

Course Name - Nonlinear Dynamical Systems

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Institute Name - IIT Bombay

Course Syllabus -

Introduction to nonlinear dynamical systems' features, existence and uniqueness of solutions, Lipschitz condition, Linearization and local analysis, classification of equilibrium points (planar case), periodic orbits, Lyapunov theory, Lure problem, sector nonlinearity, Nyquist criterion, Lp stability, Small gain theorem, passivity result, circle/Popov criteria, Describing function method.

COURSE DETAIL

- 1 Introduction and outline of course, notation, some features of nonlinear dynamical systems.
- 2 Scalar differential equations, examples of population dynamics, definition of equilibrium point.
- 3 Vector differential equations, solution for the linear case. Vector fields and phase portraits.
- 4 Planar case: classification of equilibrium points, relation with eigenvalues and eigenvectors, phase portraits and vector fields.
- 5 Oscillators: van der Pol oscillators, necessary conditions for periodic orbits, sufficient conditions for such orbits.
- 6 Conditions for existence and uniqueness of solutions, proof using fixed point theorem, examples of nonuniqueness and finite-escape time features.
- 7 Lyapunov stability definition and theorem/proof, converse theorems, linearization about an equilibrium point.
- 8 Nyquist criterion, Feedback interconnections, Absolute stability, Lp stability, Small-gain theorem, Passivity results.
- 9 Loop transformations, circle/Popov criteria, derivations.
- 10 Describing function method.