Ordinary Differential Equations and Applications - Video course

COURSE OUTLINE

Motivation and real life examples:
Preliminaries; Basics from linear algebra and real analysis like concepts of dependence, independence, basis, Rank-Nullity theorem, determinants and eigenvalues, remarks on Jordan decomposition theorem - convergence, uniform convergence, fixed point theorems, Lipschitz continuity etc.:
First and second order linear equations; Examples, A systematic procedure to solve first order and development of the concept integrating factor, Second order homogeneous and non-homogeneous equations, Wronskian, methods of solving:
General Existence and Uniqueness theory; Picard's iteration, Peano's exisentce theory, Existence via Arzela Ascoli theorem, non-uniqueness, continuous dependence:
Linear systems; Understanding linear system via linear algebra, stability of Linear systems, Explicit phase portrait in 2D linear with constant coefficients :
Periodic Solutions; Stability, Floquet theory, particular case o second order equations-Hill's equation:
Sturm-Liouville theory; Oscillation theorems:
Qualitative Analysis; Examples of nonlinear systems, Stability analysis, Liapunov stability, phase portrait of 2D systems, Poincare Bendixon theory, Leinard's theorem:
Introduction to two-point Boundary value problems; Linear equations, Green's function, nonlinear equations, existence and uniqueness:

COURSE DETAIL

Module No.	Topic/s	Lectures
1	**Motivation and real life examples:** • An introduction about differential equations and why this course. • Present various examples like population growth, spring-mass-dashpot system and other nonlinear system. These	4

NP-TEL

NPTEL

http://nptel.ac.in

Mathematics

Pre-requisites:

First course on linear algebra and real analysis (knowledge of multi variable calculus including implicit and inverse function theorems would be preferable)

Additional Reading:

S. Wiggins, *Introduction to Applied Nonlinear Dynamical Systems and Chaos*, Texts in Applied Mathematics, Vol. 2, Springer, 1990

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	examples will be recalled as and when necessary.	
2	**Preliminaries** • Basic concepts from linear algebra • Some important preliminaries from analysis like uniform convergence, Arzela-Ascoli theorem, fixed point theorems etc.	5
3	**First and second order linear equations** • First order linear differential equations, Exact differential equations and integrating factors. • Second order linear differential equations (homogeneous and non-homogeneous. Equation with constant coefficients, analysis of spring-mass-dashpot system.	5
4	**General Existence and Uniqueness theory** • Examples of non-uniqueness, non-existence, importance of existence uniqueness theory, Picard's iteration, Peano's existence theory, Existence via Arzela Ascoli theorem, continuous dependence: • Methods of solving (series solution).	9
5	**Linear systems** • Understanding linear system via linear algebra, stability of Linear systems, Explicit phase portrait of 2D linear systems with constant coefficients, General case, Non-homogeneous Systems :	5
6	**Qualitative Analysis**	9

	• Examples of nonlinear systems, Stability analysis, Liapunov stability, phase portrait of 2D systems, Poincare Bendixon theory, Leinard's theorem:	
7	**Introduction to two-point Boundary value problems** • Linear equations, Green's function, nonlinear equations, existence and uniqueness:	3

References:

1. E. A. Coddington and N. Levinson, *Theory of ordinary Differential Equations*, Tata-McGraw Hill, 1972.
2. M. W. Hrisch, S. Smale and R. L. Devaney, *Differential Equations, Dynamical Systems & An Introduction to Chaos*, Academic Press, 2004.
3. E. L. Ince, *Ordinary Differential Equations*, Dover, 1956.
4. S. Lefschetz, *Differential Equations: Geometric Theory*, Dover, 1977.
5. L. Perko, *Differential Equations and Dynamical Systems*, Springer International Edition, 2001.
6. G. F. Simmons, *Differential Equations with Applications and Historical Notes*, Tata-McGraw Hill, 1991.
7. G. F. Simmons and S. G. Krantz, *Differential Equations; Theory, Techniques and Practice*, Tata-McGraw Hill, 2007.