Book Reviews

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BOOK REVIEWS

M. Grigoriu: STOCHASTIC CALCULUS. APPLICATIONS IN SCIENCE AND ENGINEERING. Birkhäuser-Verlag, Boston 2002. ISBN 0-8176-4242-0, xii+774 pages, price EUR 115.56.

It is fairly easy to say what the book under review *is not*. It is definitely not a treatise on stochastic calculus in the abstract style of the "Strasbourg school". It is not a monograph devoted to an in-depth study of any particular field of science by probabilistic methods. It has some features of a textbook, and various courses on probability theory for applied scientists might be probably based on some portions of the book, however, as a whole it is too densely filled with notions and results to serve as a usual textbook. To describe what this highly original book *is* about is much more difficult. The author's aim seems to be to present to applied scientists and engineers the wealth of powerful probabilistic techniques that are now available and may be successfully employed in their research, and at the same time to demonstrate to probabilists that there are plethora of models in physics, mechanics or engineering using probabilistic tools, often in a purely heuristic manner, which would deserve further and more rigorous study.

The book is organised conformably to this twofold aim. In Chapters 2 to 5, the theoretical background is developed: basics of probability theory are explained in the second chapter, stochastic processes and random fields are dealt with in the next chapter, Itô's formula and stochastic differential equations are the topic of Chapter 4. In Chapter 5, various problems concerning Monte Carlo simulations are discussed. The presentation has a unified style: in each section or subsection, the most fundamental definitions, theorems and examples are given first, important statements and formulae being often boxed, followed by notes and/or proofs in a small print, which provide additional information, more precise statements or minor hypotheses missing in the main text, the proofs (or their parts) being included mainly if they offer a deeper insight. The amount of results treated is surprisingly large, but the rather concisely written text should be read with some caution. (For example, on page 70 it is defined that real random variables X_n with distribution functions F_n converge in distribution to a random variable with a distribution function F, if $F_n(x) \longrightarrow F(x)$ for all $x \in \mathbb{R}$.)

Chapters 6 to 9 are devoted to applications, which are classified according to the deterministic or random nature of the system and its inputs. (Chapter 6 on deterministic systems with deterministic inputs is focused on probabilistic methods for finding solutions to such systems: Feynman-Kac formulae, sphere walk methods, boundary walk methods…) Besides particular models, general methods for studying certain classes of models are introduced, e.g., a section on Lyapunov exponents and stochastic stability may be found in the eighth chapter. In spite of the fact that the book is quite voluminous (almost eight hundred pages), the coverage is so broad that most of the topics are presented in a bit sketchy way, the goal being to provide ideas, not a detailed information.

It is beyond the scope of my expertise to decide whether Grigoriu's book is useful for engineers and scientists, albeit I expect the answer to be affirmative, but I am convinced that it is very useful for every mathematician who is professionally interested in stochastic analysis: it helps to recognise the gap between abstract theories and the tools that "are really needed", a gap representing a true challenge.

Jan Seidler

P. Colli, C. Verdi, A. Visintin, eds.: FREE BOUNDARY PROBLEMS, THEORY AND APPLICATIONS. Birkhäuser-Verlag, Basel, 2003. ISBN 3-7643-2193-8, 356 pages, hardcover, price EUR 98.–.

This volume collects the proceedings of a conference on free boundary problems that took place in Trento (Italy) in June 2002. More than 150 scientists coming from a long list of countries participated at this meeting.

The key topics included free boundary problems in polymer science and biomathematics, image processing, grain boundary motion, numerical aspects of free boundary problems, modelling in crystal growth and transition in anisotropic materials.

The volume consists of 26 papers, Preface and List of Participants. Specialists in the field of free boundary problems will find here a variety of interesting topics arising from industrial engineering and physical problems treated with great mathematical erudition. The bibliographical data given in the papers can be a rich source of further references for those who are not yet deeply involved in the field.

Ivan Straškraba

A. Ženíšek: SOBOLEV SPACES AND THEIR APPLICATIONS IN THE FINITE ELEMENT METHOD. Brno Univ. of Technology, VUTIUM Press, 2005. ISBN 80-214-2630-6, 522 pages, price Kč 500.–.

The book is divided into five main parts and forty chapters. It contains a complete finite element analysis of variational problems in 2 and 3 spatial dimensions. Some chapters are based on the author's original articles.

Part I is devoted to the theory of Sobolev spaces that is needed for the introduction of the finite element method. In particular, the reader gets acquainted with the Beppo Levi spaces, imbedding theorems, the Poincaré inequality, the Bramble-Hilbert lemma, the Calderon and Nikolskij extensions, the Rellich theorem, etc.

Part II surveys basic applications of the theory of Sobolev spaces in the finite element method. The author introduces the Lax-Milgram lemma, Friedrich's inequality, the interpolation theorem, theorems on density of infinitely differentiable functions in the case of mixed boundary conditions, etc. The convergence of finite element solutions is proved in the case of numerical integration and approximation of a curved boundary.

Part III deals with variational problems in domains with cusp-points. For the discretization by the finite element method the maximum angle condition is used.

Part IV contains a continuous and discrete formulation of parabolic-elliptic variational problems. Theorems on existence, uniqueness and convergence are proved.

Finally, Part V is devoted to families of semiregular finite elements. A special emphasis is laid on triangular and tetrahedral finite elements of the Hermite type. Convergence results in the case of semiregular finite elements are presented.

The book is a helpful tool for researches and Ph.D. students in numerical analysis.

Michal Křížek