B.E. ELECTRICAL ENGINEERING FOURTH YEAR SECOND SEMESTER EXAM 2019
NONLINEAR AND OPTIMAL CONTROL (SPECIAL PAPER-I)

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 electromechanical systems.

[8+12=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+16=20]

3. a) State and explain the general notion of stability from the concept of Lyapunov stability theorem.

b) Explain the terms "Global asymptotic stability" and "Local asymptotic stability".

c) Extend the Direct method of Lyapunov for linear time invariant system and hence comment on it.

[4+6+10=20]

4. a) Write a note on the basic approach of state-feedback linearization of nonlinear systems.

b) Explain with example, the basic approach for the design of a state-feedback control law for a nonlinear system by Integrator Backstepping.

[10+10=20]

5. a) Define the following:

(i) Admissible control, (ii) Admissible trajectory, (iii) Functional

b) What are the basic requirements to formulate an optimal control problem? Explain the basic procedure to formulate an optimal control problem for speed control of an electric drive system.

[6+14=20]

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

[20]

7. a) Explain the following:

(i) Closeness of functions, (ii) Increment of functional, (iii) Variation of a functional.

b) Explain how to derive the extreme values of the functions and functionals. Hence derive the fundamental theorem of the Calculus of Variations.

[6+14=20]

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

(i) Describing function as analytical tool for nonlinear system.

(ii) Linearization of mathematical model of nonlinear systems and its relation to Lyapunov's first method.

(iii) Formulation of Lyapunov's Candidate Function.

(iv) Formulation of optimal state regulator problem.