USN | | | | | | | | | | |　　　　**06EE55**

Fifth Semester B.E. Degree Examination, Dec.09/Jan.10
Modern Control Theory

Time: 3 hrs.　　　　Max. Marks:100

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

PART – A

1 a. Compare modern control theory with conventional control theory. **(05 Marks)**

b. Obtain the state model of the electric network shown in Fig. 1(b), selecting v_1 and v_2 as state variables and current thorough e_2 as the output. **(07 Marks)**

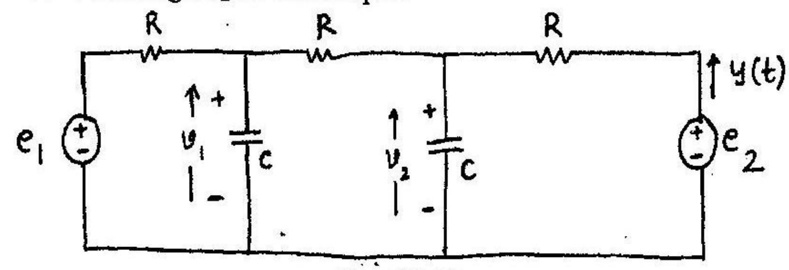

Fig. Q1(b)

c. Obtain the state model by direct decomposition method for the system whose transfer function is given by $\frac{y(s)}{u(s)} = \frac{5s^2+6s+8}{s^3+3s^2+7s+9}$. **(08 Marks)**

2 a. What are the advantages and limitations of phase variable method? **(05 Marks)**

b. Develop a state model in diagonal or Jordan form for the system whose transfer function is given by $\frac{y(s)}{u(s)} = \frac{s^2+4s+4}{s^3+5s^2+4s}$, show that the original transfer function is obtained from the state model. **(15 Marks)**

3 a. For the system matrix given by $A = \begin{bmatrix} 0 & 2 & 0 \\ 4 & 0 & 1 \\ -48 & -34 & -9 \end{bmatrix}$

determine : i) Characteristic equation ii) Eigen values iii) Eigen vectors iv) modal matrix. Also prove that the transformation matrix $M^{-1}AM$ results in a diagonal matrix. **(10 Marks)**

b. Find the modal matrix given, $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}; B = \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix}; C = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$; $D = \phi$ and hence obtain the state model in the canonical form. **(10 Marks)**

4 a. Find the complete time response for a unit step input to the system given by

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 5 \end{bmatrix} u(t); \quad y(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t); \text{ and } x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$ **(12 Marks)**

b. What is state transition matrix? Obtain the state transition matrix using Cayle–Hamilton theorem, given $A = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$. **(08 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – B

5 a. Define controllability and observability. Determine whether the system is completely controllable and completely observable or not

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

(10 Marks)

b. A system is described by $\dot{x} = \begin{bmatrix} 0 & 1 \\ 9 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 9 \end{bmatrix} u$. Compute state feedback gain matrix "k" so that the control law u = -kx places the closed loop poles at -3 ± j3 by i) using direct substitution method ii) using Ackermann's formula. **(10 Marks)**

6 a. A system is described by $\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u \,; y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x$. Design a full order observer such that the observer eigen values are at $-2 \pm j\, 2\sqrt{3}$ and -5. **(10 Marks)**

b. Explain the common physical non-linearities. **(10 Marks)**

7 a. What are singular points? Explain the different singular points with respect to stability of non-linear systems. **(10 Marks)**

b. What is phase-plane plot? Describe delta method of drawing phase-plane trajectories. **(10 Marks)**

8 a. Using Krasovskii's theorem, find the stability region of the equilibrium state at x = 0 for the system described by

$$\dot{x}_1 = -x_1$$

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

(10 Marks)

b. Determine the stability of the system described by $\dot{x} = A\,x$ where $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ by Liapunov's theorem and determine a suitable Liapunov function. **(10 Marks)**

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