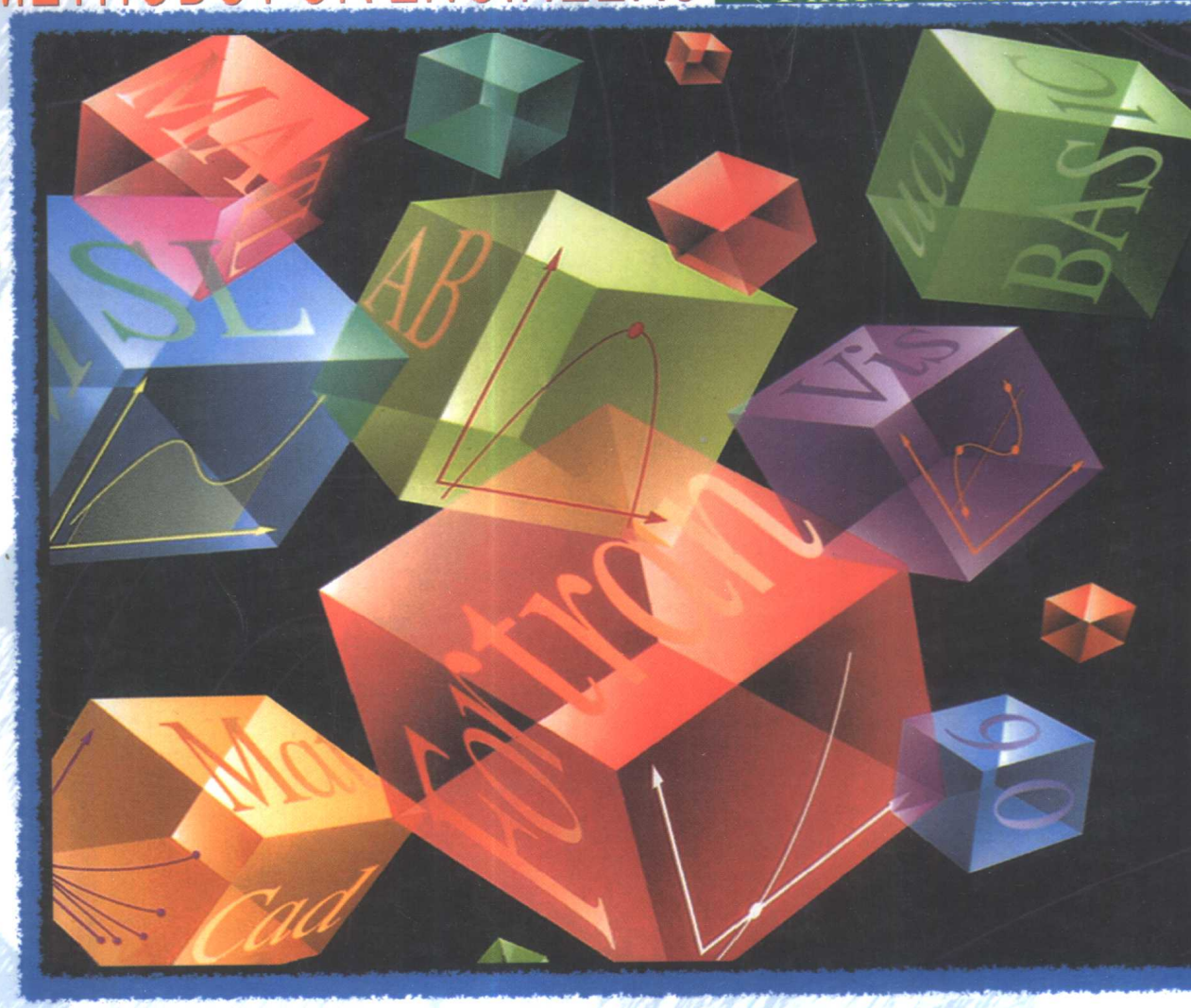
中国科学院研究生教学丛书

工程中的数值方法（第三版）

NUMERICAL METHODS FOR ENGINEERS (Third Edition)

Steven C. Chapra
Raymond P.Canale



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影印版

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内 容 简 介

本书属于中国科学院推荐的研究生用原版教材。作为曾获得美国工程教育协会最佳教材奖的一本优秀教材，本书对理工类师生及工程技术人员均大有裨益。90 万字的篇幅涵盖了工程技术中用到的绝大多数数值计算方法。从实际的工程实践中总结出来的 500 多个实例使本书的实用性大大强于许多同类的教科书。丰富的计算机程序及相应的应用软件的介绍使本书的读者能很容易地在计算机上实现大部分算法的求解，精心编排的章后习题及书末附录均会使读者在使用时感到受益匪浅。

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《中国科学院研究生教学丛书》序

在21世纪曙光初露，中国科技、教育面临重大改革和蓬勃发展之际，《中国科学院研究生教学丛书》——这套凝聚了中国科学院新老科学家、研究生导师们多年心血的研究生教材面世了。相信这套丛书的出版，会在一定程度上缓解研究生教材不足的困难，对提高研究生教育质量起着积极的推动作用。

21世纪将是科学技术日新月异，迅猛发展的新世纪，科学技术将成为经济发展的最重要的资源和不竭的动力，成为经济和社会发展的首要推动力量。世界各国之间综合国力的竞争，实质上是科技实力的竞争。而一个国家科技实力的决定因素是它所拥有的科技人才的数量和质量。我国要想在21世纪顺利地实施“科教兴国”和“可持续发展”战略，实现邓小平同志规划的第三步战略目标——把我国建设成中等发达国家，关键在于培养造就一支数量宏大、素质优良、结构合理、有能力参与国际竞争与合作的科技大军。这是摆在我国高等教育面前的一项十分繁重而光荣的战略任务。

中国科学院作为我国自然科学与高新技术的综合研究与发展中心，在建院之初就明确了出成果出人才并举的办院宗旨，长期坚持走科研与教育相结合的道路，发挥了高级科技专家多、科研条件好、科研水平高的优势，结合科研工作，积极培养研究生；在出成果的同时，为国家培养了数以万计的研究生。当前，中国科学院正在按照江泽民同志关于中国科学院要努力建设好“三个基地”的指示，在建设具有国际先进水平的科学研究基地和促进高新技术产业发展基地的同时，加强研究生教育，努力建设好高级人才培养基地，在肩负起发展我国科学技术及促进高新技术产业发展重任的同时，为国家源源不断地培养输送大批高级科技人才。

质量是研究生教育的生命，全面提高研究生培养质量是当前我国研究生教育的首要任务。研究生教材建设是提高研究生培养质量的一项重要的基础性工作。由于各种原因，目前我国研究生教材的建设滞后于研究生教育的发展。为了改变这种情况，中国科学院组织了一批在科学前沿工作，同时又具有相当教学经验的科学家撰写研究生教材，并以专项资金资助优秀的研究生教材的出版。希望通过数年努力，出版一套面向21世纪科技发展、体现中国科学院特色的高水平的研究生教学丛书。本丛书内容力求具有科学性、系统性和基础性，同时也兼顾前沿性，使阅读者不仅能获得相关学科的比较系统的科学基础知识，也能被引导进入当代科学研究的前沿。这套研究生教学丛书，不仅适合于在校研究生学习使用，也可以作为高校教师和专业研究人员工作和学习的参考书。

“桃李不言，下自成蹊。”我相信，通过中国科学院一批科学家的辛勤耕耘，《中国科学院研究生教学丛书》将成为我国研究生教育园地的一丛鲜花，也将似润物春雨，滋养莘莘学子的心田，把他们引向科学的殿堂，不仅为科学院，也为全国研究生教育的发展作出重要贡献。

To

Margaret and Gabriel Chapra
Helen and Chester Canale

PREFACE

This third edition of *Numerical Methods for Engineers* differs from the second edition in five key ways:

1. *Inclusion of sections on major software packages and libraries.* At appropriate points throughout the text, we present overviews of how numerical methods can be implemented on a variety of popular software packages and libraries: Mathcad, Excel, MATLAB, and the IMSL software library. The intent here is to acknowledge and support the increased use of these tools for numerical analysis. We provide students with the necessary guidance to implement the methods with these packages and relate them to the theory in the text. Several homework problems in each part are also designed to illustrate how the packages can be employed. Prerequisite information (e.g., "Getting Started with Mathcad") is included as appendices.
2. *Computer languages.* Our continued emphasis on algorithms and program structure may seem somewhat archaic to some instructors. Although we understand that canned software packages are important, we do not hold with those who contend that their use will make programming obsolete. In fact, even if packages were to become the primary tools for numerical calculations, advanced applications involving macros and scripts all require fundamental knowledge of programming and algorithm structure. As in the previous edition, we predominantly use pseudocode to describe our algorithms. In contrast to the previous edition, where the emphasis was on complete programs, this edition stresses a more modular approach using subroutines and functions.
3. *New material.* Although there are many minor changes and refinements throughout the text, there are only two major additions to the general coverage. First, we have included a major new part on optimization. Second, we have added a new chapter on determining the roots of polynomials. The optimization section was developed because (1) engineering students are increasingly using optimization and (2) optimization is used in a variety of numerical methods contexts such as root location and regression.
4. *New homework problems.* The homework problems have been significantly revamped. In particular, we have modified most of the problems from the previous edition as well as including a number of new problems in every chapter.

5. *Windows version of Numerical Methods TOOLKIT.* We have developed a Windows version of the Numerical Methods TOOLKIT that is included with the text on a 3 1/2-inch diskette. Aside from enhancing some of the methods (e.g., calculation of matrix inverse, integration of several simultaneous ODEs), the new version is much more user friendly because of its integration with Windows. Thus, built-in Windows utilities, such as printer output, can be exploited. Aside from student use, the software has been designed to expedite classroom demonstrations by the instructor.

Aside from these additions, the third edition is very similar to the second edition in most other respects. In particular, we have endeavored to maintain most of the features contributing to its pedagogical effectiveness. These include the overall organization, the use of introductions and epilogues to consolidate major topics, and the extensive use of worked examples and engineering applications.

It should be noted that our book has a web site. Its URL is www.mhhe.com/engcs/general/chapra/. Feel free to consult it for additional information on this book. In particular, you can use it to provide us with your feedback.

Finally, as with the previous editions, we have exerted a conscious effort to make this book as student friendly as possible. Thus, we have endeavored to keep our explanations straightforward and oriented practically. Although our primary intent is to provide students with a sound introduction to numerical methods, we have the ancillary objective of making this introduction exciting and pleasurable. We believe that motivated students who enjoy numerical methods, computers, and mathematics will, in the end, make better engineers. If our book fosters an enthusiasm for these subjects, we will consider our efforts a success.

Acknowledgments. Special thanks to Jery Stedinger of Cornell University, who generously shared many insights and suggestions. His comments on optimization were particularly useful to us. David Clough of the University of Colorado shared his wisdom and catholic understanding of numerical methods and software packages. In addition, useful suggestions and reviews were made by David V. Chase (The University of Dayton), Raymundo Cordero (ITESM), Theresa Good (Texas A&M University), Wallace Grant (Virginia Tech/Virgina Polytechnic Institute & State), James W. Hiestand (University of Tennessee at Chattanooga), Steve Klegka (U.S. Military Academy), James L. Kuester (Arizona State University), Karim Müci (ITESM), Robert L. Rankin (Arizona State University), Elisa D. Sotelino (Purdue University), and Hewlon Zimmer (U.S. Merchant Marine Academy).

Finally, it should be stressed that, although we received useful advice from the aforementioned individuals, we are responsible for any inaccuracies or mistakes you may detect in this edition.

Steven C. Chapra
Raymond P. Canale

ABOUT THE AUTHORS

Steve Chapra teaches in the Civil, Environmental, and Architectural Engineering Department at the University of Colorado. His other books include *Surface Water-Quality Modeling* and *Introduction to Computing for Engineers.*

Dr. Chapra received engineering degrees from Manhattan College and the University of Michigan. Before joining the faculty at the University of Colorado, he worked for the Environmental Protection Agency and the National Oceanic and Atmospheric Administration, and was an Associate Professor at Texas A&M University. His general research interests focus on surface water-quality modeling and advanced computer applications in environmental engineering.

He has received a number of awards for his scholarly contributions, including the 1993 Rudolph Hering Medal (ASCE) and the 1987 Meriam-Wiley Distinguished Author Award (American Society for Engineering Education). He has also been recognized as the outstanding teacher among the engineering faculties at both Texas A&M University (1986 Tenneco Award) and the University of Colorado (1992 Hutchinson Award).

Raymond P. Canale is an emeritus professor at the University of Michigan. During his over 20-year career at the university, he taught numerous courses in the area of computers, numerical methods, and environmental engineering. He also directed extensive research programs in the area of mathematical and computer modeling of aquatic ecosystems. He has authored or co-authored several books and has published over 100 scientific papers and reports. He has also designed and developed personal computer software to facilitate engineering education and the solution of engineering problems. He has been given the Meriam-Wiley Distinguished Author Award by the American Society for Engineering Education for his books and software and several awards for his technical publications.

Professor Canale is now devoting his energies to applied problems, where he works with engineering firms and industry and governmental agencies as a consultant and expert witness.

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