Seat No.: _____ Enrolment No.______

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. I[ST] Semester–Remedial Examination – July- 2011

Subject code: 712904N

Subject Name: Advanced Control Theory

Date:12/07/2011 **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.**
4. **Notations used have usual meaning.**

Q.1 **(a)** Define state space, state variable and state vector. Discuss the advantages and limitations of state space techniques. **07**

(b) Obtain state space representation of field controlled DC motor. **07**

Q.2 **(a)** The state equations of a control system are given as, **07**

$\dot{x}_1 = -\frac{1}{T_1}x_1 + \frac{1}{T_1}u$, $\dot{x}_2 = -\frac{1}{T_2}x_2 + \frac{1}{T_2}u$

Estimate for complete state controllability.

(b) Using Nyquist criterion investigate the closed loop stability of the system whose open loop transfer function is given as, **07**

$$G(s)H(s) = \frac{1.25(s+1)}{(s+0.5)(s-2)}$$

OR

(b) Discuss Eular-Langrange equations for optimal control of the system. **07**

Q.3 **(a)** Determine the state space model of series RLC circuit which is energized through unit step supply source e. assume capacitor voltage and current through inductor as state variables. **07**

(b) Obtain the state space equations for the transfer function given as, **07**

$$G(s) = \frac{10(s+1)}{(s+5)(s+2)^2}$$

OR

Q.3 **(a)** For regulatory system, **07**

$$\dot{X} = Ax + Bu$$

Where,

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

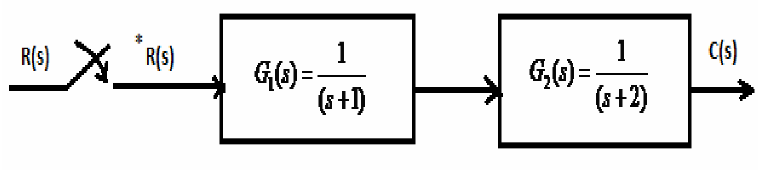
The system uses the state feed back control $u = -Kx$. Determine the state feed back gain matrix K for the desired closed loop pole located at,

$s = -1 - j$, $s = -1 + j$ and $s = -8$

(b) Find z transformation of following functions, **07**

$$f(t) = e^{-\alpha t}\cos(wt)$$

Q.4 **(a)** Find the pulsed transfer function for the system represented by the block diagram, **07**



(b) Find state transition matrix Φ(t) for following system. **07**

$$\dot{X} = Ax$$

Where,

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

OR

Q.4 **(a)** Explain Variable structure control with appropriate example. **07**

(b) Consider linear time invariant system, **07**

$$\dot{X} = Ax = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$$

Determine the stability of system using Liapunov's direct method.

Q.5 **(a)** Explain mapping from s- plane to z- plane with illustration. And discuss how stability of a system can be determined using z- plane. **07**

(b) Evaluate the observability of the following system, **07**

$$\dot{X} = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}u$$

$$Y = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

OR

Q.5 **(a)** For the system described by the state model $\dot{X} = Ax$ and $Y = Cx$ where, $A = \begin{bmatrix} -1 & 1 \\ 1 & 2 \end{bmatrix}$, $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$ design a full state observer. The eigen values for the observer matrix are $u_1 = -5$ and $u_2 = -5$. **07**

(b) Determine the stability of nonlinear system governed by the equations using liapunov's method. **07**

$$\dot{x}_1 = -x_1 + 2x_1^2 x_2$$

$$\dot{x}_2 = -x_2$$

****