USN | | | | | | | | | | | 10EE55

Fifth Semester B.E. Degree Examination, July/August 2021
Modern Control Theory

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

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.

1 a. What are the advantages of state variable analysis over classical control theory? **(05 Marks)**

b. For an electrical network shown in Fig Q1(b), obtain the state model. Choose the voltage across capacitor c as the output variable.

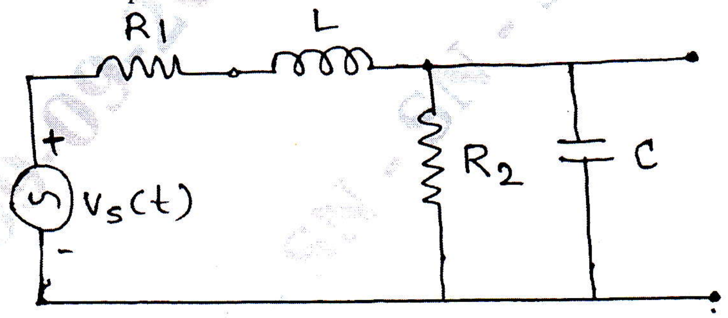

Fig Q1(b) **(07 Marks)**

c. Derive the state model of an armature controlled dc motor. **(08 Marks)**

2 a. A feedback system is characterized by the closed loop transfer function $\frac{Y(s)}{U(s)} = \frac{(s^2+4)}{(s+1)(s+2)(s+3)}$. Obtain the state model in canonical form (diagonal form). Also draw the block diagram. **(08 Marks)**

b. A feedback system is characterized by closed loop transfer function $\frac{Y(s)}{U(s)} = \frac{(2s^2+6s+7)}{(s+1)^2(s+2)}$. Obtain the state model in Jordan canonical form. Also draw the block diagram. **(08 Marks)**

c. Discuss briefly about Linearization of state equation. **(04 Marks)**

3 a. For the system represented by the state equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -1 & 0 & 1 \\ 1 & -2 & 0 \\ 0 & 0 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t)$$

$y = [0 \ 1 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$. Obtain the system transfer function. **(08 Marks)**

b. What are the advantages of diagonalization techniques? **(04 Marks)**

c. Given $A = \begin{bmatrix} 0 & 2 & 0 \\ -1 & -3 & 0 \\ 0 & 2 & -4 \end{bmatrix}$, find the eigen values and modal matrix of A. **(08 Marks)**

4 a. List the properties of state transition matrix. **(04 Marks)**

b. The state equation and initial state of a linear unforced system are given respectively by

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}1 & 2\\ 0 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix};\quad \begin{bmatrix}x_1(0)\\ x_2(0)\end{bmatrix}=\begin{bmatrix}1\\ 2\end{bmatrix}.$$

Obtain the state transition matrix of the system and hence obtain the solution (zero input response) **(08 Marks)**

c. Check the observability of the system described by the following equations by
i) Kalman's test ii) Gilberts test

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u(t)$$

$$y=[3\ 4\ 1]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}.$$

(08 Marks)

5 a. Consider a system described by the following state equation.

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -1 & -5 & -6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}+\begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u(t)$$

By using the state feedback control U = –Kx, it is desired to have the closed loop poles at $s=-1\pm j2, s=-10$. Determine the state feedback gain matrix by any two methods. **(12 Marks)**

b. What are controllers? Explain the basic classification of controllers. Explain proportional control mode. **(08 Marks)**

6 a. What is a state observer? Explain briefly the concept of state observer. **(08 Marks)**

b. Explain the following types of non-linearities with relevant input-output characteristics.
i) Dead zone ii) Back lash iii) Friction. **(12 Marks)**

7 a. Explain isodine method for the construction of phase trajectory. **(10 Marks)**

b. Explain the following terms as referred to phase plane method
i) Singular point ii) Limit cycle. **(10 Marks)**

8 a. Define : i) Stability in the sense of Liapunov ii) Asymptotic stability **(06 Marks)**

b. Check for positive definiteness of the following quadratic form

i) $v(X)=8X_1^2+X_2^2+4X_3^2+2X_2X_2-4X_1X_3-2X_2X_3$

ii) $v(X)=10X_1^2+4X_2^2+X_3^2+2X_1X_2-2X_2X_3-4X_1X_3$ **(08 Marks)**

c. Explain Liapunov's direct method. **(06 Marks)**

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