Ref. No. : **Ex/EE/5/T/513A/2024(S)**

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING)
FIFITH YEAR FIRST SEMESTER SUPPLEMENTARY EXAM - 2024

NONLINEAR AND OPTIMAL CONTROL

Time : 3 hours Full Marks : 100

Answer any FIVE questions.

1.a) Describe various forms of nonlinearities that are commonly observed in control systems with suitable sketches of their input-output behavior.

b) "State-space modeling technique is very appropriate for analysis and control law design for nonlinear systems" – Explain with suitable examples.

[15+5=20]

2. a) "Phase plane method, although has limitations, it can give much insight about the reduced order nonlinear systems"- Explain.

b) Draw the Phase-portraits for a second order LTI system for (i) undamped, (ii) under-damped, (iii) critically-damped and (iv) overdamped cases, clearly showing their distinct features

[4+ 16 =20]

3. a) Explain the terms: (i) BIBO Stability, (ii) Local Stability, (iii) Global Stability, (iv) Asymptotic Stability, (v) Exponential Stability.

b) Explain the concept of Equilibrium in the context of Stability of a dynamic system.

[15+5=20]

4. a) Explain, with example, the Indirect Method of Lyapunov for the stability analysis of nonlinear systems. What are its limitations?

b) Explain the important features of Lyapunov Candidate Functions.

[(10+5)+5=20]

5. a) How does the accuracy of the system model affect the effectiveness of the optimal control input that has been designed based on that model?

b) Explain the basic procedure to formulate an optimal control problem for minimization of driving time requirement of a car.

[10+10=20]

6. Describe the classification of optimal control problems based on various performance measures.

[20]

7. Write short note on **any two** from the following:

(i) Direct Method of Lyapunov for the stability analysis.

(ii) Basic approach for the formulation of Constrained Optimization.

(iii) Significant features of nonlinear systems.

(iv) Advantages and disadvantages of optimal control.

[10x2=20]