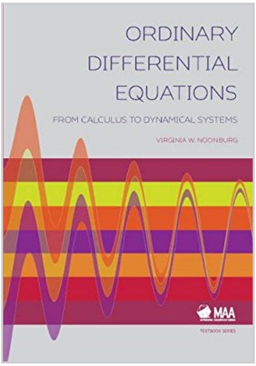

Ordinary Differential Equations: From Calculus to Dynamical Systems (Maa Textbooks)

By Virginia W. Noonburg

Ordinary Differential Equations: From Calculus to Dynamical Systems (Maa Textbooks) By Virginia W. Noonburg

This book presents a modern treatment of material traditionally covered in the sophomore-level course in ordinary differential equations. While this course is usually required for engineering students the material is attractive to students in any field of applied science, including those in the biological sciences.

The standard analytic methods for solving first and second-order differential equations are covered in the first three chapters. Numerical and graphical methods are considered, side-by-side with the analytic methods, and are then used throughout the text. An early emphasis on the graphical treatment of autonomous first-order equations leads easily into a discussion of bifurcation of solutions with respect to parameters.

The fourth chapter begins the study of linear systems of first-order equations and includes a section containing all of the material on matrix algebra needed in the remainder of the text. Building on the linear analysis, the fifth chapter brings the student to a level where two-dimensional nonlinear systems can be analyzed graphically via the phase plane. The study of bifurcations is extended to systems of equations, using several compelling examples, many of which are drawn from population biology. In this chapter the student is gently introduced to some of the more important results in the theory of dynamical systems. A student project, involving a problem recently appearing in the mathematical literature on dynamical systems, is included at the end of Chapter 5.

A full treatment of the Laplace transform is given in Chapter 6, with several of the examples taken from the biological sciences. An appendix contains completely worked-out solutions to all of the odd-numbered exercises.

The book is aimed at students with a good calculus background that want to learn more about how calculus is used to solve real problems in today's world. It can be used as a text for the introductory differential equations course, and is readable enough to be used even if the class is being "flipped." The book is also accessible as a self-study text for anyone who has completed two terms of calculus, including highly motivated high school students. Graduate students preparing to take courses in dynamical systems theory will also find this text useful.

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Editorial Review

Review
Although Noonburg's book is slim, it covers (and covers well) all of the familiar topics one expects to find in a first semester sophomore-level ODE course, and then some. It also has some interesting features that distinguish it from most of the existing textbook literature, chief among them being a strong emphasis on the dynamical systems approach, which manifests itself in, for example, an early introduction to the idea of a system of differential equations, as well as an early introduction to the concept of the phase line and phase plane for autonomous first and second order ODEs. ...

The author's writing style is very clear and should be quite accessible to most students reading the book. There are lots of worked examples and interesting applications, including some fairly unusual ones. There are also numerous exercises, ranging in difficulty from the very routine (verify that such-and-such function is a solution to such-and-such differential equation) to more elaborate student projects, some of which are based on research papers. Some (carefully marked) exercises require computer assistance. Solutions to the odd-numbered problems appear in a 40 page appendix. ...
This book may not be for everyone, simply because it invokes a different approach than is found in many other books. I do think, however, that the way I first learned differential equations as a student in the early 1970s (which, even then, seemed to me to be no more exciting than an endless set of quadratic formula problems) needs to be changed (and is changing). This book offers a clean, concise, modern, reader-friendly, approach to the subject, at a price that won t make an instructor feel guilty about assigning it. It is certainly worth a very serious look. --Mark Hunacek MAA Reviews

This is a textbook that could be used for a standard undergraduate course in ordinary differential equations. It is substantially cheaper than most of the alternatives from commercial publishers, it is well-written, and it appears to have been carefully proofread.
The target audience seems to be students whose background in mathematics is ot particularly strong. No prior exposure to linear algebra is assumed. When the method of partial fractions is used to invert Laplace transforms, this method is presented in substantial detail. The balance between computation and theory seems tilted more towards the former than in competing texts. In the back of the book, solutions--not just final answers--are provided for all odd-numbered exercises.
The approach is modern in the sense that computer algebra systems are presented as important tools for the student, and also in the sense that geometric treatment of nonlinear equations gets substantial attention. --Christopher P. Grant, Mathematical Review Clippings

This book has the traditional outline of a first course in ODEs: Introduction, first-order equations, second-order equations, linear systems, geometry of autonomous systems, and Laplace transforms. Overall, there are lots of pictures of solutions. Students are encouraged to use computer algebra and numerical methods. Examples (and projects) coming from easy-to-comprehend applications are common, and complicated solution techniques aren't avoided when needed. Readers, in keeping up, will learn a lot that will be useful elsewhere.
There's particularly good coverage of beats and resonance, phase plane pictures, the matrix exponential (and its simplicity compared to corresponding eigenvalue/eigenvector representations), bifurcation, limit cycles, and the Laplace transform (which many authors make so simple that it provides no added value).
The writing is clear, the problems are good, and the material is well motivated and largely self-contained. Some previous acquaintance with linear algebra would, however, be helpful.

In summary, this new book is highly recommended for students anxious to discover new techniques. --SIAM Review

About the Author

V.W. Noonburg, better known by her middle name Anne, has enjoyed a somewhat varied professional career. It began with a B.A. in mathematics from Cornell University, followed by a four-year stint as a computer programmer at the knolls Atomic Power Lab near Schenectady, New York. After returning to Cornell and earning a Ph.D. in mathematics, she taught first at Vanderbilt University in Nashville, Tennessee and then at the University of Hartford in West Hartford, Connecticut (from which she has recently retired as professor emerita). During the late 1980s she twice taught as a visiting professor at Cornell, and also earned a Cornell M.S. Eng. degree in computer science.

It was during the first sabbatical at Cornell that she was fortunate to meet John Hubbard and Beverly West as they were working on a mold-breaking book on differential equations (*Differential Equations: A Dynamical Systems Approach*, *Part I*, Springer Verlag, 1990). She also had the good fortune to be able to sit in on a course given by John Guckenheimer and Philip Holmes, in which they were using their newly written book on dynamical systems (*Nonlinear Oscillations, Dynamical Systems, and Bifurcations of Vector Fields*, Springer-Verlag, 1983). All of this, together with being one of the initial members of the C-ODE-E group founded by Bob Borrelli and Courtney Coleman at Harvey Mudd College, led to a lasting interest in the learning and teaching of ordinary differential equations. This book is the result.

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