C 80775 (Pages : 2) Name.....

Reg. No.....

SIXTH SEMESTER B.TECH. (ENGINEERING) (09 SCHEME) DEGREE EXAMINATION, APRIL 2015

EE/PTEE 09 603—MODERN CONTROL THEORY

Time : Three Hours Maximum : 70 Marks

Part A

Answer **all** *the questions.*
Each question carries 2 *marks.*

1. Mention *two* merits of the diagonalized form of system matrix representation.
2. What is a state diagram ? Write its features.
3. Sketch the portrait of the system, with its singular point as unstable node.
4. State the definition of a tracking problem.
5. Write a scalar function which is negative semi definite.

(5 × 2 = 10 marks)

Part B

Answer any **four** *questions.*
Each question carries 5 *marks.*

6. List the properties of state transition matrix.
7. Explain how the amplitude and frequency of the limit cycle can be established by describing function method.
8. Explain the multi-valued response shown by non-linear elements.
9. Write and explain the mathematical definition of Liapunov stability.
10. What is meant by quadratic performance measure ? What is its significance ? explain.
11. State and explain the concept of controllability and observability mentioning its physical significance.

(4 × 5 = 20 marks)

Part C

Answer **four** *full questions.*
Each question carries 10 *marks.*
Missing data may suitably be assumed.

12. (a) Construct two different state models of which one in canonical form for the system :

$$\frac{d^3y}{dx^3} + 6\frac{d^2y}{dx^2} + 11\frac{dy}{dx} + 6y = u(t).$$

(10 marks)

Or

Turn over

(b) For the system described by $\dot{X}(t) = \begin{pmatrix} -8 & 6 \\ -6 & 4 \end{pmatrix} X(t) + \begin{pmatrix} 4 \\ -6 \end{pmatrix} u(t)$, $y(t) = (1, -1)\, X(t)$, find $X(t)$ for a unit step input.

(10 marks)

13. (a) Construct the phase plane trajectory of the system described by $\ddot{x} + 2\dot{x} + x = 0$ using isocline method and comment about the stability of the equilibrium point.

(10 marks)

Or

(b) An ideal relay with output ceiling at 10V is connected in-front of the system with transfer function, $G(s) = \dfrac{10}{s(s+10)(s+20)}$. Discuss the stability of the system using describing function method.

(10 marks)

14. (a) A non-linear system is described by the equations, $\dot{x}_1 = -3x_1 + x_2$, $\dot{x}_2 = -x_1 - x_2 - x_2^3$. By using the Krasoviskii method, investigate the stability of the system.

(10 marks)

Or

(b) For the system represented using equations, $\dot{x}_1 = x_2$, $\dot{x}_2 = -x_1 - x_2 + 4$, find the equilibrium point and investigate the stability of the equilibrium state using Lyapunov's direct method.

(10 marks)

15. (a) A system is represented by $\dot{X}(t) = \begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix} X(t) + \begin{pmatrix} 0 \\ 1 \end{pmatrix} u(t)$. If the cost function is $\int_0^\infty (x^2 + u^2)dt$, form the Riccati equation and solve to get the optimal control law.

(10 marks)

Or

(b) Obtain the mathematical formulation of continuous linear regulator problem using state variable approach. suggest a method to solve such problems.

(10 marks)

[4 × 10 = 40 marks]