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BOOK REVIEWS

YOUSEF SAAD, *Iterative Methods for Sparse Linear Systems, second ed.*, SIAM, Philadelphia, PA, 2003, ISBN 0-89871-534-2 (pbk), XVII+528 pp.

The second edition of this book gives an in-depth, up-to-date view of practical algorithms for solving large-scale linear systems of equations. Many of the chapters have been updated or shortened, in order to reflect the progress in the area since the first edition was published in 1996.

The first chapter is introductive, and contains some background in linear algebra. The discretization of the PDEs (the major source of sparse matrix problems) is briefly described in the second chapter; the finite difference approximations (accompanied by the description of some fast Poisson solvers) the finite element and the finite volume methods are described. The third chapter gives an overview of sparse matrices, their properties, representation, and the data structures to store them. Chapter four, *Basic iteration methods*, studies the convergence of Jacobi, Gauss-Seidel and Successive Relaxation, and also presents the Alternating Direction Methods. Chapter 5 deals with projection methods (the one-dimensional projection process) and additive and multiplicative processes. The following two chapters deal with Krylov subspace methods. In chapter 6 are presented the Arnoldi and GMRES methods (with their different variants and implementation aspects) together with the corresponding resulted ones for the symmetric case (the Symmetric Lanczos algorithm) and the symmetric positive definite case (the conjugate gradient algorithm). The Faber-Manteuffel theorem and a convergence analysis are also presented. In chapter 7 are described the class of methods based on the biorthogonalization algoritm due to Lanczos: the Lanczos algorithm for linear systems, BICG, QMR and the transpose-free variants (BICGSTAB and TFQMR) algorithms. Chapter 8 deals with the normal equations and certain methods for solving them: row projection methods (Gauss-Seidel and Cimmino's method), the conjugate gradient and saddle point problem. The following two chapters deal with preconditioning. Chapter 9 discusses the preconditioned versions of CG and GMRES (without reference to a specific preconditioner), while chapter 10 fully discusses some standard precoditioners: incomplete LU factorization, threshold strategies, approximate inverse preconditioners, with different aspects of implementation. Chapter 11 and 12 treat parallel computations. Chapter 11 refers to parallel implementations, and presents some general considerations and certain algorithms for matrix-vector multiplication, while chapter 12 presents parallel preconditioners, graph coloring techniques, and other techniques. The last two chapters contain introductions to multigrid and the domain decomposition method.

The book is written by a specialist with outstanding results regarding the iteration methods for sparse linear systems, and we believe is destined to become the major reference in the topic. It reflects in a rigorous way the basic results and the main recent achievements in the field.

The methods are both in-depth mathematically and algorithmically described. Each chapter contains notes and references.

The book may be used not only by mathematicians and engineers, but also as a textbook, since each chapter contains well chosen exercises.

Emil Cătinaş

Robert Mattheij and Jaap Molenaar, *Ordinary Differential Equations in Theory and Practice*, SIAM, Philadelphia, PA, 2002, ISBN 0-89871-531-8 (pbk), XVII+405 pp.

The book is (re)published in the "Classics in Applied Mathematics" series (the first edition was published in 1996 by Wiley & Sons).

The first chapter is introductive, some basic notions being presented. The second chapter deals with the uniqueness, local existence and continuation of solutions, and also with the dependence of the solutions of IVPs on initial value and vector field. Chapter 3 contains the numerical analysis of one-step methods, with emphasis on the Runge-Kutta methods: local discretization error, consistency (order) of a method, the convergence of a numerical approximation to the exact solution, local extrapolation and embedding methods for estimating the local error, with applications to the adaptive choice of the step size. Chapter 4 treats in detail the linear systems of ODEs: global existence and uniqueness, explicit expression of the solution—studied in the special cases of constant and periodic systems—, similarities between linear difference equations and differential equations. Chapter 5 deals with the stability of the IVP with $t \to \infty$, more precisely to convergence to stationary points and periodic solutions. The most common definitions are first presented, explicit results for linear systems with constant coefficients, linearization and Lyapunov function for the nonlinear case; global analysis of stability properties is given for planar systems and the case of periodic systems is also considered. The chaotic systems (systems having bounded solutions as $t \to \infty$, but do not converge to a stationary or quasi-periodic solution) are presented in the following chapter. The important aspects are systematically presented: Lyapunov exponents, strange and chaotic attractors, generalized and fractal dimension. The numerical analysis of multistep methods is performed in chapter 7. The stability concept and consistency are presented (and it is shown that they constitute the necessary and sufficient condition for the convergence of a numerical solution to the exact one), how to obtain good initial conditions, predictor-corrector, variable step and variable order algorithms. Chapter 8 deals with singular perturbations and stiff differential equations. The matched asymptotic expansion method is presented, A-stability for stiff problems, as well as other aspects. Chapter 9 presents theoretical and practical considerations regarding the differential-algebraic equations. The index and differential index concepts are introduced, and the regularization methods for lowering the index are presented for the numerical treatment. Unlike the previous chapters, chapter 10 deals with boundary value problems for ODEs. The theory of existence of solutions is presented, the conditioning (dichotomy), and the shooting and the multiple shooting techniques regarding their numerical treatment. The last chapter deals with mathematical modelling, and presents several interesting applications.

The book offers a thorough introduction both to theoretical and numerical aspects of ordinary differential equations, and also presents modelling of relevant problem classes. This integrated treatment, aimed to explain the ODEs and their numerical use in real life problems, makes the book a standard reference in the field.

The audience is intended not only for researchers, but also for students and their teachers (undergraduate and graduate courses), since the book contains many well chosen exercises.

Emil Cătinaş

Jane K. Cullum and Ralph A. Willoughby, *Lanczos Algorithms for Large Symmetric Eigenvalue Computations*, SIAM, Philadelphia, 2002, ISBN 0-89871-523-7 (v. 1: pbk), XX+273 pp.

The first volume of this book is reprinted in the "Classics in Applied Mathematics" series, and describes Lanczos procedures for large symmetric (real and complex) matrices, Hermitian matrices and also deals with the singular value decomposition problem. The second volume, "Programs", (which is not republished by SIAM) contains the Fortran code of the algorithms discussed in the first volume; it is freely available from the numerical analysis community repository, `www.netlib.org`, under the name “lanczos”.

Chapter 0 of the present book contains the basic definitions and concepts from matrix theory, which are needed in the book. In Chapter 1 are summarized the properties of real symmetric matrices, Hermitian matrices, and for the real symmetric generalized eigenvalue problems. Chapter 2 describes the basic single-vector Lanczos procedure for real symmetric matrices, and analyze its properties in exact and finite precision arithmetic, when no reorthogonalization is performed. Chapter 3 analyzes the properties of general tridiagonal matrices, which will be needed in the subsequent chapters. In the main chapter of the book, chapter 4, is developed the single-vector Lanczos procedure with no reorthogonalization for real symmetric matrices. The relationship with the conjugate gradient method for solving linear systems is analyzed. Chapter 5 deals with the question of constructing a single-vector Lanczos procedure for computing singular values and vectors of real rectangular matrices. Chapter 6 addresses the question of constructing a single-vector Lanczos procedure for diagonalizable complex symmetric matrices. The last chapter deals with iteration block Lanczos procedures.

Though a lot of progress has been achieved in the field since the first volume was published (1985), the book remains a standard reference in the field.

The readership includes engineers, scientists, and mathematicians interested in computational techniques for large matrix eigenvalue problems.

Emil Cătinaş

Gilbert W. Stewart, *Matrix Algorithms, vol. II: Eigensystems*, SIAM, Philadelphia, PA, 2001, ISBN 0-89871-414-1, XIX+469 pp.

This book is the second one in a projected five-volume series, entitled “Matrix Algorithms”.

The first chapter describes the underlying mathematical theory regarding the eigenvalues and eigenvectors of matrices: definitions, Schur decompositions, Jordan forms, norms, spectral radii, matrix powers, perturbation theory. The second chapter is devoted to the QR algorithm, “the universal workhorse in this field”. The chapter starts with the power and inverse power methods, followed then by the explicitly and implicitly shifted QR algorithm; the QZ algorithm for generalized eigenvalue problems is also described. The third chapter deals with symmetric matrices and the singular value decomposition. It is shown how the QR algorithm may be adapted for symmetric matrices, and then is presented a method for updating the symmetric eigendecomposition, a divide and conquer algorithm, and some methods for band matrices. The QR algorithm and a hybrid QR-SVD algorithm are presented for the singular value decomposition problem, preceded by some background material. The last section of this chapter deals with the symmetric positive definite generalized eigenproblem. Chapter 4 contains the basic algebraic theory of eigenspaces, the analytic theory (residual analysis and perturbation bounds), the Krylov sequences for generating subspaces, and the Rayleigh-Ritz method for extracting individual vectors from a subspace. The following two chapters deal with algorithms for large eigenproblems. Chapter 5, presents decompositions associated with Krylov subspaces, which form the basis for the Arnoldi and Lanczos methods described next; the generalized eigenproblem is also dealt with. The last chapter considers two alternatives to the methods already presented: subspace iteration and methods based on Newton’s method (particularly the Jacobi-Davidson method).

This outstanding book presents in depth the essentials of the methods in this topic: how the methods are derived, the corresponding algorithms (described in pseudocode), error analysis and perturbation theory. Each section also contains historical comments, notes and pointers to further methods, which complete the joy when reading the book.

The book is written at an intermediate level, and is suitable for self-study by professionals and graduate students in the science and engineering, but, due to the emphasis in explaining in depth the material treated, can also be used with success in teaching.

We believe this book will become a standard reference in the field, and we warmly recommend it.

Emil Cătinaş

Carl Timothy Kelley, *Solving Nonlinear Equations with Newton's Method*, SIAM, Philadelphia, PA, 2003, ISBN 0-89871-546-6, XIII+104 pp.

This book accompanies the previous one on Newton's method, published by SIAM (1995), and focuses on practical aspects of algorithms, and on implementation techniques.

The first chapter is introductory, and contains a summary of the theoretical background (local convergence of the Newton and inexact Newton method, the Armijo rule), together with some numerical aspects: stopping test, failure and slow convergence.

The following three chapters provide the brief description of three classes of Newton methods, followed by different technical aspects and by the corresponding Matlab codes. Chapter 2 deals with LU factorization of the Jacobian at each Newton step, combined with the Armijo rule. Chapter 3 describes Newton-Krylov methods (GMRES, BICGSTAB and TFQMR), while the last chapter deals with the case when the linear systems at each Newton step are solved by the Broyden method.

The author discusses many crucial aspects on numerical implementation: forcing terms, stopping test, finite difference approximation of Jacobian and of Jacobian-vector products, etc. These facts allow the reader to choose the appropriate Newton-type method for a given problem and to adapt/write another efficient solver. Also, the book is a guide for troubleshooting algorithms and their most common failure modes.

The book is written by a specialist in the field, and is a must for every computational mathematician and scientist interested in the computational aspects of this topic. Students and teachers may also use with success this book in experimenting with the code supplied on the web site.

Emil Cătinaş

Arnold R. Krommer, Christoph W. Ueberhuber, *Computational Integration*, SIAM, Philadelphia, PA, 1998, ISBN 0-89871-374-9, XIX+445 pp.

This monograph offers a comprehensive and concise survey of computational integration methods, and the fundamental principles on which they are based. The book is structured in three parts: introduction, symbolic integration and numerical integration.

The first chapter introduces the fundamental mathematical concepts of Riemann integration (Riemann integrals, improper integrals, Cauchy principal value integrals, Hadamard finite part of integrals, curve and surface integrals). Chapter two, *Computational integration in practice*, demonstrates the practical importance of computational integration by presenting several areas in which this plays an important role: computational statistics, integral transforms, finite element methods an boundary integral methods. Chapter 3 presents some eclectic topics regarding the fundamentals of computational integration: frequently occurring integration regions and weight functions, main features of numerical and symbolic integration methods, advices for how to obtain existing software, etc. Chapter 4, which constitutes the second part of the book, presents the fundamentals of symbolic integration methods, and the integration of rational, elementary and nonelementary functions. Certain aspects are also presented regarding the case when dealing with mixed use of algebraic and finite precision computations. The first chapter in the second part deals with univariate integration formulas. The simple interpolatory and compound quadrature formulas are presented. Chapter 6 deals with cubature formulas and presents polynomial, number-theoretic, pseudorandom formulas, and lattice rules. Chapter 7 presents tailor-made numerical methods for particular kinds of integrals, including, e.g., oscillatory or singular integrands. Chapter 8 considers the construction of numerical algorithms, and describes several aspects (e.g., implementation of formulas, error estimation procedures, and extrapolation schemes). Chapter 9 deals with the development of numerical software for parallel and distributed computer architectures. Several parallelization schemes are reviewed. The last chapter contains criteria for assessing the quality of numerical integration programs (i.e., robustness, efficiency, etc.) and for evaluating corresponding quality indices.

The book successfully succeeds in the attempt of offering a comprehensive discussion of computational integration methods and the fundamental mathematical principles. It also covers many recent developments, such as parallel integration algorithms, and provides numerous pointers to references and to existing software products. All these determine us to believe that such a book will be highly appreciated by several specialists (computational scientists, engineers, researchers in applied numerical analysis and mathematical software) as well as in advanced courses on computing and numerical analysis.

Emil Cătinaş

Manfred Reimer, *Multivariate Polynomial Approximation*, International Series of Numerical Mathematics, Vol. 144, Birkhäuser Verlag, Basel-Boston-Berlin, 2003, 358 pp., ISBN 3-7643-1638-1.

This monograph brings a new breath over an old field of research–the approximation of functions by using multivariate polynomials. Besides surveying both classical and recent results in this field, the book also contains a certain amount of new material. The theory is characterized both by a large variety of polynomials which can be used and by a great richness of geometric situations which occur. Among these approached families of polynomials, we recall: Gegenbauer polynomials, the polynomial systems of Appell and Kampé de Feriét, the space $\mathbb{P}^r(S^{r-1})$, $r \in \mathbb{N} \setminus \{1\}$, of polynomial restriction, onto the unit sphere S^{r-1} and its subspaces, the most important of them being rotation-invariant subspaces.

The author investigates polynomial approximation to multivariate functions which are defined by linear operators. The reader will meet Bernstein polynomials, the Weierstrass theorem, the concept of best approximation and interpolatory projections in the space of the continuous real functions defined on a compact subset of $\mathbb{R}^r$, $r \in \mathbb{N}$, as well.

Distinct sections are devoted to quadratures. For example, the following are presented: Gauss quadratures, quadrature on the sphere, the geometry of nodes and weights in a positive quadrature, quadrature on the ball.

Hyperinterpolation represents another important concept treated by Manfred Reimer. It is a generalization of interpolation which shares with it the advantage of an easy evaluation but achieves simultaneously the growth order of the minimal projections. This new positive discrete polynomial approximation method is established on the sphere and then it is carried over to the balls of lower dimension.

By using summation methods such as Cesàro method or a method based on the Newman-Shapiro kernels, positive linear approximation operators are generated. A special consideration is given to the approximation on the unit ball B^r, $r \geq 2$. More precisely, orthogonal projections, Appell series and summation methods, interpolation on the ball are studied.

Among the book's outstanding features is the inclusion of some applications and a large variety of problems. As regards the applications, the author studies a recovery problem for real functions F belonging to a given space X and which are to be reconstructed from the values λF, where λ runs in a family of linear functionals on X. This way are presented both Radon transform, k-plane transform and reconstruction by approximation. As regards the problems, these are attached to help the reader to become familiar with the multivariate theory. All exercises are solved in a separate appendix.

Multivariate Polynomial Approximation includes the author's own research results developed over the last ten years, some of which build upon the results of others and some that introduce new research opportunities. His approach and proofs are straightforward constructive making the book accessible to graduate students in pure and applied mathematics and to researchers as well.

Octavian Agratini

Modern Developments in Multivariate Approximation, 5th International Conference, Witten-Bommerholz (Germany), September 2002, Werner Haussmann, Kurt Jetter, Manfred Reimer, Joachim Söckler–Editors, International Series of Numerical Mathematics, Vol. 145, Birkhäuser Verlag, Basel-Boston-Berlin, 2003, 319 pp., ISBN 3-7643-2195-4.

The volume contains the main topics and talks of the Fifth Conference on Multivariate Approximation held at the University of Dortmund during the week of September, 22–27, 2002. The conference was attended by 49 participants from 10 countries and the program included 11 one-our invited lectures and 21 contributed talks, and a problem session.

Professor William A. Light attended the conference with the lecture "Error estimates for radial basic function approximation", one of his last contributions, as he suddenly passed away three month after the conference, a hard loss for the mathematical community. Among the other participants I do mention C. K. Chui, N. Dyn, D. Levin, H. S. Shapiro, G. Nürnberger, T. Sauer, H. Wendland, G. Zimmermann.

There are included 18 papers dealing with various topics in approximation theory and applications, as nonstationary difference subdivision schemes (2 papers), transfinite interpolation by blending functions and cubature formulae, Schoenberg type operators, interpolation by polyharmonic splines, by quadratic splines and by radial functions, singularities of harmonic functions, adaptive wavelet methods, fundamental splines and triangulations, etc.

Providing an overview of the current state of affairs, the book will be of great interest to researchers in approximation theory and related areas, but also to those working in applied domains (geophysics, finance) and computer science

S. Cobzaş

Bhimsen K. Shivamoggi, *Perturbations Methods for Differential Equations,* Birkhäuser Verlag, Basel-Boston-Berlin, 2003, XIV+354 pp., ISBN: 3-7643-4189-0 and 0-8176-4189-0.

The mathematical problems associated with nonlinear equations, generally, are very complex. So that, one practical approach is to seek the solutions of these nonlinear equations as the perturbations of known solutions of a linear equation. A perturbative solution of a nonlinear problem becomes viable if it is close to the solution of another problem we already know how to solve.

After a chapter containing the asymptotic series and expansions, this book presents the regular perturbation methods for differential and partial differential equations. Other methods, such as the strained coordinates method, the averaging method, the matched asymptotic expansion method, the multiple scales method, are also very detailed presented. Very important is the fact that each chapter contains certain important applications, especially to fluid dynamics, but also to solid mechanics and plasma physics. Moreover, each chapter contains a section of specific exercises, and an appendix with basic mathematical tools.

Many methods and procedures are very well described without technical proofs. It is obvious the intention of the author to convince the reader to understand the phenomena and to learn how to apply correctly the suitable presented method.

Perturbation Methods for Differential Equations can serve as a textbook for undergraduate students in applied mathematics, physics and engineering. Researchers in these areas will also find the book an excellent reference. A comprehensive bibliography and an index complete the book.

Gh. Micula

Andrey V. Savkin and Robin J. Evans, *Hybrid Dynamical Systems (Controller and sensor switching problems)*, Birkhauser Verlag, Boston-Basel-Berlin, 2002, 153 pp., ISBN 0-8176-4224-2.

This book is primarily a research monograph that presents the latest results of the authors about a class of hybrid dynamical systems (HDS). The original results presented in this book were published by the authors (and their collaborators) in 30 journal papers and conference proceedings, most of them are dated after 1994. The proofs are presented in a very clear and accessible manner and most of them assumes only basic knowledge of differential equations and control theory. The book has an extensive bibliography (163 titles) of the topic and it's logical and clear construction with illustrative examples allows to assimilate it very easy.

The first chapter is an introduction, first of all there are presented a few definitions of HDS and the main problems studied in the book are briefly described. In Chapter 2, Quadratic State Feedback Stabilizability via Controller Switching, the authors propose algorithms to determine the switching sequences that ensure quadratic stability (the existence of a quadratic Lyapunov function) of the corresponding closed-loop system and they give sufficient conditions for quadratic stabilizability via controller switching. In this chapter the main theoretical tool is the S-procedure introduced by Aizerman and Gantmacher. In Chapter 3, Robust State Feedback Stabilizability with a Quadratic Storage Function and Controller Switching, a class of linear time-varying systems with norm bounded uncertainty is studied, a necessary and sufficient condition for robust stabilizability via state feedback controller switching with a quadratic storage function is given and there are constructed some sufficient conditions for robust stabilizability via controller switching. In Chapter 4, H^∞ Control with Synchronous Controller Switching, there are presented necessary and sufficient conditions for state feedback problem on finite and infinite time intervals. These conditions are given in the terms of the existence of a solution to a dynamic programming equation. In Chapter 5, Absolute Stabilizability via Syncronous Controller Switching, the authors present a necessary and sufficient condition for absolute output feedback stabilizability via controller switching for some dynamical systems with an integral quadratic constraint. The technique involves Ricatti equations and dynamic programming as in the previous chapter. Chapter 6, Robust Output Feedback Controllability via Synchronous Controller Switching is dedicated to the study of robust output feedback controllability for a class of uncertain linear time-varying systems. The controllers are nonlinear digital controllers with control signals belonging to a given set. A necessary and sufficient condition is proved. Chapter 7, Optimal Robust State Estimation via Sensor Switching, considers the sensor scheduling problem, which consists of estimating the state of an uncertain process based on measurements obtained by switching a given set of noisy sensors. The main result is that the optimal switching rule can be computed by solving a Ricatti differential equation and a dynamic programming procedure. The results in Chapter 8, Almost Optimal Linear Quadratic Control Using Stable Switched Controllers, show that if an extended class of controllers is allowed, the assumptions of stabilizability and detectability are sufficient for the existence of a stable controller. In Chapter 9, Simultaneous Strong Stabilization of Linear Time-Varying Systems Using Switched Controllers a new method for simultaneous stabilization of a finite collection of linear time-varying plants is given. This method involves switched controllers who's dynamic can be described by a system of ordinary differential equations with discontinuous right-hand side.

Due to the presented problems/results and its self contained unified approach, this book can be helpful to researchers and postgraduate students working in control engineering, applied mathematics, robotics and theoretical computer science.

Szilárd András

N. D. Kopachevsky, S.G. Krein, *Operator Approach to Linear Problems of Hydrodynamics*, in *Operator Theory Advances and Applications*, vol. 128, Birkhäuser Verlag, 2001, 384 pp., ISBN 3-7643-5406-2.

This book is the first volume of a set of two devoted to the operator approach to linear problems in mechanics. The purpose of this book is to present certain functional analytic methods applied to the study of small movements and normal oscillations of hydromechanical systems with cavities filled with either ideal or viscous fluids. This volume consists of two parts and deals with the study of hydrodynamical systems containing an ideal fluid, and includes basically the description of self-adjoint problems. In the first chapter the authors present the prerequisites in functional analysis that are necessary in the forthcoming chapters. The second chapter reflects to a certain extent the authors point of view that the metrics in different spaces of fluid velocity fields should have a physical meaning. In the case of an ideal fluid such a metric is provided by the quadratic form of the kinetic energy, while in the case of a viscous fluid, by the same form and the form of the energy dissipation. The aim of the second part of the book is to present several problems involving the motion of an ideal fluid in a stationary or moving container. The third chapter deals with the problem of oscillations of a heavy ideal fluid. In the next chapter the authors present the problem of oscillations of a capillary fluid under certain conditions of weightlessness. It is also discussed the problem of oscillations of a fluid in a container with an elastic bottom. Chapter 5 provides several new interesting problems based on an operator approach, which is different by those used in other chapters. We mention here the plane problems on proper oscillations of a heavy fluid in a channel, shallow water theory in problems of oscillations of heavy ideal fluids in bounded regions, etc. In the last chapter of this volume the authors construct a theory of small oscillations of an ideal homogeneous fluid that partially fills in a container and, in an unperturbed state, rotates uniformly together with that container. The book ends with a reach bibliography.

This volume is clearly written, with rigorous presentation, in a pleasant and accessible style. It is useful for researchers, engineering and students in fluid mechanics and mathematics that are interested in several aspects of operator theoretical methods for the analysis of hydrodynamical problems. We warmly recommend this book to all researchers in the field.

Mirela Kohr

Yoshio Sone, *Kinetic Theory and Fluid Dynamics*, Birkhäuser, Boston-Basel-Berlin, 2002, 353 pp., ISBN 3-7643-4284-6.

In this interesting monograph the author presents a comprehensive description of the relationship and connections between kinetic theory and fluid dynamics, mainly for a time-independent problem in a general domain. The ambiguities in this relationship are clarified and the incompleteness of classical fluid dynamics in describing the behavior of a gas in continuum limit, reported as the ghost effect, is also discussed.

By using a rigorous and systematic asymptotic analysis, the author derives fluid-dynamic type equations and their associated boundary conditions that take into account the weak effect of gas rarefaction. The equations and their boundary conditions are classified depending on the physical context of problems. Applications to various physically phenomena are also presented. These applications include flows induced by temperature fields, evaporation and condensation problems, bifurcation of flows, as well as examples of the ghost effect.

In the first chapter, the author considers a gas in a steady (or time-dependent) state in a general domain and studies its asymptotic behavior for small Knudsen numbers on the basis of kinetic theory. Here it is also presented fluid-dynamic-type equations and their associated conditions, together with their Knudsen-layer corrections, which describe the asymptotic behavior of the gas for small Knudsen numbers. The second chapter is devoted to asymptotic behavior of the solution for small Knudsen numbers of a time-independent boundary-value problem in a general domain of the linearized Boltzman equation. In the next chapter the author extends the asymptotic theory developed in the preceding chapter for small Reynolds numbers, so that to be applicable to the case where the Reynolds number takes a finite value. Chapter five deals with the nonlinear theory corresponding to finite temperature variations. In Chapter six the nonlinear theory for a flow with a finite Mach number around a simple boundary is considered. The next chapter treats a flow of a gas around its condensed phase where evaporation or condensation with speed at a finite Mach number takes place. We mention that in Chapters 3–7 various situations in the continuum limit are discussed in terms of the Hilbert expansion with a special attention to the order of the quantities in the situation under consideration. In the last chapter, the author chooses a special problem as an example of analysis in the marginal cases. The book concludes with some supplementary explanations and formulas used in the text, as well as a reach bibliography.

The book is very well written, with rigorous proofs, in a pleasant and accessible style. It is warmly recommended to graduate students, practitioners and researchers in theoretical physics, applied mathematics, and various branches of engineering.

Mirela Kohr

W.S. Slaughter, *The Linearized Theory of Elasticity*, Birkhäuser Boston-Basel-Berlin, 2002, 543 pp., ISBN 0-8176-4117-3.

This book is a modern treatment of the linearized theory of elasticity, presented as a specialization of the general theory of continuum mechanics. It is derived from notes used by the author in teaching a first-year graduate-level course in elasticity in the Department of Mechanical Engineering at the University of Pittsburgh. The book consists of 11 chapters, followed by an appendix and a list of references. In Chapter 1 it is presented a review of mechanics of materials. In fact, the purpose of this chapter is to reacquaint the reader with certain fundamental aspects of mechanics of materials, as it taught to undergraduates engineering students. The aim of the second chapter is to introduce the theory of tensor analysis. In the subsequent chapters, there are also included other mathematical topics such as the calculus of variations and the theory of functions of one complex variable. Chapters 3 to 6 are devoted to the foundations for the linearized theory of elasticity. In the third chapter, the author presents a detailed discussion of the kinematics theory. The purpose of Chapter 4 is to present several problems concerning forces and stresses. Chapter 5 is devoted to the study of the constitutive equations. Here several problems, like elasticity, constitutive linearization, material symmetry, isotropic materials, respectively cylindrical and spherical coordinates, are discussed. Chapter 6 focuses on the linearized elasticity problems, including the field equations, boundary conditions, some useful consequences of linearity, solution methods. The remaining chapters cover solution methods for a variety of classes of problems ranging from two-dimensional antiplane strain problems to three-dimensional problems. Chapter 7 is devoted to two-dimensional problems, while Chapter 8 consists of torsion of noncircular cylinders problems. Chapter 9 contains a detailed study of three-dimensional problems. We mention here field theory results, potentials in elasticity, dislocation surface, etc. The next chapter is devoted to variational methods while the last chapter includes several problems related to complex variable methods. There are presented various results connected to functions of a complex variable, antiplane strain, plane strain/stress, etc. In the appendix, the authors presents certain notions related to general curvilinear coordinates. Each chapter ends with an useful list of problems.

The book is clearly written, with rigorous presentation, in a pleasant and accessible style. This new text is an excellent resource devoted to introduce the students in mechanical or civil engineering to the linearized theory of elasticity. It is warmly recommended to all researchers in the field.

Mirela Kohr

Ronald Meester, *A Natural Introduction to Probability Theory*, Birkhäuser Verlag, Basel-Boston-Berlin, 2003, XI+191 pp., ISBN 3-7643-2188-1.

According to Leo Breiman (1968) "probability theory has a right and a left hand". The right hand refers to rigorous mathematics, and the left hand refers to "probabilistic thinking". The combination of these two aspects makes probability theory one of the most interesting fields in mathematics. One can study probability as a purely mathematical enterprise, but even doing this, all the concepts that arise do have a meaning on the intuitive level.

This book provides an introduction of discrete and continuous probability, without using algebras or sigma-algebras; only familiarity with first year calculus is required. This book may successfully be used by those who have no previous knowledge in measure theory.

The author shows in this book that one can study discrete and continuous random variables perfectly well, and with mathematical precision, within the realm of Riemann integration. For example probabilities of events are defined as soon as a certain (Riemann) integral exists.

The first four chapters deal with discrete probability. The treatment includes an elementary account on random walks, the weak law of large numbers and a first version of the central limit theorem. After that in the section called Intermezzo it is explained why discrete probability is insufficient to deal with probabilistic concepts which include infinitely "fine" operations, such as choosing a point on a line segment.

The next five chapters deal with continuous probability theory. There are discussed applications to branching processes, random walks, strong laws of large numbers, Poisson processes, limit theorems based on characteristic functions. In the final chapter it is outlined how the current theory can be extended using measure theory, it is a link between this book and probability based on measure theory.

The book contains many interesting examples and problems, taken from classical applications like gambling, geometry or graph theory, as well as from applications in biology, medicine, social sciences, sports and coding theory.

Hannelore Lisei

Vasile Berinde, *Iterative approximation of fixed points*, Efemeride, Baia Mare, 2002, ISBN 973-85243-6-9, XII+284 pp.

As its title suggests, the aim of this monograph is to provide an introduction to the basic results in iterative approximation of fixed points.

The metrical fixed point theory has developed significantly in the second part of the XXth century. There exists a lot of *metrical* fixed point theorems, more or less important from a theoretical and practical point of view, which establish existence, existence and uniqueness of fixed points for a certain contractive operator, or provide a *constructive* method for finding the fixed points.

Since the constructive methods used in metrical fixed point theory are generally *iterative* procedures, the aim of the monograph is to survey those fixed point theorems that offer information on the numerical aspects related to a fixed point iteration procedure, i.e., a priori or a posteriori error estimates, rate of convergence, data dependence of fixed point, stability of fixed point iteration procedures etc.

The book is the first monograph on this topic and is designed to serve both as a general survey and as a detailed exposition of the most used fixed point iteration procedures: Picard iteration, Krasnoselskij iteration, Mann iteration, Ishikawa iteration etc.

The book arose out of a rather long personal research work as well as of a rich didactic experience of the author: a Master degree course "Methods for approximating fixed points" and a graduate course on "Fixed point theory", taught for many years at North University of Baia Mare.

The survey is based on about 400 diversified recent publications out of more than 1000 entries in the reference list.

The diversity of results considered by the author in the book comes mainly from three directions:

1. The variety of the underlying spaces where the operators are defined;

2. The variety of contractiveness assumptions and/or topological properties associated with these operators;

3. The variety of assumptions on the parameters that define a certain fixed point iteration procedure. Sometimes these parameters depend also on the geometry of the ambient space and/or on the properties of the considered operator.

The book begins with of a Preface and an Introduction, followed by a List of symbols, and consists of 9 chapters, the List of references, and ends with the Author's Index.

The list of Chapters and Sections in the book will be suggestive for the reader.

Chapter 1. Pre-requisites of fixed points 1.1. The background of metrical fixed point theory 1.2. Fixed point iteration procedures 1.3. Fixed point formulation of typical functional equations Chapter 2. The Picard iteration 2.1. Banach's fixed point theorem 2.2. Theorem of Nemytzki-Edelstein 2.3. Quasi-nonexpansive operators 2.4. Maia's theorem 2.5. φ-contractions 2.6. Generalized φ-contractions Chapter 3. The Krasnoselskij iteration 3.1. Nonexpansive operators in Hilbert spaces 3.2. Strictly pseudocontractive operators 3.3. Lipschitzian and generalized pseudocontractive operators 3.4. Pseudo φ-contractive operators Chapter 4. The Mann iteration 4.1. The general Mann iteration 4.2. Nonexpansive and quasi-nonexpansive operators 4.3. Strongly pseudocontractive operators 4.4. Quasi-contractive type operators Chapter 5. The Ishikawa iteration 5.1. Lipschitzian and pseudo-contractive operators in Hilbert spaces 5.2. Strongly pseudo-contractive operators in Banach spaces 5.3. Nonexpansive operators in Banach spaces satisfying Opial's condition 5.4. Quasi-contractive type operators Chapter 6. Other fixed point iteration procedures 6.1. Mann and Ishikawa iterations with errors 6.2. Modified Mann and Ishikawa iterations 6.3. Ergodic fixed point iteration procedures Chapter 7. Stability of fixed point iteration procedures 7.1. Stability and almost stability of fixed point iteration procedures 7.2. Weak stability of fixed point iteration procedures 7.3. Continuous dependence of the fixed points 7.4. Sequences of applications and fixed points Chapter 8. Applications of some fixed point iteration procedures 8.1. Nonlinear equations in arbitrary Banach spaces 8.2. Nonlinear equations in smooth Banach spaces 8.3. Nonlinear m-accretive operator equations in reflexive Banach spaces Chapter 9. Error analysis of fixed point iteration procedures 9.1. Rate of convergence of iterative processes 9.2. Comparison of some fixed point iteration procedures 9.3. Empirical comparison of some fixed point iteration procedures

Each chapter ends with a section of Bibliographical Comments.

The book is well written and almost self-contained, is easy to follow, and contains much significant results in the dynamic field of fixed point iteration procedures and consequently should be useful for researchers, graduate, postgraduate and PhD students interested in this part of the fixed point theory.

A drawback must be however mentioned: the absence of exercises and problems to end each chapter, a problem that we recommend to be solved by the author in the next editions of this interesting book.

Ion Păvăloiu

Lokenath Debnath, *Wavelet Transforms and Their Applications*, Birkhäuser, Boston Basel Berlin, 2002, ISBN 0-8176-4204-8.

The last two decades have produced tremendous developments in the mathematical theory of wavelets and their great variety of applications. Since wavelet analysis is a relatively new subject, this monograph is intended to be self-contained. The book is designed as a modern and authoritative guide to wavelets, wavelet transform, time-frequency signal analysis and related topics.

It is known that some research workers look wavelets upon as a new basis for representing functions, others consider them as a technique for time-frequency analysis and some others think of them as a new mathematical subject. All these approaches are gathered in this book, which presents an accessible, introductory survey of new wavelet analysis tools and the way they can be applied to fundamental analysis problems. We point out the clear, intuitive style of presentation and the numerous examples demonstrated thorough the book illustrate how methods work in a step by step manner.

This way, the book becomes ideal for a broad audience including advanced undergraduate students, graduate and professionals in signal processing. Also, the book provides the reader with a through mathematical background and the wide variety of applications cover the interdisciplinary collaborative research in applied mathematics. The information is spread over 565 pages and is structured in 9 chapters as follows:

1. Brief Historical Introduction 2. Hilbert Spaces and Orthonormal Systems 3. Fourier Transforms and Their Applications 4. The Gabor Transform and Time-Frequency Signal Analysis 5. The Wigner-Ville Distribution and Time-Frequency Signal Analysis 6. Wavelet Transforms and Basic Properties 7. Multiresolution Analysis and Construction of Wavelets 8. Newland's Harmonic Wavelets 9. Wavelet Transform Analysis of Turbulence.

At the end of the book a key and hints for selected exercises are included.

In order to stimulate further interest in future study and to sustain the present material, a generous bibliography is listed.

Octavian Agratini

Advances in Gabor Analysis, Hans G. Feichtinger and Thomas Strohmer–Eds., Applied and Numerical Harmonic Analysis, Birkhäuser Verlag, Boston-Basel-Berlin 2003, XVIII + 356 pp., ISBN 0-8176-4239-0 and 3-7643-4239-0.

In 1946 Dennis Gábor (Nobel prize for physics in 1971) had the idea to use linear combinations of a set of regularly spaced, discrete time and frequency translates of a single Gaussian function to expand arbitrary square-integrable functions. The idea turned out to be a very fruitful and far-reaching one, with spectacular applications to quantum mechanics and electrical engineering. The Heisenberg uncertainty principle, discussed at large in one of the included chapters, is the core of the time-frequency analysis and of Gabor analysis. Gabor analysis attracted many first rate mathematicians due to the highly non-trivial mathematics lying behind it. A strong impulse came from the development of frames in Hilbert space, leading to important problems of practical computation – rate of convergence, stability, density. In the last time, M.A. Rieffel, R.E. Howe and T.J. Steger found some unexpected connections with operator algebras.

The present book can be considered as a continuation of two previous ones: *Gabor Analysis and Algorithms: Theory and Applications,* H. G. Feichtinger and T. Strohmer – Eds., Birkhäuser 1998, and the book by K. Gröchenig, *Foundations of Time-frequency Analysis,* Birkhäuser 2001. It contains survey chapters, but new results that have been not published previously are also included. The introductory chapter of the book, written by H.G. Feichtinger and T. Strohmer, contains a clear outline of the contents as well as some comments on the future developments in Gabor analysis.

Beside this introductory chapter, the book contains other eleven chapters, written by different authors, and dealing with various questions in Gabor analysis and its applications: uncertainty principles, Zak transforms, Weil-Heisenberg frames, Gabor multipliers, Gabor analysis and operator algebras, approximation methods, localization properties, optimal stochastic encoding, applications to digital signal processing and to wireless communication.

Written by leading experts in the field, the volume appeals, by its interdisciplinary character, to a large audience, both novices and experts, theoretically inclined researchers and practitioners as well. It brilliantly illustrates how application areas and pure and applied mathematics can work together with profit for all.

S. Cobzaş