Code :R5321306 **R5**

III B.Tech II Semester(R05) Supplementary Examinations, April/May 2011
ADVANCED CONTROL SYSTEMS
(Electronics & Control Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE questions
All questions carry equal marks

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1. A linear time-invariant system is characterized by the homogenous state equation.
$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$
Compute the solution of the homogeneous equation, assuming the initial state vector
$X_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

2. (a) The state space representation of a system is given below. Determine whether the system is completely controllable and observable.
$\dot{X} = \begin{bmatrix} -6 & 2 & -4 \\ -18 & 3 & -8 \\ -6 & 1 & -3 \end{bmatrix} X + \begin{bmatrix} 1 \\ 3 \\ 1 \end{bmatrix} u$
$y = \begin{bmatrix} 1 & -1 & 2 \end{bmatrix} X$
(b) Define controllability and observability. Explain about Kalman's Test of controllability and observability.

3. With suitable exampal, explain how describing function analysis of nonlinear system is used for stability analysis?

4. Linear second order servo is described by the equation $\ddot{e} + 2\tau w_n \dot{e} + w_n^2 e = 0$, where τ=0.15, $w_n = 1$ rad/sec e(0)=1.5 and $\dot{e}\,(0) = 0$. Determine the singular point. Construct the phase trajectory, using the method of isoclines.

5. (a) Determine whether or not the following quadratie form is positive definite.
$Q = x_1^2 + 6x_2^3 + 2x_3^2 + 3x_1x_2 + 6x_2x_3 - 4x_1x_3$
(b) Determine the stability of the origin of the following system
$\dot{x}_1 = x_2$
$\dot{x}_2 = -x_1^3 - x_2$

6. (a) Show that the zero's of a scaler system are invariant under linear state feedback to the input.
(b) For a single input system explain pole placement by state feedback.

7. (a) Find the curve with minimum arc length between the point $x(0) = 0$ and the curve $\theta(t) = t^2 - 10t + 24$
(b) Discuss state variable and control inequality constraints.

8. Find the optimal control $u^*(t)$ for the system
$\dot{X} = \begin{bmatrix} 0 & 1 \\ -10 & 0 \end{bmatrix} X + \begin{bmatrix} 0 \\ 10 \end{bmatrix}$ u
which minimize the performance index
$J = \frac{1}{2} \int_0^2 u^2 \, dt.$
Given $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \; x(2) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

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