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)

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1 Answer the following: (10 X 02 = 20 Marks)

(a) Define state and state variable.
(b) Write the state space model for a linear continuous time system.
(c) Define complete controllability.
(d) What is the condition for complete observability?
(e) What is state feedback controller?
(f) What is reduced order observer?
(g) What are different types of nonlinearities?
(h) What is describing function?
(i) What are the effects of pole placement by state feedback?
(j) 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.

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

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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 Lypanov:

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

OR

11 (a) State and explain the Lypanov 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 $\mu_1 = -5$, $\mu_2 = -5$

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