Reg. No. :

Question Paper Code : 11230

M.E./M.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

First Semester

Power Electronics and Drives

PS 4151 – SYSTEM THEORY

Common to: M.E. Power Systems Engineering

(Regulations 2021)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Obtain the state space model for the system represented by $5\ddot{y} + 3\dot{y} - y = 2u$.

2. Define state and state variable.

3. List the properties of state transition matrix.

4. Find the Eigen values for the matrix $= A = \begin{bmatrix} 0 & 0 & -2 \\ 0 & 1 & 0 \\ 1 & 0 & 3 \end{bmatrix}$.

5. What is the need for observability test?

6. What is meant by minimal realization?

7. Write the expression for describing function of dead zone non linearity.

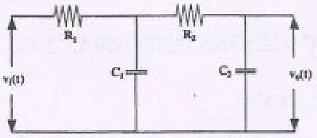
8. How the Lyapunov function is formulated to check the stability of the System?

9. What is reduced order state observer?

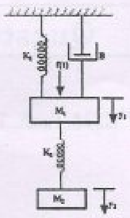
10. How the placement of poles affect the stability of the system?

PART B — (5 × 13 = 65 marks)

11. (a) Obtain the state space model for systems shown in Figure



(i)



(ii)

Or

(b) Evaluate the state space model and transfer function for the given differential equation $\dddot{x} + 6\ddot{x} + 11\dot{x} + 6x = u$ and also draw the state diagram.

12. (a) Evaluate the state transition matrix for the system $\dot{X} = AX$. Where $A = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}$.

Or

(b) Explain the (i) Cayley Hamilton's theorem (ii) Role of Eigen values and Eigen vectors.

13. (a) Determine the controllability and observability properties of the system $A = \begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & 4 \end{bmatrix}$; $B = \begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix}$; $C = [0 \quad 0 \quad 1]$.

Or

(b) Explain how to determine the control law that will stabilaize the system by applying stabilizability.

14. (a) A linear second order servo system is described by the equationë $+ 2\partial w_n \dot{e} + w_n^2 e = 0$ where, $\partial = 0.15$, $\omega_n = 1 rad/\sec$, $e(0) = 1.5$, $\dot{e}(0) = 0$. Determine the singular points. Construct the phase trajectory isoclines method.

Or

(b) For the system $\dot{x}_1 = -2x_1 + x_1 x_2$; $\dot{x}_2 + x_1 x_2$, there are two equilibrium points $[x_1 \quad x_2] = [0 \quad 0]$ and $[x_1 \quad x_2] = [1 \quad 2]$. Investigate the stability equilibrium points.

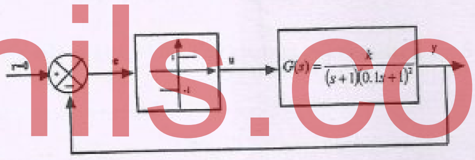
15. (a) A regulator system has the plant $\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U; Y = [1 \quad 0 \quad 0]X$. Design a full order state observer. The observer error poles are required to be located at $-2 \pm j3.464, -5$. Give all relevant observer equations and a block diagram description of the observer structure.

Or

(b) For the system described by state equation $\dot{X} = AX + Bu$ where $A = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -2 \end{bmatrix}$ *and* $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$. Determine the state feedback controller that gives closed loop Eigen values as $\lambda_1 = \lambda_2 = \lambda_3 = -1$.

PART C — (1 × 15 = 15 marks)

16. (a) Consider the relay controlled system Using the describing function analysis, investigate the stability of the system and the possibility of limit cycles.



Or

(b) Check the stability of the system described by $\dot{x}_1 = x_2$; $\dot{x}_2 = -x_1 - b_1 x_2 - b_2 x_2^2$; $b_1, b_2 > 0$. Using variable gradient method check the stability of the system.
