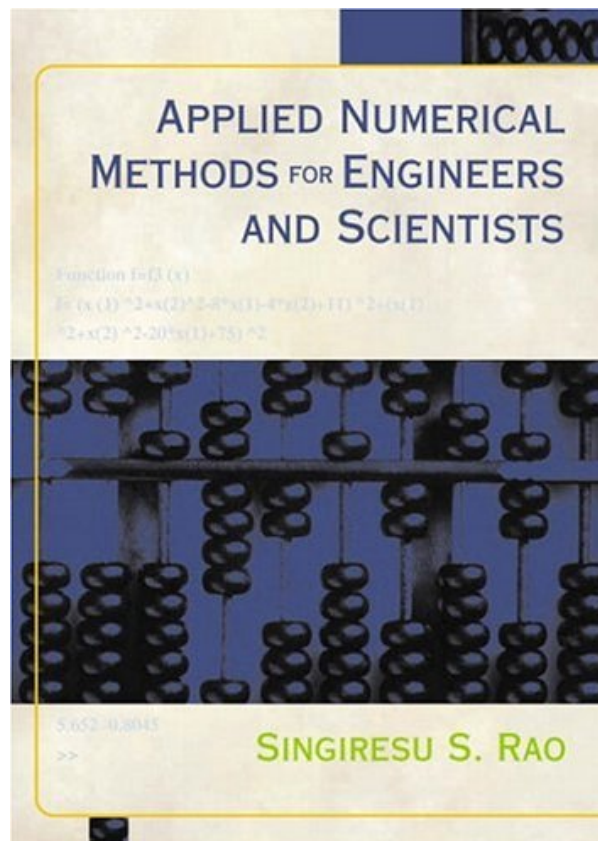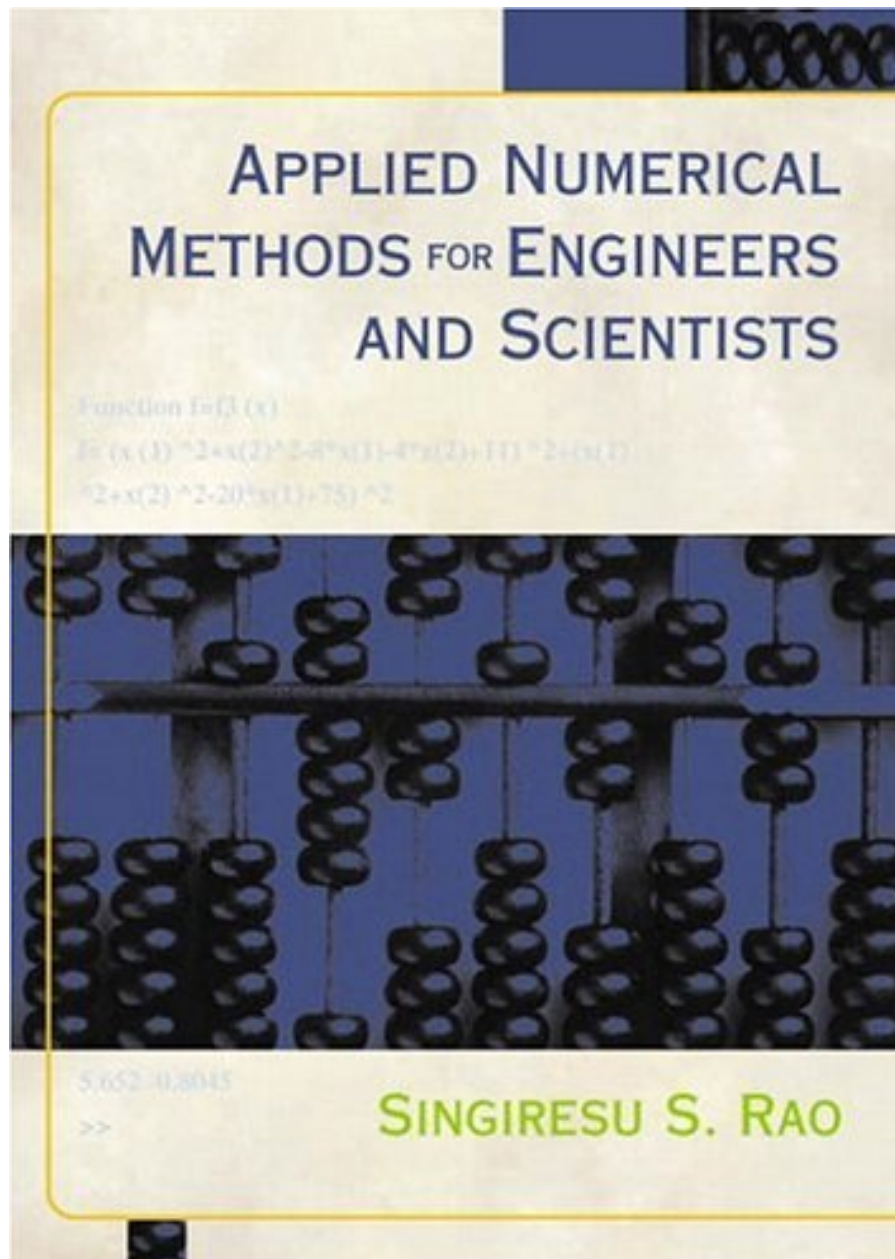# APPLIED NUMERICAL METHODS FOR ENGINEERS AND SCIENTISTS BY SINGIRESU S. RAO

APPLIED NUMERICAL
METHODS FOR ENGINEERS
AND SCIENTISTS

Function f=f3 (x)
f= (x (1) ^2+x(2)^2-6*x(1)-4*x(2)+11)^2+(x(1)
^2+x(2)^2-20*x(1)+75)^2

5.652 0.8045
>>

SINGIRESU S. RAO

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From the Back Cover

The availability of inexpensive high-speed computing power makes the numerical solution of even complex engineering problems economically feasible. In the face of ever-increasing demands on the engineering profession to perform better, students preparing to face the challenges of the twenty-first century should learn not only the theory behind the numerical methods, but also acquire the skills needed to implement the methods for computer solution. In addition, students should be aware of the many commercial software systems available and their appropriate uses in the solution of engineering problems. The student should be in a position to intelligently select and use suitable numerical methods and software systems as the need arises in practice. He or she should solve a given problem using different approaches with a variety of software systems and experiment with the various parameters of the problem. This book is intended for courses on numerical methods at the junior/senior level as well as at the beginning graduate level. The book also serves as a reference for numerical methods in engineering.

Special Features:

- In derivations and developments, steps needed for continuity of understanding have been included to aid the reader at the introductory level.
- A variety of engineering applications are presented. More than 800 problems are included.
- Review questions are given to help students in reviewing and testing their understanding of the text material. These include multiple choice questions, questions with brief answers, true(false questions, questions involving matching of related descriptions, and fill-in-the-blank type questions.
- Several open-ended project- and design-type problems are included at the end of each chapter.
- Examples and problems based on MATLAB, Maple, and Mathcad are included in each chapter.
- Representative Fortran 90 and C programs are given in the book and several additional programs can be found at the course website.
- Helpful appendices describing the basics of Fortran 90, C Language, MATLAB, Maple, Mathcad, and matrix algebra are included.
- Brief biographical information and photographs of scientists and mathematicians who contributed to the development of numerical methods are given in the book.

The use of numerical methods for the analysis, simulation, and design of engineering processes and systems has been increasing at a rapid rate in recent years. The availability of cheap high-speed computing power makes the numerical solution of even complex engineering problems economically feasible. In the face of ever increasing demands on engineering profession to perform better, the students who learn numerical methods in preparing to face the challenges of 21st century should learn not only the theory behind the methods, but also acquire skills to implement the methods for computer solution. In addition, the students should be aware of the many commercial software systems available and their use in the solution of engineering problems. Although a student may not learn all the numerical methods described in this book and use all the software systems available in any one course, he or she should be in a position to intelligently select and use suitable numerical methods and software systems as the need arises in practice.

The use of numerical methods in engineering can be considered partly science and partly art. Thus, a cookbook-type procedure will not be effective in learning the methods. A student should solve a problem using different approaches and a variety of software systems and experiment with the various parameters of the problem. The different results obtained through this process will form an experience base for selecting a suitable method and interpreting the results for a new problem. It is always desirable to compare and verify the results with other available solutions based on engineering judgment and intuition.

This book is intended for courses on numerical methods at the junior and senior level as well as at the beginning graduate level. The book also serves as a reference for numerical methods in engineering. Fortran and C programs, along with illustrative examples, are given in each chapter to implement many of the numerical methods discussed in that chapter. The use of commercial numerical softwares—MATLAB, MAPLE and MATHCAD—in the solution of practical problems is demonstrated in every chapter. Even when a program from a software package is used, we need to understand the basic principles, purpose, and limitations of the program. Often, in many engineering applications, an available standard program cannot be used directly; we need to adapt and modify it. This invariably requires a sound knowledge of the numerical method as well as some computational experience with the method. The book is aimed at presenting numerical methods along with their practical applications in a manner that helps students achieve the goals just outlined.

Organization

Applied Numerical Methods for Engineers is organized into 13 chapters and 6 appendices. Chapter 1 presents an overview of numerical methods, iterative- processes, numerical errors, software available for numerical methods, programming languages, and the various aspects of computer program development. The methods of solving nonlinear equations are given in Chapter 2. The solution of sets of linear algebraic equations is presented in Chapter 3. Both direct and iterative methods are considered. The matrix eigenvalue problem is the topic of Chapter 4. Chapter 5 deals with the methods of curve fitting and interpolation. The probabilistic and statistical methods are considered in Chapter 6. The numerical differentiation and numerical integration are the topics of Chapters 7 and 8, respectively. The numerical solution of ordinary differential equations is considered in Chapters 9 and 10. While Chapter 9 presents the methods of solving initial-value problems, Chapter 10 deals with the solution of boundary-value problems. The numerical solution of partial differential equations is considered in Chapter 11. The optimization and the finite-element methods are presented in Chapters 12 and 13, respectively. Appendices A and B provide the basics of Fortran and C languages while Appendices C, D, and E summarize the basics of MAPLE, MATLAB, and MATHCAD, respectively. A review of matrix algebra is given in Appendix F. Finally, Appendix G presents tables of statistical distributions.

The material of the book provides flexible options for different types of numerical methods courses. A junior and senior level course may cover the basic techniques of Chapters 1, 2, 3, and 5 to 9. A first-level graduate course can cover Chapters 4, 10, 11, 12, and 13 as well. The prerequisites for using the text are elementary calculus, basic concepts of linear algebra, and an introduction to differential equations.

Each topic for Applied Numerical Methods for Engineers is self-contained. In derivations and developments, steps needed for continuity of understanding have been included to aid the reader at the introductory level. Representative engineering applications are given at the beginning of each chapter so that the reader can appreciate the practical use and application of the numerical methods presented in that chapter. Many sample problems are solved by using several methods, and the results are compared, discussed, and general conclusions are drawn. Most of the algorithms described in the book are implemented in the form of Fortran and C codes and are made available at the Web site of the book. The use of different commercial software systems, as well as the programs available at the Web site of the book, is illustrated in each chapter.

Features

The specific features of the book include

Brief biographical information and photographs of scientists and mathematicians who contributed to the development of numerical methods, found at the Web site of the book. Web site of the book The Fortran and C programs used in the book, answers to problems, solutions to review questions, and brief biographical information of scientists can be found at the web site of the book: http://www.prenhall.com/rao . Note that the programs and techniques presented in the book and at the web site are intended for use by students in learning the material. Although the material has been tested, no warranty is implied as to their accuracy. I would appreciate receiving any errors found in the book.

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