{x} = Ax + Bu$ and $y = Cx$ with $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$ and $C = [0 \quad 1]$.	07
Q.3	(a) Find Eigen value for the system $\dot{x} = Ax + Bu$ and $y = cx$ with $A = \begin{bmatrix} 0 & 1 \\ 2 & 4 \end{bmatrix}$.	03
	(b) Compare conventional and modern control theory.	04
	(c) Explain dead beat response with suitable example.	07
	OR	
Q.3	(a) Explain linear dependence and independence of vectors.	03
	(b) Explain lag compensation using root locus technique.	04
	(c) Design a suitable compensator for the unity feedback system with open loop transfer function $G(s) = \frac{K}{s(s+1)(s+3)}$, to meet the following specifications:	07
	a. Phase margin at least 52 degree	
	b. Gain margin at least 8 db	
	c. Velocity error constant at least 6 sec^{-1}	
Q.4	(a) Explain need of linear quadratic regulator.	03
	(b) Explain lead compensation using root locus technique.	04
	(c) Find transfer function of system with following state space representation. Also comment on stability of the system.	07
	$A = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ $C = [0 \quad 1]$ $D = 0$.	

OR

- Q.4 (a) Explain optimal control system. **03**
(b) Explain Lyapunov stability criteria. **04**
(c) Discuss about the design of state observer with diagram and equations. **07**
- Q.5 (a) Explain the need of robust PID controller. **03**
(b) Discuss factors to be considered while designing robust control system. **04**
(c) Find state transition matrix of system with following state space representation. Also state property of state transition matrix. **07**

$$A = \begin{bmatrix} 0 & 1 \\ -4 & -6 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad C = [0 \quad 1] \quad D = 0.$$

OR

- Q.5 (a) Explain Riccati Equation. **03**
(b) Discuss Lag-Lead Compensator design in frequency domain. **04**
(c) Discuss design steps for pole placement using Ackerman's formula. **07**

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