

SRM VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

QUESTION BANK



ME-Power Systems Engineering

PS3164- SYSTEM THEORY

Regulation – 2023

Academic Year 2026–27 ODD

Prepared by

Ms.S.Vanila, A.P (Sel.G) / EEE,



SRM VALLIAMMAI ENGINEERING COLLEGE

SRM Nagar, Kattankulathur – 603 203.



DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

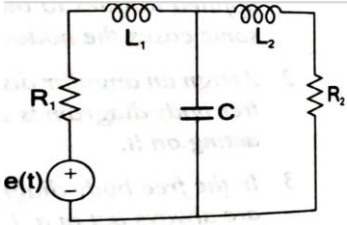
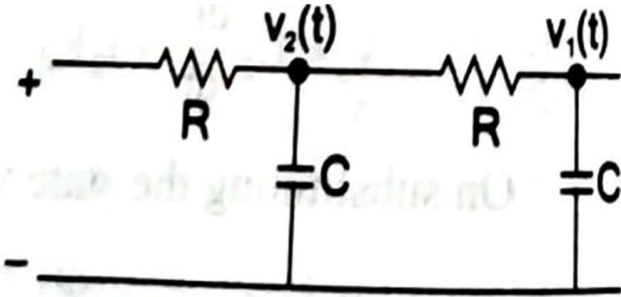
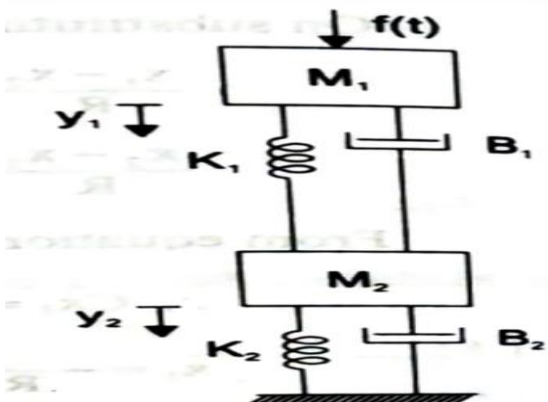
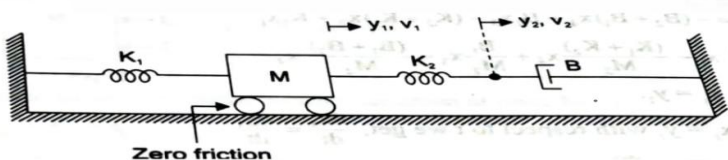
QUESTION BANK

SUBJECT & SUBJECT CODE: PS3164 – System Theory

SEM / YEAR: I Sem / I Year

UNIT I STATE VARIABLE REPRESENTATION			
Introduction-Concept of State-Space equations for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model- Physical Systems and State Assignment - free and forced responses- State Diagrams.			
PART A			
Q.No.	Questions	BTL Level	Domain
1.	What is the state of a dynamic system?	BTL 1	Remembering
2.	Define state-space representation.	BTL 1	Remembering
3.	What is the significance of state variables?	BTL 1	Remembering
4.	State the concept of state equations.	BTL 1	Remembering
5.	What is meant by a dynamic system in state-space analysis?	BTL 1	Remembering
6.	Define time-invariance in state-space systems.	BTL 1	Remembering
7.	What is linearity in state-space models?	BTL 2	Understanding
8.	Define non-uniqueness of the state model.	BTL 2	Understanding
9.	How does physical realization relate to state assignment?	BTL 2	Understanding
10.	What is the difference between free and forced response in state-space analysis?	BTL 2	Understanding
11.	What is a state diagram?	BTL 1	Remembering

12.	Why are state-space equations used in control systems?	BTL 1	Remembering
13.	What are the key components of a state-space model?	BTL 1	Remembering
14.	How do initial conditions affect the state-space model?	BTL 2	Understanding
15.	List the drawbacks in transfer function model analysis.	BTL 2	Understanding
16.	Distinguish between Physical variable model and Phase variable model.	BTL 2	Understanding
17.	Consider a system whose transfer function is given by $Y(S)/U(S) = 10(S+1)/S^3+6s^2+5s+10$. Calculate state model for this system	BTL 2	Understanding
18.	Compare the merits and demerits of realizing a given system in state variable and transfer function form.	BTL 2	Understanding
19.	List the applications of state space model for the different system.	BTL 2	Understanding
20.	Formulate state space model with state diagram for observable canonical form.	BTL 2	Understanding
21	Develop state space model with state diagram for controllable canonical form.	BTL 2	Understanding
22	What are the advantages of state space analysis?	BTL 2	Understanding
23	What are the advantages in choosing phase variables for state space modelling?	BTL 2	Understanding
24	What is the disadvantage in choosing phase variables for state space modelling?	BTL 2	Understanding
PART – B			
1.	Obtain the state model of the electrical network by choosing minimal number of state variables. (16)	BTL 3	Applying

			
2.	Obtain the state model of the electrical network by choosing $v_1(t)$ and $v_2(t)$ as state variables. (16) 	BTL 3	Applying
3.	Construct the state model of mechanical system shown. (16) 	BTL 3	Applying
4.	Obtain the state model of the mechanical system shown by choosing a minimum of three state variables. (16) 	BTL 3	Applying
5.	Determine the state model of armature controlled DC motor. (16)	BTL 3	Applying
6.	Determine the state model of field controlled DC motor. (16)	BTL 3	Applying
7.	Illustrate the expression for the state space model for the continuous system and also draw the state diagram for it. (16)	BTL3	Applying

	(16)		
8.	Formulate the expression for the (i) Controllable canonical form (ii) Observable Canonical form. (16)	BTL 3	Applying
9.	Solve the state space model for the given system (i) $Y(S)/U(S)=10/S^3+4S^2+2S+1$ by the method of (i) Laplace Transform (ii) Signal Flow Graph Method. (16)	BTL 5	Evaluating
10.	Construct the state space model for the given differential equation $\frac{d^3Y}{dt^3} + 6\frac{d^2Y}{dt^2} + 11\frac{dY}{dt} + 6Y = U(t)$ Give the block diagram representation of the state model. (16)	BTL 5	Evaluating
11.	Solve the state space model for the given system $Y(S)/U(S)=8/(S+1)(S+2)(S+3)$ by the method of (i) Laplace Transform (ii) Signal Flow Graph Method. (16)	BTL4	Analyzing
12.	Create the state space model by using signal flow graph for the given problem $Y(S)/U(S)=10/(S^3+5S^2+4S+10)$. (16)	BTL 5	Evaluating
13.	A feedback system has a closed loop transfer function $Y(s)/U(s)=10(s+4)/s(s+1)(s+3)$. Construct three different state models and give block diagram representation for each model. (16)	BTL 3	Applying
14.	Explain the state-space representation of dynamic systems and describe its components. (16)	BTL 6	Creating
15.	Define time invariance in the context of state-space systems and provide examples of time-invariant and time-varying systems. (16)	BTL 3	Applying
16.	Explain how physical systems can be modeled using state-space representation, with an example of an electrical or mechanical system. (16)	BTL 3	Applying
17.	Differentiate between free and forced responses in a dynamic system and explain their significance in system behavior. (16)	BTL 3	Applying

UNIT II SOLUTION OF STATE EQUATIONS

Existence and uniqueness of solutions to Continuous-time state equations - Solution of Nonlinear and Linear Time Varying State equations - State transition matrix and its properties – Evaluation of matrix exponential- Cayley Hamilton's Theorem System modes- Role of Eigen values and Eigen vectors.

PART A

Q.No.	Questions	BTL Level	Domain
1.	What is state transition matrix? List any two methods for finding state transition matrix.	BTL 1	Remembering
2.	Quote the formula for the solution of the state equation in time domain?	BTL 1	Remembering
3.	What is eigen values and eigen vectors? Examine how the eigen values can be calculated?	BTL 1	Remembering
4.	What is state transition matrix and identify how it is related to state of a system?	BTL 1	Remembering
5.	Quote the formula for Matrix exponential method.	BTL 1	Remembering
6.	Quote the different methods available for computing e^{At} .	BTL 1	Remembering
7.	Summarize the term Jordan canonical form.	BTL 2	Understanding
8.	Predict the transformation used to diagonalize a system matrix.	BTL 2	Understanding
9.	Estimate the transformed canonical state model of a system.	BTL 2	Understanding
10.	Express the term Model Matrix with suitable formula.	BTL 2	Understanding
11.	How the modal matrix can be determined?	BTL 2	Understanding
12.	State Cayley-Hamilton theorem.	BTL 2	Understanding
13.	How the state transition matrix e^{At} is computed by canonical transformation?	BTL 2	Understanding
14.	How the state transition matrix e^{At} is computed using Cayley- Hamilton theorem?	BTL 2	Understanding
15.	Point out how the state transition matrix is related to state of a system.	BTL 2	Understanding
16.	State the solution of homogeneous state equations.	BTL 2	Understanding

17.	Write the solution of non-homogeneous state equations.	BTL 2	Understanding
18.	Judge the term resolvent matrix.	BTL 2	Understanding
19.	What information can be inferred from the eigenvalues of a system?	BTL 2	Understanding
20.	What is a time-varying state equation?	BTL 1	Remembering
21.	What is the significance of the state transition matrix in time-invariant systems?	BTL 1	Remembering
22.	What is the relationship between eigenvalues and system stability?	BTL 1	Remembering
23.	What role do eigenvalues play in determining system behavior?	BTL 1	Remembering
24.	How is Cayley-Hamilton's theorem applied in control theory?	BTL 1	Remembering

PART – B

1.	Illustrate the expression by (i) Matrix Exponential Method (ii) Laplace Transform Method for state transition of matrix. (16)	BTL 3	Applying
2.	Obtain the state space Model $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 4 \\ 5 \end{bmatrix} U; y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Convert the state space model into canonical form state space model. And also calculate the value of state transition matrix. (16)	BTL 3	Applying
3.	State Cayley-Hamilton's Theorem. Derive and explain the expression of state transition matrix using Cayley-Hamilton's theorem for continuous system. (16)	BTL 3	Applying
4.	Evaluate the state transition matrix for the given discrete system matrix $A = \begin{bmatrix} 0 & 1 \\ -12 & 7 \end{bmatrix}$ By i. Z-transform technique ii. Cayley-Hamilton's theorem. (16)	BTL 5	Evaluating

5.	The given state space model $A = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix}$; Calculate the (i) Eigen values and Eigen vectors (ii) Rank of the matrix. (16)	BTL 3	Applying
6.	Evaluate the value of e^{At} by (i) Trial and Error Method (ii) Cayley Hamilton's Theorem. $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ (16)	BTL 5	Evaluating
7.	Analyze the value of state transition matrix or e^{At} by using (a) Laplace Transform Method (b) Cayley Hamilton's Theorem (c) A^{10} in which $A = \begin{bmatrix} 0 & 1 \\ -12 & 7 \end{bmatrix}$ (16)	BTL 4	Analyzing
8.	The given matrix $A = \begin{bmatrix} -1 & 1 & 1 \\ 0 & -1 & 1 \\ 0 & 0 & -1 \end{bmatrix}$; Calculate the state transition matrix by using Laplace transform method. (16)	BTL 3	Applying
9.	The given matrix $A = \begin{bmatrix} 2 & 1 & 4 \\ 0 & 2 & 0 \\ 0 & 3 & 1 \end{bmatrix}$; Estimate the value of state transition matrix by using Cayley Hamilton's Theorem. (16)	BTL 4	Analyzing
10.	Convert the transfer function for the state space model and calculate $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \end{bmatrix} U ; y = [1 \ 0] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} U ; y = [1 \ 2] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -0.4 & -1.3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U ; y = [0.8 \ 1] \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \quad (16)$	BTL 3	Applying

11.	Solve and Calculate the value of state transition matrix or e^{At} by using (a) Laplace Transform Method (b) Cayley Hamilton's Theorem(c) A^{10} in which $A = \begin{bmatrix} 0 & 1 \\ -12 & 7 \end{bmatrix}$ (16)	BTL 4	Analyzing
12.	Find and point out the value of e^{At} by (i) Trial and Error Method (ii) Cayley Hamilton's Theorem. $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ (16)	BTL 4	Analyzing
13.	Consider a system whose transfer function is given by $Y(S)/U(S) = \frac{10(S+1)}{S^3+6S^2+5S+10}$ Evaluate the state model for the system (i) by Block diagram reduction (ii) Signal flow graph Method. (16)	BTL 5	Evaluating
14.	Create the expression for the following Methods for State Transition Matrix as follows (i) Trial and Error Method (iii) Laplace Transform Method (iv) Canonical Form. (16)	BTL 6	Creating
15.	Discuss Cayley-Hamilton's Theorem and its significance in control theory. (16)	BTL 4	Analyzing
16.	What is the Matrix Exponential, and how is it evaluated for solving Linear Time-Invariant Systems? (16)	BTL 4	Analyzing
17.	Discuss the series expansion method and alternative techniques such as diagonalization and Jordan canonical form. (16)	BTL 4	Analyzing

UNIT III PROPERTIES OF THE CONTROL SYSTEM

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems

Time varying and Time invariant case-Output Controllability-Reducibility-System Realizations.

PART A

Q.No.	Questions	BTL Level	Domain
1.	What is meant by the rank of the matrix ?	BTL 1	Remembering
2.	Define the duality of the system between controllability and observability concept?	BTL 1	Remembering
3.	The given state space model	BTL 1	Remembering

	$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 4 \\ 5 \end{bmatrix} U; y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Check whether the given is controllable		
4.	Examine the need for observability test.	BTL 1	Remembering
5.	State the condition for observability by Gilbert's method.	BTL 1	Remembering
6.	When the Controllability test is normally applicable ?.	BTL 1	Remembering
7.	Summarize the condition for controllability by Gilbert's method.	BTL 2	Understanding
8.	State the condition for controllability by Kalman's method.	BTL 2	Understanding
9.	What is meant by minimal realization? Give the expression for it.	BTL 2	Understanding
10.	Discuss the effect of pole zero cancellation in transfer function approach.	BTL 2	Understanding
11.	Illustrate the concept of stabilizability.	BTL 2	Understanding
12.	Illustrate the concept of detectability.	BTL 2	Understanding
13.	List the advantage and disadvantage in Kalman's test for observability?	BTL 2	Understanding
14.	The given state space model $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 4 \\ 5 \end{bmatrix} U; y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Solve whether the given is controllable	BTL 2	Understanding
15.	Analyze the condition for output controllability by Kalman's method.	BTL 2	Understanding
16.	Analyze the condition for observability by Kalman's method.	BTL 2	Understanding
17.	Given two equivalent mathematical expressions which state that a given pair of matrices(A, B) is controllable. Evaluate the	BTL 2	Understanding

	expression.		
18.	Write the Ackerman's formula for state feed back gain and explain it.	BTL 1	Remembering
19.	Write the formula for Observability of the system.	BTL 1	Remembering
20.	What is meant by duality of the system?	BTL 1	Remembering
21.	What is a system realization?	BTL 1	Remembering
22.	What does reducibility mean in control systems?	BTL 1	Remembering
23.	Differentiate between time-varying and time-invariant systems.	BTL 2	Understanding
24.	How is observability tested in continuous-time systems?	BTL 2	Understanding

PART – B

1.	What is meant by rank of the matrix? Analyze whether the rank of the matrix depends on controllability or not. (16)	BTL 4	Analyzing
2.	Define the concept of Controllability and observability of the system. Write the expression for the controllability and observability in (i) Kalman's Method (ii) Gilbert's Method. (16)	BTL 4	Analyzing
3.	Derive the expression for the (i) Controllable canonical form (ii) Observable Canonical Form. (16)	BTL 4	Analyzing
4.	The given state space model $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} U$ $; y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Check whether the given is controllable and observable or not by Kalman's approach and Gilbert's method. (16)	BTL 4	Analyzing
5.	The given state space model $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix} U ; y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Check whether the system is controllable and observable or not.	BTL 3	Applying

	Also check the duality by Kalman's approach and Gilbert's method. (16)		
6.	The transfer function of the system $Y(S)/U(S)=3/S^3+6S^2+11S+6$. Check whether the given system is controllable as well as observable. And also check the duality. by Kalman's approach and Gilbert's method. (16)	BTL 3	Applying
7.	Estimate the controllable canonical realization of the following systems. Hence, obtain the state space model in controllable canonical form (i) $H(S)=(S+2)/(S+5)$ (ii) $H(S)=(S+2)/(S^2+2S+5)$ (iii) $H(S)=(2S+9)/(S^3+8S^2+12S+1)$ (iv) $H(S)=(S^2+2S+3)/(S^4+3S^3+12S^2+9S+10)$ (16)	BTL 3	Applying
8.	Illustrate the expression for the Controllability and Observability in (i) Kalman's Method (ii) Gilbert's Method. (16)	BTL 3	Applying
9.	Explain i) Reducibility (ii) System Realization. Explain with an example for each for solving a problem. (16)	BTL 3	Applying
10.	Explain with an example explain (i) Output Controllability and Observability (ii) Controllable and Observability concept applicable for time varying and invariant system. (16)	BTL 4	Analyzing
11.	Consider a system with state space model is given below. $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 2 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 4 \end{bmatrix} U; y = [2 \ -4 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Point out that the system is observable and controllable. (16)	BTL 4	Analyzing
12.	The given state space model $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 3 \end{bmatrix} U; y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Check whether the given is controllable and observable or not. And also	BTL 4	Analyzing

	Point out the duality by Kalman's approach and Gilbert's method. (16)		
13.	With the case study summarize (i) Armature control of DC Motor (ii) Field Control of DC Motor. And also draw the (i) Block diagram (ii) State diagram and state space model for the system. (16)	BTL 5	Evaluating
14.	(i) Consider a system whose transfer function is given by $Y(S)/U(S) = 10(S+1)/S^3+6s^2+5s+10$. Solve and explain state model for this system. (ii) The given state space model $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -5 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 4 \\ 5 \end{bmatrix} U ; y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Point out whether the system is controllable or observable or not. And also check the duality principle. (16)	BTL 4	Analyzing
15.	What is Output Controllability, and how does it differ from State Controllability? (16)	BTL 3	Applying
16.	Explain the Kalman rank condition and how it applies to both time-varying and time-invariant systems. Illustrate with examples. (16)	BTL 3	Applying
17.	What are Stabilizability and Detectability in control theory? Discuss their significance in system design. (16)	BTL 3	Applying

UNIT IV NON-LINEARITIES AND STABILITY ANALYSIS

Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems- Types of nonlinearity – Phase plane analysis – Singular points – Limit cycles – Construction of phase trajectories – Describing function method – Derivation of describing functions. Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems - Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems- Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradient Method.

PART A

Q.No.	Questions	BTL Level	Domain
1.	Define (i) Conditionally Stable (ii) Limitedly Stable (iii) Marginally Stable (iv) Unstable.	BTL 1	Remembering

2.	Define BIBO stability.	BTL 1	Remembering
3.	Define positive definiteness of scalar functions. Give an example.	BTL 1	Remembering
4.	Point out Lyapunov's asymptotic stability.	BTL 1	Remembering
5.	Define the term stability.	BTL 1	Remembering
6.	Evaluate the concept of equilibrium points.	BTL 1	Remembering
7.	What is meant by autonomous system?	BTL 2	Understanding
8.	State the negative definiteness of scalar functions.	BTL 2	Understanding
9.	Illustrate Lyapunov's instability theorem.	BTL 2	Understanding
10.	Define positive semi definiteness of scalar functions.	BTL 1	Remembering
11.	Draw and quote graphical representation of stable, asymptotic stable and unstable equilibrium states with their trajectory .	BTL 1	Remembering
12.	Show that the following quadratic form is + ve definite. $V(X)=10x_1^2 +4x_2^2 +x_3^2+2x_1x_2-2x_2x_3 -4x_1x_3$	BTL 2	Understanding
13.	Check whether the following quadratic form is – ve definite. $V(X) = -x_1^2 -3x_2^2 -11x_3^2 + 2x_1x_2 -4x_2x_3 -2x_1x_3$	BTL 2	Understanding
14.	In routh array analyze the conclusions when there is a row of all zeros.	BTL 2	Understanding
15.	Analyze the concept of limitedly stable system.	BTL 2	Understanding
16.	List the necessary and sufficient condition for stability.	BTL 2	Understanding
17.	A system has repeated Eigen values on imaginary axis. What can you create about the asymptotic stability of the system?	BTL 2	Understanding
18.	List out various methods for stability analysis of nonlinear system.	BTL 2	Understanding
19.	Define Lyapunov's sufficient condition for asymptotic stability.	BTL 1	Remembering
20.	Mention the advantages of Lyapunov's stability criteria	BTL 2	Understanding
21.	What is Krasovskii method?	BTL 1	Remembering
22.	What is Variable-Gradient Method?	BTL 1	Remembering
23.	What is the equilibrium stability of nonlinear continuous-time autonomous systems?	BTL 1	Remembering
24.	What is the describing function method?	BTL 1	Remembering
PART – B			

1.	Describe the modeling energy system in terms of quadratic function. (16)	BTL 4	Analyzing
2.	Explain Lyapunov's stability criteria with diagrammatic representation (i) Asymptotically stable (ii) Stable (iii) Unstable. (16)	BTL 4	Analyzing
3.	Examine Lyapunov's stability analysis for (i) Linear time invariant system (ii) Nonlinear Continuous system. (16)	BTL 4	Analyzing
4.	Explain the Lyapunov's criterion stability analysis for (i) Continuous system (ii) Discrete time systems. (16)	BTL 4	Analyzing
5.	Summarize Krasovskii method and how it can be applicable for stability analysis explain with an example for it. (16)	BTL 4	Analyzing
6.	Summarize direct method of Lyapunov's function how it can be applicable for nonlinear continuous time system. (16)	BTL 4	Analyzing
7.	Examine Lyapunov's direct method of Lyapunov for Continuous time autonomous system. (16)	BTL 4	Analyzing
8.	Examine the following terminology (i) Stability in the sense of Lyapunov (ii) BIBO Stability for Linear Time Invariant System. (16)	BTL 4	Analyzing
9.	Design and determine if the following matrix is positive definite. $V(X)=10x_1^2 +4x_2^2 +x_3^2+2x_1x_2-2x_2x_3 -4x_1x_3$ (16)	BTL 3	Applying
10.	Estimate the direct method of Lyapunov's function how it can be applicable for nonlinear continuous time system. (16)	BTL 3	Applying
11.	Illustrate the following methods for stability analysis (i)Krasovskii Method (ii) Variable-Gradient Method with suitable example. (16)	BTL 3	Applying
12.	Describe Lyapunov's Method Stability analysis for (i) Linear System (ii) Non-Linear System with suitable example. (16)	BTL 3	Applying
13.	What is meant by autonomous of the system ? Analyze how the Lyapunov's Method applicable for Linear and Nonlinear autonomous system. (16)	BTL 3	Applying

14.	Explain following stability concepts (i) Lyapunov's Method stability at origin (ii) Lyapunov's Method stability in stable boundary (iii) Lyapunov's Method for unstable condition. (16)	BTL 3	Applying
15	Explain the concept of Lyapunov stability for both linear and nonlinear systems. (16)	BTL 3	Applying
16	Discuss the conditions for BIBO stability in linear time-invariant (LTI) systems, and explain how the location of poles affects system stability. (16)	BTL 3	Applying
17	Explain Krasovskii's method and the variable-gradient method for constructing Lyapunov functions for nonlinear continuous-time autonomous systems. (16)		

UNIT V MODAL ANALYSIS

Controllable and Observable Companion Forms - SISO and MIMO Systems – Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

PART A

Q.No.	Questions	BTL Level	Domain
1.	What is the state observer? Draw the diagram for State Observer and point out main features.	BTL 1	Remembering
2.	Analyze the need for state observer for the system.	BTL 1	Remembering
3.	Summarize the following terms (i) Full-order observer (ii) Reduced order observer (iii) Minimum-order state observer.	BTL 1	Remembering
4.	What is the necessary condition to be satisfied for the design of state observer? Write the Ackermann's formula to identify the state observer gain matrix, G.	BTL 2	Understanding
5.	Define the term Pole Placement of controller.	BTL 1	Remembering
6.	Formulate the Ackermann's formula to find the state feedback gain matrix, K.	BTL 2	Understanding
7.	What are Controllable and Observable Companion Forms?	BTL 2	Understanding

8.	State the pole placement controller by state feedback.	BTL 2	Understanding
9.	How will you evaluate the transformation matrix, P_O to the state model to observable phase variable form?	BTL 2	Understanding
10.	How control system design is carried in state space?	BTL 1	Remembering
11.	Quote the necessary condition to be satisfied for design using state feedback.	BTL 1	Remembering
12.	Illustrate the block diagram of a system with state feedback concept for controller.	BTL 2	Understanding
13.	Express the general form of controllable phase variable form of state model approach.	BTL 2	Understanding
14.	What is meant by Control law?.	BTL 1	Remembering
15.	How will you find the transformation matrix, P_c to transform the state model to controllable phase variable form using the characteristic equation?	BTL 1	Remembering
16.	How will you examine the transformation matrix, P_c to transform the state model to controllable phase variable form using the characteristic equation?	BTL 2	Understanding
17.	Differentiate between SISO and MIMO systems.	BTL 2	Understanding
18.	State observability of the system.	BTL 1	Remembering
19.	How does state feedback affect observability?	BTL 1	Remembering
20.	How does state feedback affect controllability?.	BTL 1	Remembering
21.	What is a reduced-order observer?	BTL 2	Understanding
22.	What is a full-order observer?	BTL 2	Understanding
23.	What is the difference between pole placement for SISO and MIMO systems?	BTL 2	Understanding
24.	What is pole placement by state feedback?	BTL 2	Understanding
PART – B			
1.	Examine the design of pole placement concept for SISO and MIMO System with suitable diagram and expression. (16)	BTL 4	Analyzing

2.	Consider the state space model described by $\dot{X}(t) = AX(t)$ $Y(t) = CX(t)$ $A = \begin{bmatrix} -1 & 1 \\ -1 & -2 \end{bmatrix}$; $C = [1 \ 0]$. Design and examine a full-order state observer. The desired Eigen values for the observer matrix $\mu_1 = -5; \mu_2 = -5$. (16)	BTL 4	Analyzing
3.	Explain the controllable canonical form and observable canonical form for an example. (16)	BTL 3	Applying
4.	Analyze the expression for (i) Full order observer (ii) Reduced Order Observer (iii) Pole Placement of Controller. (16)	BTL 5	Evaluating
5.	Describe the effect of feedback on the concept of Controllability and Observability of the system. (16)	BTL 4	Analyzing
6.	Describe in detail the concept of state space model for full order observer and reduced order observer. (16)	BTL 4	Analyzing
7.	Discuss briefly about the controllable and observable forms of SISO systems. (16)	BTL 4	Analyzing
8.	(i) Illustrate the Controllable Canonical Form and Observable Canonical forms for MIMO system. (ii) Illustrate the effect of state feedback on Controllability and Observability. (16)	BTL 4	Analyzing
9.	What is meant by state observer? Explain with an example for state space with feedback (i) Full Order (ii) Reduced Order Observer. (16)	BTL 6	Creating
10.	The given state space model as follows $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} U; y = [1 \ 0 \ 0] \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ Convert the state model into observable phase variable format and evaluate it. (16)	BTL 5	Evaluating
11.	Illustrate the effect of state feedback gain by pole placement (i) Open loop state space without feedback gain (ii) Closed loop state feedback gain with control law for obtaining gain K by any one of the method with necessary condition. (16)	BTL 3	Applying

12.	Consider the state space model described by $\dot{X}(t) = AX(t)$ $Y(t) = CX(t)$ $A = \begin{bmatrix} -1 & 1 \\ -1 & -2 \end{bmatrix}$; $C = [1 \ 0]$. Design and express a full-order state observer. The desired Eigen values for the observer matrix $\mu_1 = -5; \mu_2 = -5$. (16)	BTL 4	Analyzing
13.	What is meant by observer? How the observer concept related with Observability. (16)	BTL 4	Analyzing
14.	Describe the design and implementation of Full-Order Observers and Reduced-Order Observers. (16)	BTL 4	Analyzing
15.	Explain the concept of Controllable and Observable Companion Forms. (16)	BTL 4	Analyzing
16.	How do the concepts of controllability and observability differ between SISO and MIMO systems? (16)	BTL 4	Analyzing
17.	How does state feedback influence the controllability and observability of a system? (16)	BTL 4	Analyzing