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10EE55

Fifth Semester B.E. Degree Examination, June/July 2019

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. Compare Modern Control Theory and conventional control theory. **(06 Marks)**

b. Obtain the state model for the system represented by Fig.Q.1(b) by selecting appropriate state variables. **(06 Marks)**

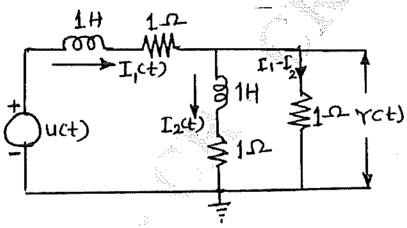

Fig.Q.1(b)

c. Obtain the state model using phase variables for the system described by

$\frac{d^3y(t)}{dt^3} + 8\frac{d^2y(t)}{dt^2} + 14\frac{dy(t)}{dt} + 4y(t) = 10u(t)$. Draw state diagram also. **(08 Marks)**

2 a. Obtain the state model of the system given in Fig.Q.2(a) selecting displacements as output. **(07 Marks)**

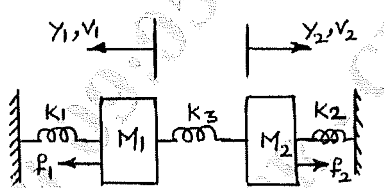

Fig.Q.2(a)

b. Obtain the state model in diagonal form for the system represented by transfer function

$G(s) = \frac{s^2 + 6s + 8}{s^2 + 4s + 3}$. Also draw the block diagram. **(08 Marks)**

c. Derive an expression to find transfer function from the given state model. **(05 Marks)**

3 a. Obtain the transfer function of the system represented by state equation and output equation as

$\dot{x}_1 = -5x_1 - x_2 + 24$

$\dot{x}_2 = 3x_1 - x_2 + 54$

$y = x_1 + 2x_2$ **(06 Marks)**

b. Find the transformation matrix 'M' that transforms the matrix

$A = \begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$ into diagonal or Jordan form. **(10 Marks)**

c. Write in brief about generalized eigen vectors. **(04 Marks)**

4 a. Given $A_1 = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$ $A_2 = \begin{bmatrix} 0 & 3 \\ -3 & 0 \end{bmatrix}$ and $A = \begin{bmatrix} 2 & 3 \\ -3 & 2 \end{bmatrix}$. If $A_1 A_2 = A_2 A_1$, prove $e^{A_1 t} \times e^{A_2 t} = e^{At}$. **(08 Marks)**

b. Compute e^{At} for the system represented as $\dot{x} = AX$, where $A = \begin{bmatrix} 0 & 2 \\ -2 & -4 \end{bmatrix}$ by Caley Hamilton method. **(06 Marks)**

c. Test observability and controllability for the system represented by

$$\dot{x} = \begin{bmatrix} -1 & -2 & -2 \\ 0 & -1 & 1 \\ 1 & 0 & -1 \end{bmatrix} x + \begin{bmatrix} 2 \\ 0 \\ 1 \end{bmatrix} u \; ; \; y = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix} x .$$

(06 Marks)

PART – B

5 a. Draw the block diagram of Leunberger observer and write the state equations in estimated states. **(05 Marks)**

b. Consider the system represented by $\dot{x} = Ax + Bu$; where $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$; $B = \begin{bmatrix} 0 \\ 2 \end{bmatrix}$. It is desired to place the eigen values at S = -3 and S = -5 by using state feed back control u = -KX. Determine the gain matrix K by using Ackerman's formula. **(08 Marks)**

c. A system described by $\dot{x} = Ax$; and y = Cx where $A = \begin{bmatrix} -1 & 1 \\ 1 & 2 \end{bmatrix}$, $C = \begin{bmatrix} 1 & 0 \end{bmatrix}$. Design full order observer to have the eigen values of an observer at (-5 + j5) and (-5 - j5) by direct substitution method. **(07 Marks)**

6 a. Write a note on PID controllers. **(05 Marks)**

b. Explain the properties of non linear systems. **(05 Marks)**

c. Explain the common physical non linearities with their input-output characteristics. **(10 Marks)**

7 a. Explain the construction of phase trajectory by isoclines method for a second order system. **(08 Marks)**

b. Find out the singular points for the following:

i) $\ddot{Y} + 3\dot{Y} - 10Y = 0$ ii) $\ddot{Y} + 3\dot{Y} + 2Y = 0$ **(08 Marks)**

c. Write a note on limit cycles. **(04 Marks)**

8 a. Explain : i) Stability ii) Asymptotic stability iii) Asymptotic stability in large and iv) Instability with respect to Lyapunov stability theorem. **(08 Marks)**

b. Check the negative definiteness of the quadratic equation

$Q = -x_1^2 - 3x_2^2 - 11x_3^2 + 2x_1x_2 - 4x_2x_3 - 2x_1x_3$. **(04 Marks)**

c. Determine the stability of the origin of the following system:

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

$\dot{x}_2 = x_1 + x_2 - x_2^3$ **(08 Marks)**

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