

Classical Methods in Ordinary Differential Equations

With Applications to
Boundary Value Problems

Stuart P. Hastings
J. Bryce McLeod

Graduate Studies
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Classical Methods In Ordinary Differential Equations

Graduate Studies In Mathematics

J. C. Butcher



Classical Methods In Ordinary Differential Equations Graduate Studies In Mathematics:

Classical Methods in Ordinary Differential Equations Stuart P. Hastings, J. Bryce McLeod, 2011-12-15 This text emphasizes rigorous mathematical techniques for the analysis of boundary value problems for ODEs arising in applications. The emphasis is on proving existence of solutions but there is also a substantial chapter on uniqueness and multiplicity questions and several chapters which deal with the asymptotic behavior of solutions with respect to either the independent variable or some parameter. These equations may give special solutions of important PDEs such as steady state or traveling wave solutions. Often two or even three approaches to the same problem are described. The advantages and disadvantages of different methods are discussed. The book gives complete classical proofs while also emphasizing the importance of modern methods especially when extensions to infinite dimensional settings are needed. There are some new results as well as new and improved proofs of known theorems. The final chapter presents three unsolved problems which have received much attention over the years. Both graduate students and more experienced researchers will be interested in the power of classical methods for problems which have also been studied with more abstract techniques. The presentation should be more accessible to mathematically inclined researchers from other areas of science and engineering than most graduate texts in mathematics.

Ordinary Differential Equations and Dynamical Systems Gerald Teschl, 2024-01-12 This book provides a self contained introduction to ordinary differential equations and dynamical systems suitable for beginning graduate students. The first part begins with some simple examples of explicitly solvable equations and a first glance at qualitative methods. Then the fundamental results concerning the initial value problem are proved: existence, uniqueness, extensibility, dependence on initial conditions. Furthermore linear equations are considered including the Floquet theorem and some perturbation results. As somewhat independent topics the Frobenius method for linear equations in the complex domain is established and Sturm Liouville boundary value problems including oscillation theory are investigated. The second part introduces the concept of a dynamical system. The Poincaré-Bendixson theorem is proved and several examples of planar systems from classical mechanics, ecology and electrical engineering are investigated. Moreover attractors, Hamiltonian systems, the KAM theorem and periodic solutions are discussed. Finally stability is studied including the stable manifold and the Hartman-Grobman theorem for both continuous and discrete systems. The third part introduces chaos beginning with the basics for iterated interval maps and ending with the Smale-Birkhoff theorem and the Melnikov method for homoclinic orbits. The text contains almost three hundred exercises. Additionally the use of mathematical software systems is incorporated throughout showing how they can help in the study of differential equations.

Lectures on Differential Equations Philip L. Korman, 2019-08-30 Lectures on Differential Equations provides a clear and concise presentation of differential equations for undergraduates and beginning graduate students. There is more than enough material here for a year long course. In fact the text developed from the author's notes for three courses: the undergraduate introduction to ordinary differential

equations the undergraduate course in Fourier analysis and partial differential equations and a first graduate course in differential equations The first four chapters cover the classical syllabus for the undergraduate ODE course leavened by a modern awareness of computing and qualitative methods The next two chapters contain a well developed exposition of linear and nonlinear systems with a similarly fresh approach The final two chapters cover boundary value problems Fourier analysis and the elementary theory of PDEs The author makes a concerted effort to use plain language and to always start from a simple example or application The presentation should appeal to and be readable by students especially students in engineering and science Without being excessively theoretical the book does address a number of unusual topics Massera's theorem Lyapunov's inequality the isoperimetric inequality numerical solutions of nonlinear boundary value problems and more There are also some new approaches to standard topics including a rethought presentation of series solutions and a nonstandard but more intuitive proof of the existence and uniqueness theorem The collection of problems is especially rich and contains many very challenging exercises Philip Korman is professor of mathematics at the University of Cincinnati He is the author of over one hundred research articles in differential equations and the monograph *Global Solution Curves for Semilinear Elliptic Equations* Korman has served on the editorial boards of *Communications on Applied Nonlinear Analysis* *Electronic Journal of Differential Equations* *SIAM Review* and *Differential Equations and Applications*

General Linear Methods for Ordinary Differential Equations Zdzislaw Jackiewicz, 2009-08-14 Learn to develop numerical methods for ordinary differential equations *General Linear Methods for Ordinary Differential Equations* fills a gap in the existing literature by presenting a comprehensive and up to date collection of recent advances and developments in the field This book provides modern coverage of the theory construction and implementation of both classical and modern general linear methods for solving ordinary differential equations as they apply to a variety of related areas including mathematics applied science and engineering The author provides the theoretical foundation for understanding basic concepts and presents a short introduction to ordinary differential equations that encompasses the related concepts of existence and uniqueness theory stability theory and stiff differential equations and systems In addition a thorough presentation of general linear methods explores relevant subtopics such as pre consistency consistency stage consistency zero stability convergence order and stage order conditions local discretization error and linear stability theory Subsequent chapters feature coverage of Differential equations and systems Introduction to general linear methods GLMs Diagonally implicit multistage integration methods DIMSIMs Implementation of DIMSIMs Two step Runge Kutta TSRK methods Implementation of TSRK methods GLMs with inherent Runge Kutta stability IRKS Implementation of GLMs with IRKS *General Linear Methods for Ordinary Differential Equations* is an excellent book for courses on numerical ordinary differential equations at the upper undergraduate and graduate levels It is also a useful reference for academic and research professionals in the fields of computational and applied mathematics computational physics civil and chemical engineering chemistry and the life sciences

Topological Methods in the Study of Boundary Value Problems Pablo Amster, 2013-10-23 This textbook is devoted to the study of some simple but representative nonlinear boundary value problems by topological methods The approach is elementary with only a few model ordinary differential equations and applications chosen in such a way that the student may avoid most of the technical difficulties and focus on the application of topological methods Only basic knowledge of general analysis is needed making the book understandable to non specialists The main topics in the study of boundary value problems are present in this text so readers with some experience in functional analysis or differential equations may also find some elements that complement and enrich their tools for solving nonlinear problems In comparison with other texts in the field this one has the advantage of a concise and informal style thus allowing graduate and undergraduate students to enjoy some of the beauties of this interesting branch of mathematics Exercises and examples are included throughout the book providing motivation for the reader

Riemann-Hilbert Problems, Their Numerical Solution, and the Computation of Nonlinear Special Functions Thomas Trogdon, Sheehan Olver, 2015-12-22 Riemann Hilbert problems are fundamental objects of study within complex analysis Many problems in differential equations and integrable systems probability and random matrix theory and asymptotic analysis can be solved by reformulation as a Riemann Hilbert problem This book the most comprehensive one to date on the applied and computational theory of Riemann Hilbert problems includes an introduction to computational complex analysis an introduction to the applied theory of Riemann Hilbert problems from an analytical and numerical perspective and a discussion of applications to integrable systems differential equations and special function theory It also includes six fundamental examples and five more sophisticated examples of the analytical and numerical Riemann Hilbert method each of mathematical or physical significance or both

Ordinary Differential Equations with Applications Sze-Bi Hsu, 2006 During the past three decades the development of nonlinear analysis dynamical systems and their applications to science and engineering has stimulated renewed enthusiasm for the theory of Ordinary Differential Equations ODE This useful book which is based around the lecture notes of a well received graduate course emphasizes both theory and applications taking numerous examples from physics and biology to illustrate the application of ODE theory and techniques Written in a straightforward and easily accessible style this volume presents dynamical systems in the spirit of nonlinear analysis to readers at a graduate level and serves both as a textbook or as a valuable resource for researchers

Ordinary Differential Equations With Applications (Third Edition) Sze-bi Hsu, Kuo-chang Chen, 2022-12-02 Written in a straightforward and easily accessible style this volume is suitable as a textbook for advanced undergraduate or first year graduate students in mathematics physical sciences and engineering The aim is to provide students with a strong background in the theories of Ordinary Differential Equations Dynamical Systems and Boundary Value Problems including regular and singular perturbations It is also a valuable resource for researchers This volume presents an abundance of examples in physical and biological sciences and engineering to illustrate the applications of the theorems in the text

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Numerical Methods for Ordinary Differential Equations J. C. Butcher, 2016-08-29 A new edition of this classic work comprehensively revised to present exciting new developments in this important subject The study of numerical methods for solving ordinary differential equations is constantly developing and regenerating and this third edition of a popular classic volume written by one of the world's leading experts in the field presents an account of the subject which reflects both its historical and well established place in computational science and its vital role as a cornerstone of modern applied mathematics In addition to serving as a broad and comprehensive study of numerical methods for initial value problems this book contains a special emphasis on Runge Kutta methods by the mathematician who transformed the subject into its modern form dating from his classic 1963 and 1972 papers A second feature is general linear methods which have now matured and grown from being a framework for a unified theory of a wide range of diverse numerical schemes to a source of new and practical algorithms in their own right As the founder of general linear method research John Butcher has been a leading contributor to its development his special role is reflected in the text The book is written in the lucid style characteristic of the author and combines enlightening explanations with rigorous and precise analysis In addition to these anticipated features the book breaks new ground by including the latest results on the highly efficient G symplectic methods which compete strongly with the well known symplectic Runge Kutta methods for long term integration of conservative mechanical systems This third edition of Numerical Methods for Ordinary Differential Equations will serve as a key text for senior undergraduate and graduate courses in numerical analysis and is an essential resource for research workers in applied mathematics physics and engineering

Green's Functions and Linear Differential Equations Prem K. Kythe, 2011-01-21 Green's Functions and Linear Differential Equations Theory Applications and Computation presents a variety of methods to solve linear ordinary differential equations ODEs and partial differential equations PDEs The text provides a sufficient theoretical basis to understand Green's function method which is used to solve initial and boundary

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