

BACHELOR OF ENGINEERING (ELECTRICAL ENGINEERING)
FIFTH YEAR FIRST SEMESTER - 2024
NONLINEAR AND OPTIMAL CONTROL

Time : 3 hours

Full Marks : 100

Answer any FIVE questions.

1. a) Explain few important behaviors of nonlinear systems with suitable examples.
b) Describe various nonlinearities that are commonly found in various dynamic systems.

[6+14=20]

2. a) Write the advantages and limitations of Phase Plane method.
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. Hence comment on the phase portrait of a nonlinear second order system.

[4+(12+4)=20]

3. a) Explain the terms "Global stability" and "Local stability".
b) Explain, with example, the Direct method of Lyapunov for the stability analysis of nonlinear systems.

[6+14=20]

4. a) Explain the important features of Lyapunov Candidate Functions.
b) Explain Krasovskii's method of finding Lyapunov Candidate function. What are its limitations?

[4+(14+2)=20]

5. a) Explain the following with proper diagram:

(i) Control history, (ii) State trajectory, (iii) Admissible control, (iv) Admissible trajectory

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

[12+8=20]

[Turn over

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

[20]

7. a) State the major challenges for the design of optimal control law.

b) "Accuracy of the controlled output from an optimal controller depends on the accuracy of the plant model adopted for the formulation of the optimal control problem."- Justify whether the statement is True or False with suitable example.

[8+12=20]

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

(i) Advantages and disadvantages of nonlinear control approach.

(ii) Asymptotic stability and Exponential stability.

(iv) Constraints in the formulation of optimal control problem.

[10x2=20]