ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES
(AUTONOMOUS)

M.Tech II-Semester Regular Examinations, May 2016

Advanced Control Systems

(Control Systems Engineering)

Date: **Time: 3 hours** **Max Marks: 60**

Answer ONE Question from each unit
All questions carry equal marks
All parts of the question must be answered at one place only

UNIT-I

1.a) Explain why state variable approach is known as modern control approach. 6M

b) Define and explain state, state variable and Non uniqueness of state models 6M

(OR)

2.a) Prove that a system described by state model of the form 6M

$\dot{x}(t)=Ax(t)+B\,u(t)$

$y(t)=Cx(t)+Du(t)$;where A,B,C,D constants matrices and time invariants.

b) A System is described by the equation 6M

$$x(k+1)=\begin{bmatrix}-3 & 1 & 0\\ -4 & 0 & 1\\ -1 & 0 & 0\end{bmatrix}x(k)+\begin{bmatrix}-3\\ -7\\ 0\end{bmatrix}u(k)$$

$x(0)=x^0$, Using Z-transform technique, transform the state equation into a set of linear algebraic equations in the form

$\hat{x}(z)=\hat{G}(z)x^0+\hat{H}(z)\hat{u}(z)$

UNIT-II

3.a) Find the state transition matrix of the following homogeneous equation. 6M

$\dot{x}(t)=\begin{bmatrix}t & 1\\ 1 & t\end{bmatrix}x(t)$

b) Consider the state equation 6M

$\dot{x}(t)=\begin{bmatrix}0 & 1\\ -1 & -2\end{bmatrix}x(t)$. Find a set of states $x_1(1)$,$x_2(1)$ such that $x_1(2)=2$

(OR)

4.a) Derive an expression to find the solution to state equation using the solution to differential equation. 6M

b) For the state equation.$\dot{x}(t)=\begin{bmatrix}0 & 1 & 0\\ 3 & 0 & 2\\ -12 & -7 & -6\end{bmatrix}x(t)$. Find the initial condition vector x(0)=which will only excite the mode corresponding to the eigen value with the most negative real part. 6M

UNIT-III

5.a) Explain controllable canonical form of the state space representation. 6M

b) Investigate the controllability and observability of the following system. 6M

$$\dot{x}(t)=\begin{bmatrix}1 & 0\\ 0 & 2t\end{bmatrix}x(t)+\begin{bmatrix}0\\ 1\end{bmatrix}u(t)$$

$Y(t)=[\,0 \quad 1\,]\,x(t)$

MODEL PAPER

(OR)

6.a) Consider the system

$X(k+1)=\begin{bmatrix}1 & k\\0 & -1\end{bmatrix}x(k)+\begin{bmatrix}2\\k\end{bmatrix}u(k)$ 6M

In this system controllable at k=0? If Yes, find a control sequence to drive the system from

$x(0)=\begin{bmatrix}0\\0\end{bmatrix}$ to $x^1=\begin{bmatrix}1\\1\end{bmatrix}$

b) Consider the system 6M

$\dot{x}(t)=\begin{bmatrix}0 & 1 & 0\\0 & 0 & 1\\-2 & -5 & -4\end{bmatrix}x(t)+\begin{bmatrix}0 & 1\\1 & 0\\1 & 1\end{bmatrix}u(t)$

Find, if possible a control law to transfer the state from

$x(1)=\begin{bmatrix}1\\0\\0\end{bmatrix}$ to $x(4)=\begin{bmatrix}3\\2\\0\end{bmatrix}$

UNIT-IV

7.a) Define and explain the significance of equilibrium points. 6M

b) Consider the linear autonomous system 6M

$x(k+1)=\begin{bmatrix}0.5 & 1\\-1 & -1\end{bmatrix}x(k).$

Using direct method of Lyapunov, determine stability of the equilibrium state.

(OR)

8.a) Explain the Lyapunov's instability theorem 6M

b) Construct Lyapunov;s function for the following 6M

$\dot{x}_1=x_2$

$\dot{x}_2= -x_1^2x_2-2x_1^3$ and determine it's stability.

UNIT-V

9.a) Show that the zeros of a scalar system are invariant under linear state feedback to the input. 6M

b) Consider the state model 6M

$\dot{X}=\begin{bmatrix}0 & 0 & 0\\0 & -1 & 0\\0 & 0 & -3\end{bmatrix}x+\begin{bmatrix}1\\1\\1\end{bmatrix}u$ Y=[40/3 -15 5/3]

Determine the transfer function $\hat{Y}(s)/\hat{U}(s)$.

10.a) Explain the design of prediction observer. 6M

b) Explain the necessary and sufficient condition for arbitrary pole- placement. 6M

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