

# Applications of Mathematics

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## Book Reviews

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## BOOK REVIEWS

*P. Šolín: PARTIAL DIFFERENTIAL EQUATIONS AND THE FINITE ELEMENT METHOD.* J. Wiley & Sons, Hoboken, 2006. ISBN 13978-0-471-72070-6, 100-471-72070-4, 472 pages, price EUR 89,60.

The book is a contribution to the theory as well as practice of the finite element method. The method is presented as an important general tool for many applications of mathematics to solving partial differential equations, i.e. to different fields of human activities, primarily to science and technology.

The book is aimed at graduate and doctoral students of all disciplines where partial differential equations are used as a description of real processes. The style of presentation requires minimum prerequisites and the material can be used as textbook for students of various disciplines including engineering, physics, and other majors. The finite element method, in particular the higher-order method, is shown to be the most general and most efficient tool for solving differential equations.

The book consists of seven chapters and two appendices. The first chapter provides an introduction to the modern theory of elliptic, parabolic, and hyperbolic PDE's. In the second chapter, finite elements for 1D problems are treated, including assembling the matrix of the resulting linear algebraic system and solving the system efficiently.

The third chapter is concerned with nodal finite elements that form the fundamentals of the finite element method. In the fourth chapter, elements for 2D problems are constructed, including higher-order elements, and the higher-order numerical quadrature necessary for the implementation of this procedure is treated.

Transient problems are investigated in Chapter 5 with help of the method of lines and ODE solvers are presented since the original problem is transformed to an initial value problem for a system of ordinary differential equations.

Chapters 6 and 7 focus on more advanced application of the finite element method to fourth-order problems (e.g., bending of elastic beams and plates) and equations describing electromagnetic fields.

Appendix A is called Basics of functional analysis and contains fundamental material about linear spaces, normed spaces, inner product spaces, and Sobolev spaces. Virtually all topics are accompanied by illustrative examples. The reader can find basic information on software available for solving sparse linear systems and on the author's finite element system HERMES (including examples) in Appendix B.

The presentation has the standard structure definition–theorem–proof. The emphasis is on finite element methods of higher order of approximation and, in this connection, also on higher-order numerical quadrature.

The material of the book is well structured. It provides a large number of examples, figures, and exercises from the mathematical, physical, and engineering context to which the theory is applied. The book is undoubtedly accessible to a large audience with diverse background and interests. It will certainly find its position among many other textbooks on the finite element method.

*Karel Segeth*

*J.-M. Muller*: ELEMENTARY FUNCTIONS. ALGORITHMS AND IMPLEMENTATIONS. Second edition. Birkhäuser-Verlag, Basel-Boston-Berlin, 2006. ISBN 0-8176-4372-9, 266 pages, price EUR 48,-.

The second edition of the book contains new techniques and improvements of existing ones that have appeared since the first edition. A new chapter on multiple-precision arithmetic is added, too.

The research of the computer approximation of elementary functions (trigonometric, hyperbolic, their inverses, logarithmic and exponential) is by far not completed. The requirements on the approximation grow steadily. Today, it is not satisfying to have an approximation exact to 1 or 2 last bits. The approximation must be a correctly rounded value of the true value. Moreover we have demands of monotonicity, symmetry, of conserving the range of functions. In recent years the architecture of the processors influenced the study of the problems of approximation and the hardware must also be taken into consideration. The IEE 754 standard has influenced the research substantially.

The material of the book is divided into three parts preceded by an Introduction and a chapter summarizing the notions about computer arithmetic. The first part is devoted to polynomial and rational approximations and the use of tables. The problems of the multiple precision approximations are dealt with here, too. The second part handles the hardware-oriented “shift and add” algorithms, the close CORDIC algorithm and other methods. The third part is devoted mainly to the problems of range reduction, monotonicity and the final rounding of the result. It includes notes about exception handling, special functions, functions of complex variables and in one chapter presents implementation examples.

The book does not suppose special knowledge on the part of the reader, it is oriented towards the description of the methods rather than presentation of ready-made recipes. It contains a bibliography of 330 items (the last being from 2005). The presentation is reader-friendly. Therefore the book will be useful not only to professionals and researchers, but also to students and to anyone who only wants to obtain information on an interesting subject where mathematics and computer science meet.

*Milan Práger*