Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E –Ist SEMESTER–EXAMINATION – JULY- 2012

Subject code: 710301N **Date: 05/07/2012**

Subject Name: Control Engineering

Time: 2:30 pm – 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.**

Q.1 **(a)** Prove that the state model $\dot{x}(t) = Ax(t) + Bu(t)$ **07**

$y(t) = Cx(t) + Du(t)$

is BIBO stable if and only if $H(t) = Ce^{At}B$ satisfies,

$$\int_0^{\infty} |h_{ij}(\tau)|\, d\tau = N < \infty$$

for all i = 1, 2, ……, q

j = 1, 2, …….p

(b) State and prove Lyapunov's stability theorem. **07**

Q.2 **(a)** State the Krasovskii method to find Lyapunov functions for nonlinear continuous time autonomous system. Prove that the nonlinear system $\dot{x} = f(x)$; $f(0) = 0$ is asymptotically stable at the origin if there exist a constant, positive definite, symmetric matrix P such that the matrix $F(x) = J^T(x)P + PJ(x)$ is negative definite for all x and $v(x) = f^TPf$ **07**

(b) For the nonlinear system described by following state equation, Check for asymptotic stability narrating specific limitations. **07**

$\dot{x}_1 = -3x_2 - h(x_1)$

$\dot{x}_2 = -x_2 + h(x_1)$ where $h(x_1) = h'(x_1)\, x_1$

OR

(b) If the system $\dot{x}(t) = Ax(t) + Bu(t)$ **07**

$y(t) = Cx(t) + Du(t)$

is controllable and b_i ($\neq 0$) is the ith column of B, then prove that there exist a matrix K, such that the single input system $\dot{x} = (A + BK_i)\, x + b_i r_i$ is controllable.

Q.3 **(a)** Explain full order observers. **07**

(b) Derive the equations for deadbeat control by state feedback. **07**

OR

Q.3 **(a)** Explain reduced order observers. **07**

(b) For the system $\dot{x} = Ax + Bu$, design a linear state variable feedback such that the closed loop poles are located at -1, -2 and -3. Consider A and B as follows. **07**

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix} \qquad B = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 1 \end{bmatrix}$$

Q.4 **(a)** Give different problems for formulation of the optimal control system design. **07**

(b) Give the formulation of variational calculus using Hamiltonian method. **07**

OR

Q.4 **(a)** Give the flow chart of dynamic programming algorithm for optimal control problem in discrete time system. **07**

	(b)	Explain steepest descent method for optimal control problem.	**07**
Q.5	**(a)**	Explain discrete time linear state regulator with appropriate plant.	**07**
	(b)	Explain the stochastic process characterization for random variable.	**07**

OR

Q.5	**(a)**	Explain continuous time linear state regulator with appropriate plant.	**07**
	(b)	Derive the response of linear discrete time system to white noise.	**07**

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