USN

10EE55

Fifth Semester B.E. Degree Examination, Dec.2018/Jan.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. Define the concept of i) State ii) State variables iii) State space. **(06 Marks)**

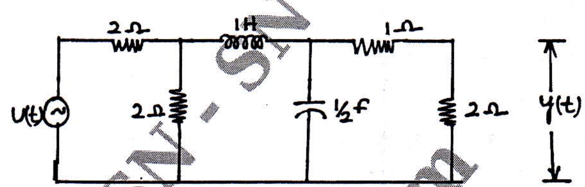
b. Consider the multivariable system described by the differential equations, obtain the state model of the system.

$$\frac{d^2y_1(t)}{dt^2}+4\frac{dy_1(t)}{dt}-3y_2(t)=u_1(t)\to(1)$$

$$\frac{dy_1(t)}{dt}+\frac{dy_2(t)}{dt}+y_1(t)+2y_2(t)=u_2(t)\to(2).$$ **(06 Marks)**

c. Represent the electrical network given in Fig.Q.1(c) by a state equation and output equation. **(08 Marks)**

Fig.Q.1(c)

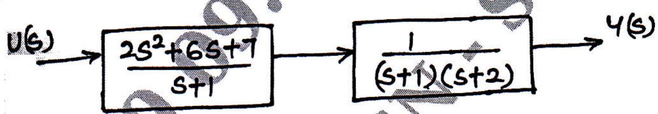


2 a. Obtain the two state variable forms and hence draw the state diagram for both forms i.e., i) Phase variable form ii) Canonical variable form, for the following transfer function,

$$\frac{Y(s)}{U(s)}=\frac{6}{s^3+6s^2+11s+6}.$$ **(12 Marks)**

b. Write down the canonical model for the given complete system shown in Fig.Q.2(b). **(08 Marks)**

Fig.Q.2(b)



3 a. For the given state model obtain the transfer function,

$$\begin{bmatrix}x_1'\\x_2'\\x_3'\end{bmatrix}=\begin{bmatrix}0&1&0\\0&-1&1\\0&-1&-10\end{bmatrix}\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix}+\begin{bmatrix}0\\0\\10\end{bmatrix}u$$

$$y=\begin{bmatrix}1&0&0\end{bmatrix}\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix}$$ **(08 Marks)**

b. Narrate the importance of diagonalization. **(02 Marks)**

c. Consider a matrix A given below,

$$A=\begin{bmatrix}0&1&0\\3&0&2\\-12&-7&-6\end{bmatrix}$$

Obtain the diagolized matrix A. **(10 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.

4 a. Define state transition matrix and mention any two properties. (04 Marks)

b. Consider a control system with state model

$$\begin{bmatrix} x_1' \\ x_2' \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix}u; \begin{bmatrix} x_1(0) \\ x_2(0) \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

Compute the state transition matrix and there from find the unit step response, for the given initial condition. (08 Marks)

c. Consider the system with state equation,

$$\begin{bmatrix} x_1' \\ x_2' \\ x_3' \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix}u(t)$$

$$y = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Evaluate controllability and observability using either Kalman's test or Gilbert's test. (08 Marks)

PART – B

5 a. Prove that a necessary and sufficient condition for arbitrary pole placement in that system is completely state controllable. (10 Marks)

b. Consider the system represented by,

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}; \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}.$$ Design a full order observer such that the observer eigen values are at $-2 \pm j2\sqrt{3}$ and -5. (10 Marks)

6 a. Write a short note on: i) Saturation ii) Dead zone iii) friction. (06 Marks)

b. Consider the system designed by,

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

Using state feedback control u = -KX, it is desired to have the closed loop poles at $S = -1 \pm j2$, $S = -10$. Determine the state feed back gain matrix K. (08 Marks)

c. Define controller. Explain P and PI controller with the help of block diagram. What are the advantages of PID controller? (06 Marks)

7 a. With reference to non-linear system explain i) Jump resonance ii) Limit cycles. (06 Marks)

b. What are singular points? Find out singular points for the following systems.

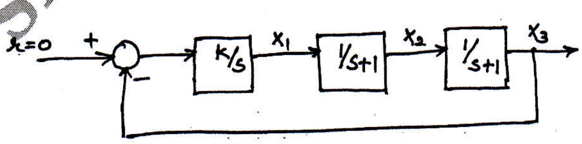
i) $y'' + 3y' - 10 = 0$ ii) $y'' + 3y' + 2y = 0$

Also show the trajectories for the singular points. (14 Marks)

8 a. Explain with an example: i) Liapunov main stability theorem ii) Liapunov second method iii) Krasovskii's theorem. (10 Marks)

b. Using Lyapunov's direct method, find the range of K to guarantee stability of the system shown in Fig.Q.8(b). (10 Marks)

Fig.Q.8(b)



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