U.S.N

P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Sixth Semester, B.E. - Electrical and Electronics Engineering
Semester End Examination; May/June - 2018
Modern Control Theory

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1	a.	Explain the effects of PID controller for second order system with relevant block diagram.	6
	b.	What are compensation networks? Explain different types of compensation.	6
	c.	With the help of the circuit diagram, explain the lag compensator and derive its transfer function.	8
2	a.	Discuss the effects of PI and PD controller with relevant block diagrams for the secondary system.	8
	b.	Explain the effects and limitations of Lead and Lag compensators.	12

UNIT - II

3	a.	Obtain the state model for a series RLC circuit with a source 'V' and the voltage across the capacitor as the output. Take current through the inductor and voltage across the capacitor as the state variables.	6
	b.	Obtain the state space equation in controllable canonical form and draw its block diagram for the system having transfer function; $\frac{Y(S)}{U(S)}=\frac{S+3}{S^3+9S^2+24S+20}$	7
	c.	Determine the state space equation in diagonal form for a general n^{th} order system.	7
4	a.	Mention the advantages of state space analysis.	4
	b.	Show that the eigen values of characteristic matrix A are inveriant under linear transformation.	4
	c.	Obtain the state space equation in Jordan canonical form for the system given by the transfer function. $\frac{Y(S)}{U(S)}=\frac{S^2+2S+3}{S^3+7S^2+16S+12}$	6
	d.	Derive the transfer function of the system given by the state equation $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-1 & -2\\ 3 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}1\\ 2\end{bmatrix}[u]$; $y=[2 \quad 1]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$	6

Contd…2

UNIT - III

5 a. What is state transition matrix? Enumerate its properties. 6

b. Compute the state transition matrix using Cayley-Hamilton theorem for a system having coefficient matrix $A = \begin{bmatrix} -2 & -1 \\ -2 & -3 \end{bmatrix}$ 6

c. Determine the time response for unit step input of a system given by,

$$\underline{\dot{x}}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \underline{x} + \begin{bmatrix} 0 \\ 5 \end{bmatrix} \underline{u}$$

8

$$y(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \underline{x} \text{ and } \underline{x}(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

6 a. Explain the concept of controllability and observability and define them. 6

b. Derive Kalman's condition for complete controllability. 6

c. Determine complete state controllability and observability of the system given by,

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

8

UNIT - IV

7 a. Derive Ackermann's formula for determining state feedback control matrix. 6

b. A second order linear plant is described by,

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -2 & -4 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 1 \end{bmatrix} [u]$$

6

Design a state feedback controller such that the poles are moved to -3 and -4.

c. Explain pole placement technique with block diagram. 8

8 a. Consider the system defined by $\underline{\dot{x}} = A\underline{x} + B\underline{u}$ where,

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

12

By using the state feedback control, it is desired to have the closed loops poles at $(-1 \pm j2)$ and -10: Determine the state feedback gain matrix K using;

i) Direct substitution method ii) Ackermann's formula

b. An observable system is described by,

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

8

Design a state observer so that the Eigen values are -4 and (-3±j1). Use Ackermann's formula.

UNIT - V

9 a. Define stability in the sense of Liapunov, asymptatic stability and instability by graphical means. 6

b. Determine the sign definitness of the quadratic form $-4x_1^2 - 3x_2^2 - 2x_3^2 + 2x_1x_2 - 2x_2x_3 - 4x_1x_3$ 6

c. A LTI system is described by,

$$\underline{\dot{x}} = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} \underline{x}$$ 8

Using Liapunov method, investigate on stability and also determine Liapunov functions for the system.

10 a. Define positive, negative and negative semi definiteness of scalar functions. 6

b. State and prove Krasovskii's theorem. 6

c. Investigate the stability of the system described by $\dot{x}_1 = -3x_1 - x_2; \dot{x}_2 = x_1 - x_2 - x_2^3$ using Krasovskii's method. Find Liapunov function V(x). 8

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