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

(An Autonomous Institution affiliated to VTU, Belgaum)

Sixth Semester, B.E. - Electrical and Electronics Engineering

Semester End Examination; June/July - 2015

Modern Control Theory

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer any **FIVE** full questions, selecting at least **TWO** full questions from each **part**.*

PART - A

1. a. Define: state, state variables, state space, and state model of a system. State and explain non uniqueness of state variables. 10

b. Obtain the state model of the system shown in Fig. 1(b). 10

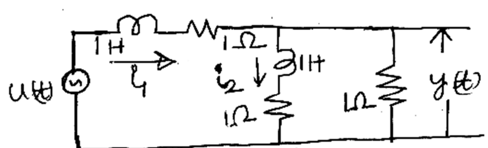

Fig 1(b)

2 a. Determine the state model of an armature controlled dc motor. 10

b. Obtain the three canonical forms of state model for the system described by the transfer function. 10

$$\frac{Y(s)}{X(s)} = \frac{10s+40}{s^3+4s^2+3s}$$

3 a. What are Eigen values and Eigen vectors? Use them to diagonalize the matrix 10

$$A = \begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$$

b. Find the ZIR of the system $\dot{X} = AX \;\; if \;\; A = \begin{bmatrix} 0 & 0 & -2 \\ 0 & 1 & 0 \\ 1 & 0 & 3 \end{bmatrix} \quad and \quad X(0) = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$ 10

4 a. Derive the TF from the state model. Find the TF if the state model is 10

$$\dot{X} = \begin{bmatrix} -2 & -3 \\ 4 & 2 \end{bmatrix} X + \begin{bmatrix} 3 \\ 5 \end{bmatrix} u \;\; and \;\; y = [1\;1]\,X$$

b. Define ZIR and ZSR. Derive equations for the total response in terms of ZIR and ZSR. 10

PART – B

5 a. Discuss the controllability and observability criteria and the duality property associated with them. 10

b. Ascertain the controllability and observability of the system described by the equations: 10

$$\dot{x}_1 = x_1 + 3x_3 + u$$
$$\dot{x}_2 = 2x_1 - x_2 - x_3$$
$$\dot{x}_3 = -3x_1 + x_2 - x_3$$
$$y = x_1 + 2x_2 + x_3$$

6 a. Design a state feedback controller so that the closed loop poles of the system. 10

$$\dot{X} = AX + Bu \text{ where } A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \text{ and } B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \text{ are placed at } -2 \pm j3.464 \text{ and } -5$$

using Ackermann formula.

b. What is an observer system? Draw the block diagram of a feedback system employing the observer. Give the stepwise procedure to design an observer. 10

7 a. Define: Positive definiteness; Negative definiteness; and indefiniteness. 8

b. Examine the stability of the system $\dot{X} = AX$ if $A\begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix}$ using Liapunov method. 12

8 a. Explain: (i) Equilibrium state (ii) Asymptotic stability (iii) Asymptotic stability in the large (iv) Instability. 10

b. Examine the stability, by the Krasovaskii theorem, of the system described by 10

$$\dot{x}_1 = -x_1$$
$$\dot{x}_2 = x_1 - x_2 - x_2^3$$

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