Sr. No 009503

December 2023

B.Tech. EIC V^{th} SEMESTER

Modern Control System (EI 502)

Time: 3 Hours **Max. Marks:75**

Instructions:
1. *It is compulsory to answer all the questions (1.5 marks each) of Part -A in short.*
2. *Answer any four questions from Part -B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*
4. *Assume any missing data*

PART -A

Q1 (a) List the demerits of classical control theory. (1.5)

(b) What are eigen values? State its significance. (1.5)

(c) Define state observers. (1.5)

(d) What are the factors that influence the choice of state variables in a dynamic system? (1.5)

(e) Differentiate between transfer matrix and transfer function. (1.5)

(f) State the necessary condition for carrying pole placement design. (1.5)

(g) What are the parameters for designing state observers? (1.5)

(h) Define multivariable systems. (1.5)

(i) What do you mean by integral control? What it its impact on state feedback? (1.5)

(j) How the controllability of discrete time systems is determined? (1.5)

PART -B

Q2 (a) Obtain the transfer function for the system (08)

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

$$y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x$$

(b) A single input single output system is given by (07)

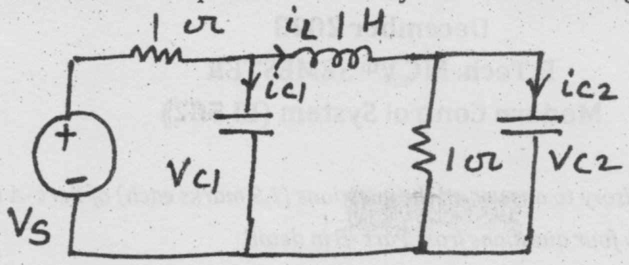
$$\dot{X}(t) = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 & 2 \end{bmatrix} x(t)$$

Test for controllability and observability.

Q3 (a) State the properties of state transition matrix. (05)

(b) Write the state equation for the system shown in fig. (10)



Q4 (a) Consider a system (08)

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

Find the eigenvalues of A and determine the stability of system.

(b) A linear continuous system is represented by state model (07)

$$\dot{X} = \begin{bmatrix} -3 & 1 \\ 0 & -2 \end{bmatrix} X + \begin{bmatrix} 1 \\ 2 \end{bmatrix} u \qquad Y = \begin{bmatrix} 2 & 1 \end{bmatrix} X$$

Design a feedback controller that places the closed loop poles at s= -3+-j4

Q5 (a) Explain pole placement using state feedback. Discuss the principle of feedback controller design. (05)

(b) What is the effect of addition of observer on closed loop system? Also derive the transfer function of observer-based controller. (10)

Q6 (a) A linear continuous system is represented by state model (10)

$$\dot{X} = \begin{bmatrix} 0 & 2 \\ 0 & 2 \end{bmatrix} X + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u \qquad Y = \begin{bmatrix} 1 & 0 \end{bmatrix} X$$

Design an observer with poles at s=-8,-8.

(b) What do you mean by linear discrete state space model? How state variable analysis is done for such systems? (05)

Q7 (a) Given a block diagram of the system, explain the method of obtaining its state model. (07)

(b) What do you mean by canonical form of state model? List the features. (08)

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