

Code No: A4903, A4303

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.TECH I SEMESTER EXAMINATIONS, APRIL/MAY-2012

MODERN CONTROL THEORY

(COMMON TO ELECTRICAL POWER ENGINEERING, POWER ELECTRONICS)

Time: 3hours

Max.Marks:60

Answer any five questions
All questions carry equal marks

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1. (a) Explain the advantages and disadvantages of
- physical variables
 - phase variables
 - Canonical variables for state –space formulation of control systems.

- (b) Differential equation of dynamic system is given by

$$\dot{c}_1 + \dot{c}_1 + 3c_1 - 5c_2 = r_1$$

$$\ddot{c}_2 + 2c_1 + c_2 = r_2$$

write state equation and output equation.

2. (a) Derive the solution of Non-homogeneous state equations.
(b) Obtain the time response of the system where $u(t)$ is the unit step function occurring at $t=0$.

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

3. (a) Explain with an example the concept of observability in continuous time invariant system.

- (b) Consider the system given by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -1 & 1 \end{bmatrix} u(t); \quad z(t) = \begin{bmatrix} 0 & 1 & -1 \\ 1 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix}$$

Check for controllability and observability of the above system.

4. For the system represented by state equation $\dot{X}(t) = A X(t)$ the response is

$$X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix} \text{ when } X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}; \text{ and } X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix} \text{ when } x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

determine the System matrix A and the state transition matrix.

5. (a) State the Lyapunov theorems?
(b) Consider a non-linear system described by the equations:

$$\dot{x}_1 = -2x_1 + x_1x_2$$

$$\dot{x}_2 = -x_2 + x_1x_2$$

Investigate the stability about the equilibrium point $X = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$

Contd...2

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6. A linear time invariant system is described by the state equation

$$\dot{X}(t) = AX(t) + bu(t) \quad \text{where}$$

$$A = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}; \quad b = \begin{bmatrix} 1 \\ 1 \end{bmatrix} \quad y(t) = [2 \quad -1]X(t)$$

Design a state observer that makes the estimation error to decay at least as fast as e^{-10t} .

7. 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

minimizes the performance index $J = \frac{1}{2} \int_0^2 u^2 dt$ Given $X(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, X(2) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$

8. (a) What is the variable end point problem? Discuss the generalized boundary condition.
b) Explain the term-Linear quadratic regulator.
