

B.Tech IV Year I Semester (R13) Supplementary Examinations June 2017

MODERN CONTROL THEORY
(Electrical and Electronics Engineering)

Time: 3 hours

Max. Marks: 70

PART – A
(Compulsory Question)

- 1 Answer the following: (10 X 02 = 20 Marks)
- Define state and state variable.
 - Write the state space model for a linear continuous time system.
 - Define complete controllability.
 - What is the condition for complete observability?
 - What is state feedback controller?
 - What is reduced order observer?
 - What are different types of nonlinearities?
 - What is describing function?
 - What are the effects of pole placement by state feedback?
 - Write stability in the sense of Lypanov.

PART – B
(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

- 2 (a) What is state transition matrix? List the properties of state transition matrix.
(b) Given the state model of a system:
- $$\dot{x} = \begin{bmatrix} 0 & 1 \\ -4 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u, \quad y = [1 \quad 0]x$$
- With initial condition $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, determine the state transition matrix.

OR

- 3 Develop the state model of linear system and draw block diagram of state model and explain each block.

UNIT – II

- 4 (a) Explain the concept of controllability and observability.
(b) Determine thee controllability and observability of the following state model:
- $$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u, \quad y = [10 \quad 5 \quad 1]x$$

OR

- 5 (a) State the duality between controllability and observability.
(b) A linear dynamical time variant system represented by:
- $$X = A\dot{X} + BU, \text{ where } A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix}, B = \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 1 & 0 \end{bmatrix}$$
- Find weather the system is completely controllable or not.

UNIT – III

- 6 Draw and explain the block diagram of a system with observer based state feedback controller.

OR

- 7 (a) Describe full order observer and reduced order observer.
(b) It is desired to place the closed loop poles of the following system at $s = -3$ and $s = -4$ by a state feedback controller with the control law $u = -Kx$. Determine the state feedback matrix K and the control signal.

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u \quad y = [1 \quad 0]x$$

Contd. in page 2

UNIT – IV

- 8 (a) Discuss the basic features of the following non-linearities: (i) Non-linear friction. (ii) Back-lash.
(b) Explain the concept of jump resonance with a suitable example.

OR

- 9 (a) Explain describing function of saturation non-linearity.
(b) Explain the construction of a phase trajectory either by isocline method or by delta method.

UNIT – V

- 10 (a) Define: (i) Stability. (ii) Asymptotic stability
(b) Investigate the stability of the following nonlinear system using direct method of Lyapunov:

$$\dot{x}_1 = x_2 \quad \dot{x}_2 = -x_1 - x_1^2 x_2$$

OR

- 11 (a) State and explain the Lyapunov stability theorem.
(b) Consider the second order system described by:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad c = [1 \quad 0]$$

Design a full order state observer. The desired Eigen values for the observer matrix are $\mu_1 = -5$, $\mu_2 = -5$
