BOOK REVIEWS

D. Bucur, G. Buttazzo: VARIATIONAL METHODS IN SHAPE OPTIMIZATION. Birkhäuser-Verlag, Boston, 2005. ISBN 0-8176-4359-1, xiii+216 pages, hardcover, price EUR 60,–.

In shape optimization, a set $\mathcal{A}$ of admissible domains is given together with a cost function F that evaluates $A \in \mathcal{A}$. The goal is to find a minimum of $\{F(A)\colon A \in \mathcal{A}\}$. This task is complicated by the structure of the cost function F that, to evaluate $A \in \mathcal{A}$, includes the solution of a (partial) differential equation defined on a domain A.

Since, in general, the existence of an optimal domain is not guaranteed, it is necessary to impose some assumptions on $\mathcal{A}$ and F. The stronger the assumptions are (that is, putting rather severe restrictions on $\mathcal{A}$ and F), the simpler and more conventional mathematical tools can be used to prove the existence of an optimal solution (optimal domain). If, however, the assumptions are rather weak, advanced mathematical tools are necessary to show the existence of an optimum and, moreover, it can even happen that the optimal solution can only be defined in a *relaxed* sense.

Although the book under review does not omit the former approach, it concentrates on the latter situation, that is, the authors predominantly analyze optimal shape and optimal control problems under rather weak assumptions.

To introduce the various subjects treated in the book, let us list the titles of its chapters: 1. Introduction to Shape Optimization Theory and Some Classical Problems, 2. Optimization Problems over Classes of Convex Domains, 3. Optimal Control Problems: A General Scheme, 4. Shape Optimization Problems with Dirichlet Condition on the Free Boundary, 5. Existence of Classical Solutions, 6. Optimization Problems for Functions of Eigenvalues, 7. Shape Optimization Problems with Neumann Condition on the Free Boundary.

The book, though slim, is rich in content and provides the reader with a wealth of information, numerous analysis and proof techniques, as well as useful references (197 items). It is assumed, however, that the reader is at least partly familiar with some topics in functional analysis, topology, and measure theory that can be considered rather advanced because they do not usually appear in undergraduate courses. The definitions of other key notions (such as the Γ- and γ-convergence, convergence in the sense of Mosco, or the capacity of a subset) are included and the relevant properties are listed. Numerous nontrivial examples illustrate the theory and can please even those readers who are rather application-oriented.

To summarize, let us quote one paragraph from the back cover of the book: "In this work, these (shape optimization) problems are treated from both the classical and modern perspectives and target a broad audience of graduate students in pure and applied mathematics, as well as engineers requiring a solid mathematical basis for the solution of practical problems."

Jan Chleboun

B. Fauser, J. Tolksdorf, E. Zeidler, eds.: QUANTUM GRAVITY—MATHEMATICAL MODELS AND EXPERIMENTAL BOUNDS. Birkhäuser-Verlag, Basel, 2007. ISBN 978-3-7643-7977-3, 352 pages, hardcover, price EUR 89,90.

The problem of the formulation of a consistent theory of quantum gravity is a long-standing problem of principal importance, often considered the biggest challenge in mathematical physics and frequently requiring highly advanced mathematical methods. Although a lot of effort has been devoted to this problem during several decades, with first attempts going back to the 1930s, a satisfactory resolution has not been reached yet. However, these attempts represent a driving force in the development of mathematical physics and they have also substantially influenced several related areas in mathematics.

This volume presents a selection of contributions presented at the workshop "Mathematical and Physical aspects of Quantum Gravity" held at the Heinrich-Fabri institute in Blaubeuren in Germany in summer 2005. The reader is provided with an overview of the principal approaches to quantum gravity—String Theory and Loop Quantum Gravity. Other approaches, such as those based on non-commutative geometry by A. Connes are discussed as well. An overview of the experimental status of quantum gravity effects is also given in an article by Claus Lammerzahl. The presentation of various approaches to quantum gravity in one volume is rather unique and provides reader with an opportunity to compare their advantages and disadvantages.

A significant advantage of this volume is that the articles are written in a less technical style, focusing only on major theoretical questions, with many contributions being accessible to non-specialists and thus providing a broad overview of this fascinating field of research.

Vojtěch Pravda

Rowan Garnier, John Taylor, eds.: DISCRETE MATHEMATICS. PROOFS, STRUCTURES, AND APPLICATIONS. Third edition. CRC Press, Boca Raton-London-New York, 2010. ISBN 978-1-4398-1280-8, 821 pages, hardcover, price USD 89,95.

This book covers the standard topics of discrete mathematics in a competent manner. New to the third edition is a chapter on number theory. The other topics covered in this book include logic, mathematical proof, sets, relations, functions, matrix algebra, systems of linear equations, algebraic structures, boolean algebra, and graph theory. This book is definitely suitable for the standard undergraduate course in discrete structures. An interesting nonstandard topic covered in this book are Hasse diagrams which condenses the representation of a finite poset. Other interesting topics in this book are the sections on codes and public key cryptography.

Lawrence Somer