Seat No.: __________ Enrolment No.____________

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –I Examination Feb. - 2012

Subject code: 710301N **Date: 11/02/2012**
Subject Name: Control Engineering
Time: 10.30 am – 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.**

Q.1 **(a)** Define: **08**

(i) Asymptotically stable in-the-large
(ii) Asymptotically stable at the origin
(iii) Total stability
(iv) Admissible control

(b) Prove that if the system, $\dot{x}(t) = Ax(t) + Bu(t), y(t) = Cx(t) + Du(t)$ is controllable and b_i ($\neq 0$) is the ith column of B, then there exist a feedback matrix K_i such that the single-input system $\dot{x} = (A+BK_i)x + b_i r_i$ is controllable. **06**

Q.2 **(a)** Prove that the state model, , $\dot{x}(t) = Ax(t) + Bu(t)$, $y(t) = Cx(t) + Du(t)$ is Bounded Input Bounded Output stable if and only if $H(t) = Ce^{At}B$ satisfies, $\int_0^\infty |hij(\tau)| d\tau = N < \infty$ for all i = 1, 2, 3,….,q **08**

j= 1, 2,……,p

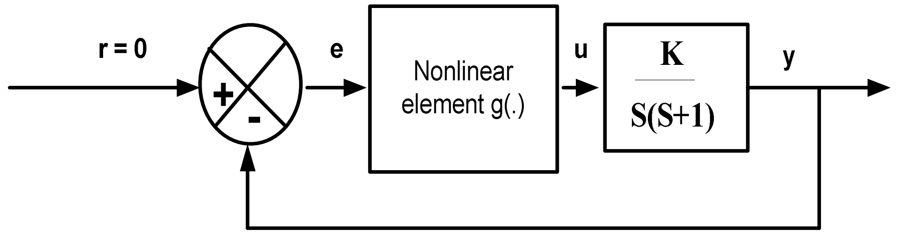
(b) Check the stability of the following system using R-H criteria **06**

(i) $3\lambda^4 + 10\lambda^3 + 5\lambda^2 + 5\lambda + 2 = 0$
(ii) $\lambda^6 + \lambda^5 + 3\lambda^4 + 3\lambda^3 + 3\lambda^2 + 2\lambda + 1 = 0$

OR

(b) Derive the equation of performance index for minimum fuel problem and state regulator problem. **06**

Q.3 **(a)** Consider the nonlinear system shown in figure, where the nonlinear element is given as u = g(e) **12**



Find the condition for asymptotic stability using Krasovskii method.

	(b)	Draw the structure of Full-order state observer.	**02**

OR

Q.3	**(a)**	For the linear system described by the transfer function $\frac{\hat{y}(s)}{\hat{u}(s)} = \frac{10}{s(s+1)(s+2)}$ Design a feedback controller with a state feedback so that the eigen values of closed loop system are at -2, -1, $\pm j1$.	**09**
	(b)	Find the extremals for the following functional: J(x) $= \int_0^{\pi/4}(x^2 - \dot{x}^2)\, dt$; x(0) = 0, x(π/4) is free	**05**
Q.4	**(a)**	State and explain Principle of Causality and Principle of Invariant Imbedding for Optimal control system.	**06**
	(b)	Find the optimal control $u^*(t)$ for the system $\dot{x} = u$; x(0) = 1 Which minimizes $J = \frac{1}{2}x^2(4) + \frac{1}{2}\int_0^4 u^2\, dt$	**08**

OR

Q.4	**(a)**	Derive the fundamental necessary condition for the optimization of fixed end points problem.	**05**
	(b)	Derive the equation of state feedback control law for the continuous time linear state regulator system.	**09**
Q.5	**(a)**	Show that the extremal for the functional, J(x)= $\int_0^{\pi/2} \dot{x}^2 - x^2\, dt$ Which satisfies the boundry conditions x(0) = 0 ; x(π/2) =1 is $x^*(t) = \sin t$.	**08**
	(b)	Give the response of linear discrete time system to white noise.	**06**

OR

Q.5	**(a)**	Derive the equation of the feedback matrix K for time invariant linear state regulator system.	**08**
	(b)	Define stochastic vector process and discrete white noise. Draw the structure of plant with optimal estimator.	**06**

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