Total No. of Questions :8] *[Total No. of Printed Pages :2*

Roll No ....

MEIC-205

M.E./M.Tech., II Semester

Examination, June 2013

Advance Controlled Systems

Time : Three Hours

Maximum Marks : 70

Note: Attempt any *five* questions. All questions carry equal marks. Wherever mentioned the signal $1(t)$ means unit step function of time.

1. Discretize the given continuous-time state dynamics $\dot{x} = \begin{bmatrix} 2 & 1 \\ 4 & 2 \end{bmatrix} x + \begin{bmatrix} 2 \\ 8 \end{bmatrix} u$ with output $y = x_1$ and sampling time $T = 0.02$ second. Determine the eigen-values of the discretized system. 14

2. The state space description of a homogeneous second order system is described as, $\dot{x} = \begin{bmatrix} 4 & 1 \\ -24 & -10 \end{bmatrix} x$. Determine eigen-values and eigen-vectors. Compute $P^{-1}AP$. What will be the nature of phase trajectory if $x(0) = [1 \;\; 1]^T$. 14

3. Given $\dot{x} = \begin{bmatrix} 1 & 1 \\ 3 & 3 \end{bmatrix} x + \begin{bmatrix} 2 \\ 10 \end{bmatrix} u$ with output $y = x_1$. Let the error $e = z_1 = y_R - y$ and the control law is $u = Kz_1$ with $K = 10$. Derive the description for error state dynamics. Obtain the error state vector solution when $Y_R = 1(t)$. 14

4. Given the same system as in Q. 3. Define error $e = y_R - y$. Use feedback control $u = Ke$ to regulate the error $e \to 0$. Determine the range of K for closed loop stability by using Lyapunov method. 14

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5. Use state feedback control $u = -[k_1 \;\; k_2]x$ in the same state space description given in Q.3. Determine the ranges of k_1 and k_2 for closed loop stability by using Routh-Hurwitz criteria. 14

6. Given $\dot{x} = \begin{bmatrix} 2 & 1 \\ 4 & 2 \end{bmatrix} x + \begin{bmatrix} 2 \\ 8 \end{bmatrix} u$ with output $y = x_1$. Let the error $e = z_1 = y_R - y$ and $z_2 = \dot{z}_1 + 2u$, then design the VSC so that the error dynamics follow the sliding surface $\sigma = [8 \;\; 1]z$. 14

7. A nonlinear system is described by $\begin{aligned} \dot{x}_1 &= x_2 + 5x_1^2 \\ \dot{x}_2 &= -5x_2 + 5u \end{aligned}$. Obtain a control law by using Lyapunov function so that the state $x \to 0$ in steady state. 14

8. Derive the conditions of optimality for the cost function $J\langle x \rangle = \int_{t_0}^{t_f} \phi(x, \dot{x}, t)\, dt$ without any constaints. Discuss about the boundary conditions. 14