

dent to complete. The lessons can be done either after the topic has been introduced in class, or in some cases, before its introduction in order to help the student learn to anticipate and gain an intuitive understanding of new material. The following sample of lesson titles will give an idea of the variety of material included: Analytic Solution of Separable DEs, Slope Fields, Linear First-Order DEs, Euler's Method, The Logistic Population Growth Model, A First Look at a Simple Mass-Spring System, Simple Pendulum Behavior, Eigenvalues and Eigenvectors, and A First Look at Laplace Transforms.

I tried the lesson entitled "Solving First-Order Linear Equations" with my introductory DEs class since they seemed to be having a lot of trouble with the technique. Not only did it give them a new perspective on the method and a nice set of sample problems, but it also included a section showing the students exactly how to use **Maple** to check their solutions. Appendices on both **Maple** and **Mathematica** are included in the text. This relieves the instructor of having to write out precise instructions for using these packages.

This book should make a very nice addition to any introductory level DEs course.

BOOK REVIEW

DIFFERENTIAL EQUATIONS: A MODELING PERSPECTIVE

Ami Radunskaya

This new differential equations textbook is a rich, modernized, introductory text designed for undergraduates from a variety of scientific disciplines. The approach taken by the authors, Robert Borrelli and Courtney Coleman, emphasizes physical models as sources and motivation for the problems arising in differential equations, and embraces numerical solvers as useful analytical tools from the very beginning. Part of this modeling approach involves the introduction of dynamical systems terminology and concepts, such as bifurcations, sensitivity to initial conditions, and chaotic behavior. Models also lead naturally to the description of the time-evolution of several different variables at once, and so systems of differen-

tial equations are introduced earlier than in most texts.

The relationship between differential equations and the real world is brought home by an abundance of examples and graphs illustrating their solutions. Some ideas are supported by one particular model, but often different examples are brought in to demonstrate a wider applicability: for example, problems relating to population growth, radiocarbon dating, and ballistics are juxtaposed in one of the earlier sections. The students can be drawn into a discussion of a model by first using their intuition as to how the system will behave, and then use their new-found solving techniques to verify—or destroy—their guesses. The design of the text is ideal for this discovery process: students are led to make guesses, gain intuition from computer experiments, and then, if possible, verify their conjectures analytically.

The book is abundantly sprinkled with graphical representations of solution curves, direction fields, and orbits of differential equations. These graphics help the students to visualize the ideas presented in the text, and also make them more comfortable drawing their own conclusions from computer-generated graphics they may create while doing problems. It is easy to duplicate, and thence modify, these graphics since the equations and all relevant data are supplied in each picture. I found this a big help in preparing visual aids for lectures or labs. In addition to the many graphs, the main body of the text is decorated with cheerful graphics depicting anthropomorphized computer terminals in varying activities and emotional states, as well as diagrams, marginal comments, and wonderful historical footnotes. A brief survey of my students indicated that these details were one of the most pleasant aspects of reading the text, especially the often humorous, but historically accurate mini-biographies of some of the pioneers in the field.

The use of technology is tightly interwoven into the text and the problems. While no particular platform or software is indicated, and indeed the text could be used without the use of any computers, access to numerical solvers and the ability to graph solutions greatly enhances the usefulness

of the book. Because the choice of program was left up to the users, it was necessary in our class to provide some additional instruction on the use of the available numerical solvers. On the other hand, the lack of specificity allows the instructor complete freedom in the selection and structuring of the computer exercises.

In addition to the applications, the theory of differential equations is presented in full detail, as are the standard methods of finding explicit solutions. Some of the more involved proofs are provided in an appendix, but many are at least outlined in the text. Techniques for finding solutions include the method of undetermined coefficients, variation of parameter, Laplace transforms, as well as series solutions. Chapter 10 deals with Fourier series, and discusses Sturm-Liouville problems, separation of variables, and the heat equation. As mentioned above, some dynamical systems theory is also presented: for example two chapters are devoted to questions of stability and discussions of cycles, behavior and what it means for a system to be chaotic, although the definition is informal. These two chapters, with their examples, give a good taste of the subject, and the problems provide the framework for some interesting numerical investigations of some famous chaotic models. In fact, there is so much in this book that some careful planning is necessary in order to design a course suitable for the particular class of students.

At the end of each section there is a problem set which contains three types of problems: pencil-and-paper problems; problems which require a numerical solver and/or plotter, which are singled out by a computer icon; and more involved, open-ended problems suggested as group projects, which are also designated by their own icon. This makes it easy to design problem sets with a variety of types of problems, or to pick out problems suitable for a computer lab. The problems exhibit a wide range of difficulty, from routine to challenging. In fact some material, for example several of the techniques for finding explicit solutions, is developed in the exercises, so that doing these problems is an integral part of the course. My survey indicated that students appreciated the variety and scope of the problems, and were grateful for the few which had solutions in the back of the text. Additional instructional materials include an instructor's handbook which contains solutions to all the homework problems, as well as suggestions on which ideas to highlight, how much time to spend on each section, and sample problem sets.

The authors assume a course in single variable calculus, with some experience in partial derivatives necessary to understand a few of the sections. While they do not assume a course in linear algebra, I think that such a course makes the going a bit easier. While some explanation of linear concepts such as linear independence, basis

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sets, and linear operators, to name a few, are given briefly in the text, I found that a deeper understanding was required. The book, however, does a nice job of expanding on ideas already learned in linear algebra.

This book is an excellent basis for a fun, challenging, innovative course in differential equations. It is especially well suited for instructors who want

a modern, relevant, dynamical systems approach to this course. My only regret in using the text is that we don't have enough time to cover all eleven chapters!

Differential Equations: A Modeling Perspective by Robert L. Borrelli and Courtney S. Coleman is published by John Wiley and Sons, Inc.

ODE ARCHITECT

Coming on the market early next year from John Wiley & Sons is a multimedia software product developed with NSF sponsorship by C·ODE·E, John Wiley & Sons, Inc. and IntelliPro, Inc. The product goes by the name **ODE Architect** and provides a highly interactive environment for constructing and exploring your own mathematical models of real-world phenomena which involve linear or nonlinear systems of ordinary differential equations. The Architect uses a first-rate family of numerical solvers (based on those developed by L.F. Shampine, Southern Methodist University) to support mathematical simulation, graphic animation and a multimedia learning environment. For more on ODE Architect, see page 2.

The ODE Architect software runs best with the following system specifications:

- Pentium 75Mhz processor or better (486DX66 minimum)
- 4X CD-ROM (2X minimum)
- 20 MB Free hard disk space
- True-color or 16-bit graphics mode (256 color minimum)
- Windows 95 (Windows 3.1x minimum)
- Sound Blaster compatible sound card
- Mouse

Consortium for Ordinary Differential Equations Experiments

The sponsors of the ODE Consortium and the institutional representatives are:

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The goal of the ODE Consortium, which is composed of faculty associated with each of the seven sponsoring institutions, is to distribute information on the design and use of interactive computer experiments in courses involving ODEs. The Consortium is funded by the NSF through the Division of Undergraduate Education and sponsors summer faculty workshops towards this goal. Many of the items in C·ODE·E are based upon work supported by the National Science Foundation under Grant No. DUE-9154300. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.