

Preface to the Second Edition

In this second edition, the outline of chapters and sections has been preserved. The subtitle “An Introduction”, as suggested by several reviewers, has been deleted. The content, however, is brought up to date, both in the text and in the notes. Many passages in the text have been either corrected or improved. Some biographical notes have been added as well as a few exercises and computer assignments. The typographical appearance has also been improved by printing vectors and matrices consistently in boldface types.

With regard to computer language in illustrations and exercises, we now adopt uniformly Matlab. For readers not familiar with Matlab, there are a number of introductory texts available, some, like Moler [2004], Otto and Denier [2005], Stanoyevitch [2005] that combine Matlab with numerical computing, others, like Knight [2000], Higham and Higham [2005], Hunt, Lipsman and Rosenberg [2006], and Driscoll [2009], more exclusively focused on Matlab.

The major novelty, however, is a complete set of detailed solutions to all exercises and machine assignments. The solution manual is available to instructors upon request at the publisher’s website <http://www.birkhauser-science.com/978-0-8176-8258-3>. Selected solutions are also included in the text to give students an idea of what is expected. The bibliography has been expanded to reflect technical advances in the field and to include references to new books and expository accounts. As a result, the text has undergone an expansion in size of about 20%.

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Preface to the First Edition

The book is designed for use in a graduate program in Numerical Analysis that is structured so as to include a basic introductory course and subsequent more specialized courses. The latter are envisaged to cover such topics as numerical linear algebra, the numerical solution of ordinary and partial differential equations, and perhaps additional topics related to complex analysis, to multidimensional analysis, in particular optimization, and to functional analysis and related functional equations. Viewed in this context, the first four chapters of our book could serve as a text for the basic introductory course, and the remaining three chapters (which indeed are at a distinctly higher level) could provide a text for an advanced course on the numerical solution of ordinary differential equations. In a sense, therefore, the book breaks with tradition in that it does no longer attempt to deal with all major topics of numerical mathematics. It is felt by the author that some of the current subdisciplines, particularly those dealing with linear algebra and partial differential equations, have developed into major fields of study that have attained a degree of autonomy and identity that justifies their treatment in separate books and separate courses on the graduate level. The term “Numerical Analysis” as used in this book, therefore, is to be taken in the narrow sense of the numerical analogue of Mathematical Analysis, comprising such topics as machine arithmetic, the approximation of functions, approximate differentiation and integration, and the approximate solution of nonlinear equations and of ordinary differential equations.

What is being covered, on the other hand, is done so with a view toward stressing basic principles and maintaining simplicity and student-friendliness as far as possible. In this sense, the book is “An Introduction”. Topics that, even though important and of current interest, require a level of technicality that transcends the bounds of simplicity striven for, are referenced in detailed bibliographic notes at the end of each chapter. It is hoped, in this way, to place the material treated in proper context and to help, indeed encourage, the reader to pursue advanced modern topics in more depth.

A significant feature of the book is the large collection of exercises that are designed to help the student develop problem-solving skills and to provide interesting extensions of topics treated in the text. Particular attention is given to

machine assignments, where the student is encouraged to implement numerical techniques on the computer and to make use of modern software packages.

The author has taught the basic introductory course and the advanced course on ordinary differential equations regularly at Purdue University for the last 30 years or so. The former, typically, was offered both in the fall and spring semesters, to a mixed audience consisting of graduate (and some good undergraduate) students in mathematics, computer science, and engineering, while the latter was taught only in the fall, to a smaller but also mixed audience. Written notes began to materialize in the 1970s, when the author taught the basic course repeatedly in summer courses on Mathematics held in Perugia, Italy. Indeed, for some time, these notes existed only in the Italian language. Over the years, they were progressively expanded, updated, and transposed into English, and along with that, notes for the advanced course were developed. This, briefly, is how the present book evolved.

A long gestation period such as this, of course, is not without dangers, the most notable one being a tendency for the material to become dated. The author tried to counteract this by constantly updating and revising the notes, adding newer developments when deemed appropriate. There are, however, benefits as well: over time, one develops a sense for what is likely to stand the test of time and what may only be of temporary interest, and one selects and deletes accordingly. Another benefit is the steady accumulation of exercises and the opportunity to have them tested on a large and diverse student population.

The purpose of academic teaching, in the author's view, is twofold: to transmit knowledge, and, perhaps more important, to kindle interest and even enthusiasm in the student. Accordingly, the author did not strive for comprehensiveness – even within the boundaries delineated – but rather tried to concentrate on what is essential, interesting and intellectually pleasing, and teachable. In line with this, an attempt has been made to keep the text uncluttered with numerical examples and other illustrative material. Being well aware, however, that mastery of a subject does not come from studying alone but from active participation, the author provided many exercises, including machine projects. Attributions of results to specific authors and citations to the literature have been deliberately omitted from the body of the text. Each chapter, as already mentioned, has a set of appended notes that help the reader to pursue related topics in more depth and to consult the specialized literature. It is here where attributions and historical remarks are made, and where citations to the literature – both textbook and research – appear.

The main text is preceded by a prologue, which is intended to place the book in proper perspective. In addition to other textbooks on the subject, and information on software, it gives a detailed list of topics not treated in this book, but definitely belonging to the vast area of computational mathematics, and it provides ample references to relevant texts. A list of numerical analysis journals is also included.

The reader is expected to have a good background in calculus and advanced calculus. Some passages of the text require a modest degree of acquaintance with linear algebra, complex analysis, or differential equations. These passages, however, can easily be skipped, without loss of continuity, by a student who is not familiar with these subjects.

It is a pleasure to thank the publisher for showing interest in this book and cooperating in producing it. The author is also grateful to Soren Jensen and Manil Suri, who taught from this text, and to an anonymous reader; they all made many helpful suggestions on improving the presentation. He is particularly indebted to Prof. Jensen for substantially helping in preparing the exercises to Chap. 7. The author further acknowledges assistance from Carl de Boor in preparing the notes to Chap. 2 and to Werner C. Rheinboldt for helping with the notes to Chap. 4. Last but not least, he owes a measure of gratitude to Connie Wilson for typing a preliminary version of the text and to Adam Hammer for assisting the author with the more intricate aspects of LaTeX.

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