Applications of Mathematics

Book Reviews

Applications of Mathematics, Vol. 46 (2001), No. 2, 157–160

Persistent URL: http://dml.cz/dmlcz/134462

46 (2001) APPLICATIONS OF MATHEMATICS No. 2, 157–160

BOOK REVIEWS

R. T. Ogden: ESSENTIAL WAVELETS FOR STATISTICAL APPLICATIONS AND DATA ANALYSIS. Birkhäuser-Verlag, Boston-Basel-Berlin, 1997, xviii+206 pages, ISBN 3-7643-3864-4, price DM 78,–.

Wavelets as a refinement of Fourier analysis or more exactly as a systematic way of building local orthogonal bases have found numerous applications in signal processing including image analysis (denoising in real time), in approximation theory and in data compression. The book is not a course on wavelets but an introduction to their successful applications in statistics and data analysis. Only a limited knowledge of calculus, linear algebra and elementary statistics is assumed. The book is thus accessible to advanced undergraduate students and graduate students as well as to applied statisticians and engineers concerned with data treatment and analysis.

The prologue and Chapter 1 present a basic introduction to wavelets as an analytic tool; the simplest of all bases—discontinuous Haar basis—is used to explain and demonstrate the wavelet features and approach. The extension to other wavelet bases including biorthogonal, semiorthogonal and two-dimensional bases is carried out in Chapters 4 and 9.

Chapters 2 and 3 are devoted to wavelet smoothing and tresholding techniques applied to probability density estimation and non-parametric regression. These topics are further developed in Chapters 7 and 8; also the jump and cusp detection suitable for change-point analysis is described. The remaining Chapters 5 and 6 are concerned with wavelet-based diagnostics in the real data analysis and in the treatment of functions defined on a finite interval (boundary handling). Appendix on vector spaces, glossary of terms and notation, index and a long list of references close the book, which will certainly be appreciated by a large circle of readers for its easy style, many included examples and elucidating discussion of problems presented.

It should be stressed that supplements to wavelet applications are freely available on the author's personal page `http://www.stat.sc.edu/~ogden/` (in particular Errata for the book and S+ functions for generating figures in the book).

Ivan Saxl

Vincent Giovangigli: MULTICOMPONENT FLOW MODELLING. Birkhäuser, Boston-Basel-Berlin, 1999, xvi+321 pages, ISBN 0-8176-4048-7, hardcover, price DM 138,–.

The book represents an interdisciplinary exposition of multicomponent flow models ranging over the physical, mathematical and numerical points of view. Great attention is paid to the detailed presentation of multicomponent flow models built up from the molecular kinetic level to the final macroscopic formulation. Special attention is paid to gaseous flows as multicomponent reactive flows arising in engineering applications. This concerns for example combustion, crystal growth, atmospheric reentry and chemical reactors. Chemical mechanisms are taken into account and transport phenomena are analyzed in detail.

After the models are presented, the resulting partial differential equations are investigated for mathematical structure and qualitative properties of solutions. Then the numerical aspects of selected models are discussed and numerical simulation of typical laminar flows is illustrated.

The structure of the book is as follows: After Preface and Introduction, fundamental equations are derived in Chapter 2. It includes basic conservation laws, thermodynamical considerations, chemical reactions description, transport fluxes of mass and heat, the notion of entropy and the boundary conditions formulation. In Chapter 3 approximate and simplified models are studied (one-reaction chemistry, small Mach number flows, dilution and constant density approximation). Chapter 4 is devoted to the derivation of basic macroscopic principles from the kinetic theory. Here we find Boltzmann equations, kinetic entropy equations, Enskog expansion, zero-order macroscopic equations, first-order approximation as linearized Boltzmann equations and transport linear systems. In Chapter 5 methods for evaluation of transport coefficients appearing in the multicomponent flows equations are presented through the theory of transport linear systems. Chapter 6 concerns mathematics of thermoelasticity. Here the thermodynamics of state variables is touched, the mathematical structure of chemistry source terms is studied and questions of equilibria are discussed. Investigation of transport coefficients is continued from the mathematical point of view in Chapter 7. Further, Chapter 8 is devoted to the mathematical structure of the system of partial differential equations governing multicomponent reactive flows. Chapter 9 deals with the abstract system resulting from the second order system of evolution partial differential equations arising from multicomponent reactive flows. Such issues like equilibrium points, linearized equations, global existence theorems, decay estimates, dissipativity phenomena and asymptotic analysis are addressed. In Chapter 10 chemical equilibrium flows are studied. Chapter 11, entitled *Anchored waves*, investigates the plane flame equations derived from the kinetic theory of dilute polyatomic reactive gas mixtures. Finally, Chapter 12 illustrates the previous developments by numerical simulations and indicates some of the difficulties that are specific to complex chemistry and detailed transport.

The interdisciplinary overview presented in the book will certainly attract interest of those applied mathematicians, mechanical engineers and physicists who work in the broad field of fluid flows modelling.

Ivan Straškraba

Rinaldo B. Schinazi: CLASSICAL AND SPATIAL STOCHASTIC PROCESSES. Birkhäuser-Verlag, Boston, 1999, xii+178 pages, ISBN 0-8176-4081-9, price DM 118,–.

There are many texts available for the first course on stochastic processes at undergraduate or junior graduate levels, which are often focused on basics of the Markov chains theory. The book under review is an attempt to change the traditional point of view and introduce to an elementary course new topics related to stochastic models with a spatial structure, a subject the author himself has contributed to. These topics have been paid a considerable attention recently, but they are generally considered rather technical and advanced tools are applied to study them. The author aims at showing that, nevertheless, some nontrivial results may be explained in a systematic yet lucid manner even to students without deep knowledge of probability theory.

Let us describe the contents of the book briefly. The first three chapters (taking approximately a half of the book) are devoted to Markov chains, with emphasis on methods and results that will be useful in the study of spatial stochastic processes. In Chapter 1, discrete time Markov chains on a countable state space are introduced, classical recurrence and transience criteria are treated and the coupling method is explained. In accordance with the style of the whole book, a detailed discussion of some basic examples is preferred to developing a general theory, so e.g. random walks on $\mathbb{Z}^d$, birth and death chains or Bienaymé-Galton-Watson branching processes are studied. The next chapter is about invariant measures, convergence of transition probabilities of a positive recurrent aperiodic

irreducible chain to the (unique) invariant probability being proved. Chapter 3 is devoted to continuous time birth and death chains, in particular, to the Poisson process.

The next four chapters form the core of the book. Existence of a phase transition for percolation on $\mathbb{Z}^d$ is studied in Chapter 4, moreover, it is shown that critical exponents may be computed explicitly for percolation on a tree. A cellular automaton on $\mathbb{Z}^2$ is treated and renormalization techniques are explained in the next chapter. In the sixth chapter, global and local survival probabilities for a continuous time branching random walk are investigated; the last chapter is devoted to the contact process on a homogeneous tree.

The book is well organized, each chapter opens with a detailed summary, more technical proofs are deferred to the end of the chapter and almost all sections are accompanied with many exercises. In the Preface the author states that a serious calculus course and some knowledge of elementary probability theory (without measure theory) are the only prerequisites for reading the book. As a consequence, however, some results in the second part of the book cannot be given a complete proof. Moreover, readers who do not have deeper knowledge than the required one may have difficulties in following some proofs (e.g., the Stirling formula is used without explanation in Section I.8, or a rigorous construction of continuous time processes is never provided). The reviewer would not choose Schinazi's textbook for courses he teaches, but he finds it very useful as a source of inspiration.

Jan Seidler

D. C. Ionescu, N. Limnios, eds.: STATISTICAL AND PROBABILISTIC MODELS IN RELIABILITY. Birkhäuser-Verlag, Boston-Basel-Berlin, 1999, xxxvi+352 pages, ISBN 3-7643-4068-1, price DM 178.–

Reliability is an everyday topic in the contemporary society almost used to traffic collisions (which are true catastrophes when viewed globaly and per day) but extremely uneasy when facing possibilities of however rare and small nuclear accidents. Nevertheless, the importance of a deep theoretical background of reliability is usually not completely appreciated and understood. An improvement of this state of affairs was the primary intention of the 1st International Conference on Mathematical Methods in Reliability held at Politehnica University of Bucharest, September 16-19, 1997. The book from the series „Statistics for Industry and Technology“ collects twenty four (from sixty one) papers presented.

The first part (8 chapters) deals with *statistical methods*. The opening chapter surveys models and analysis of repairable systems. A great attention is then devoted to modeling and estimation of accelerated experiments (3 chapters), goodness-of-fit tests, estimation of semi-Markov systems and competing risk problems.

Probabilistic methods of the second part (9 chapters) bring together asymptotic methods, Markovian repairman problems (queueing process), limit reliability functions of large systems, modeling by stiff Markov chains in dependability and performance evaluation, failure rates of systems subjected to stress environments and failure time for consecutive k-out-of-n systems (the system fails only after k of n consecutive components have failed).

The closing part on *special techniques and applications* (7 chapters) includes papers concerned with two-stage start-up demonstration testing, optimal control of systems with partly observable parameters, methods to compute reliability of networks and of totally amenable systems, applications of Stochastic Petri Nets to modeling the behaviour of various systems, lifetime of high temperature working pipes.

The carefully edited book with a detailed glossary of terms, subject index and many references will be of interest for professionals in industrial statistics, reliability engineering and risk analysis.

Ivan Saxl

W. G. Litvinov: OPTIMIZATION IN ELLIPTIC PROBLEMS WITH APPLICATIONS TO MECHANICS OF DEFORMABLE BODIES AND FLUID MECHANICS. Birkhäuser-Verlag, Basel-Boston-Berlin, 2000, xxii+522 pages, ISBN 3-7643-6199-9, price DM 238,–.

The book is devoted to the optimization problems for elliptic equations and systems. The results are then applied to various optimization problems in which the coefficients of equations, the shapes of domains, and the right hand sides are considered to be controls. The setting of the problem is followed by the proof of existence theorems that form a base for the construction of approximate solutions. The infinite-dimensional optimization problem is reduced to a sequence of finite-dimensional problems such that the corresponding solutions converge, in a sense, to a solution of the original problem.

The book starts with an introductory chapter where the necessary functional analytic background is set. The next two chapters are devoted to optimization by the coefficients and the right hand sides; various problems of eigenvalue and domain shape optimization as well as optimization of systems described by variational inequalities are studied. In Chapter 4, direct problems for various models of plates and shells, problems of stress-strain state, stability, and free vibrations are studied. Chapter 5 is devoted to the optimization of structures. Optimization problems for steady flows of viscous and nonlinear viscous fluids are studied in the last chapter.

The monograph is self-contained and can serve both as a thorough introduction to contemporary research in optimization theory and a textbook for graduate courses in optimization of elliptic systems. It will be of interest to scientists in mathematics and mechanics and also to researching engineers working in solid and fluid mechanics.

Hana Petzeltová