Register No.: ……………………………… Name: ………………………………………………………

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION (R), DECEMBER 2023
ELECTRICAL AND ELECTRONICS ENGINEERING
(2020 SCHEME)

Course Code : **20EET401**

Course Name: **Advanced Control Systems**

Max. Marks : **100** **Duration: 3 Hours**

Provide Graph sheet

PART A

(Answer all questions. Each question carries 3 marks)

1. Obtain the state space model for linear time-invariant (LTI) systems with multiple inputs and multiple outputs.
2. Derive the state space model of a series RLC circuit. Consider the current passing through the inductor and the voltage across the capacitor as the system's state variables and e(t) as the input voltage.
3. Derive the transfer function from a state space model.
4. Explain the Laplace transform method to obtain the state transition matrix.
5. Check whether the given system is controllable or not.

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \\ \dot{x_3} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u;$$

6. Explore methods and concepts related to observability and controllability.
7. Discuss the procedure to analyze the stability of a non-linear system using describing function method.
8. Derive the describing function of ideal relay non-linearity
9. Check the definiteness of the following system.

$$(i).V(x) = x_1^2 + 2x_2^2$$
$$(ii).V(x) = x_1 + x_2$$

10. Explore the concept of singular points with a relevant example.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) The transfer function of a system is $\frac{X(s)}{U(s)} = \frac{2}{s^3+6s^2+11s+6}$. Obtain the state model in any two canonical forms. (6)

b) Derive the pulse transfer function from a state space model. (8)

OR

12. a) Describe the distinction between a state space model and a transfer function model. (4)

b) Obtain the state model by direct decomposition method of a system whose transfer function is $\frac{Y(s)}{U(s)} = \frac{5s^2+6S+8}{s^3+3s^2+7s+9}$. (10)

MODULE II

13. a) A state variable formulation of a system is given by the expression $\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$. Find the transfer function of the system. (6)

b) Examine the solution of the homogeneous state equation in the presence and absence of input. (8)

OR

14. a) Discuss the procedure to obtain state transition matrix using Cayley Hamilton theorem. (4)

b) Find f(A)=A^{10}, when A=$\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$, Also find state transition matrix using Cayley Hamilton theorem. (10)

MODULE III

15. a) Elaborate any one method for designing a state feedback controller (7)

b) The transfer function of a system given by $\frac{Y(s)}{U(s)} = \frac{1}{s(s+1)}$,design a state feedback gain matrix to place the Eigen values at -2±2j. (7)

OR

16. a) Explore the idea of a state observer through the use of an appropriate block diagram. (6)

b) Consider the system designed by state model (dx/dt)=$\begin{bmatrix} -1 & 1 \\ 1 & -2 \end{bmatrix}$x, Y= [1 0] x. Design state full order observer by using -5, -5 as Eigen values. (8)

MODULE IV

17. Explain various types of nonlinearity and their distinctive characteristics. (14)

OR

18. Obtain the describing function for a dead zone non-linearity. (14)

MODULE V

19. a) (i). Define Equilibrium state of an LTI system (ii). Explain the Lyapunov Stability analysis. (6)

b) Check the positive definiteness of the following systems and obtain the Lyapunov function. (dx/dt) = $\begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$x. (8)

OR

20. A linear second order system is described by the equation $(d^2x/dt)+2\varepsilon\omega n(dx/dt)+\omega_n{}^2x=0$. Determine singular point and construct phase trajectories using isocline method. Where $\varepsilon=-1.5$, $\omega_n=1$ rad/sec and $x(o)=1.5$, $dx(o)/dt=0$. (14)

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