Seat No.: _____ Enrolment No.

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VI (NEW) EXAMINATION – WINTER 2018

Subject Code:2161707 **Date:16/11/2018**

Subject Name:Control System Design

Time: 02:30 PM TO 05:00 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)**	Consider a linear system described by differential equation $\ddot{y} + 2\dot{y} + y = \dot{u} + u$ Test the controllability of the system by Kalman's test.	**03**
	(b)	Explain basic electrical lead-lag compensator.	**04**
	(c)	With suitable example, explain the robust PID Controller.	**07**
Q.2	**(a)**	Discuss about the advantages of state space method over conventional method.	**03**
	(b)	Write steps to design a lag compensator for a given system in frequency domain.	**04**
	(c)	Obtain state model of field-controlled DC servomotor. Choose θ, $\dot{\theta}$ and i_f as state variables.	**07**
		OR	
	(c)	Design a lag compensator using root-locus method for a system whose open-loop transfer function is given by $G(s) = \frac{K}{s\,(s+1)(s+4)}$ The system is to be compensated for following specifications: Damping ratio = 0.5, settling time = 10 sec, velocity error constant ≥ 5 sec^{-1}	**07**
Q.3	**(a)**	Give the properties of state transition matrix.	**03**
	(b)	Give the design steps of lead compensator in frequency domain.	**04**
	(c)	Design a phase lead compensation network in frequency domain for a system having open-loop transfer function $G(s)H(s) = \frac{K}{s^2(1+0.05s)}$ The system have acceleration error co-efficient=100 sec^{-2} for the phase margin of 20°	**07**
		OR	
Q.3	**(a)**	Obtain the state-space equation and output equation for the system described by differential equation given by $\dddot{y} + 4\ddot{y} + 5\dot{y} + 2y = 2\ddot{u} + \ddot{u} + \dot{u} + 2u$	**03**
	(b)	Explain dead beat response with suitable example.	**04**
	(c)	Explain robustness of the system with reference to system sensitivity.	**07**
Q.4	**(a)**	Explain Internal Model Design.	**03**
	(b)	Explain the following terms for robust control system. (i) sensitivity function (ii) complementary sensitivity function (iii) additive perturbation (iv) multiplicative perturbation	**04**
	(c)	Explain the control of uncertain parameter in robust control system.	**07**

OR

Q.4 **(a)** Determine the transfer function from the following data. **03**

$A = \begin{bmatrix} -3 & 1 \\ 0 & -1 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 1 \end{bmatrix}$, D = 0

(b) Discuss the Full state Controller and Observer with associated block diagram. **04**

(c) State and derive Ackermann's formula for determination of the state feedback gain matrix K. **07**

Q.5 **(a)** Explain Ricatti Equation. **03**

(b) Explain Liapnov's stability criterion theorem. **04**

(c) Determine the state transition matrix and solution of the system described by the vector-differential equation **07**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 2 \\ -3 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

Where u(t) = 1, $t \geq 0$

= 0, $t < 0$

Assume the system to be initially relaxed.

OR

Q.5 **(a)** Explain performance index of optimal control system. **03**

(b) Explain positive definite and positive semidefinite function. **04**

(c) Explain Linear Quadratic Regulator. **07**

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