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BOOK REVIEWS

MINGJUN CHEN, ZHONGYING CHEN, GUANRONG CHEN, *Approximate Solutions of Operator Equations*, Series in Approximations and Decompositions, Vol. 9, World Scientific, Singapore–London–Hong Kong, 1997, xiii+344 pp., ISBN 981-02-3064-8.

The book is an interesting introduction to approximate solutions of operator equations in Banach spaces of real or complex functions. This abstract approach enables the authors to treat, from a unifying point of view, various kinds of linear and nonlinear, ordinary and partial differential, integral or integro-differential and functional evolution equations formulated in elementary or abstract function spaces, with initial boundary value conditions and possible additional constraints. The book is designed as an elementary and self-contained introduction to some important notions such as computational schemes, convergence analysis, stability conditions and error estimates.

The volume is divided into six chapters and two appendices. Chapter 1 – *Introduction* – is an overview of the projection approximation techniques – projection operators; projective approximation scheme. The approximate solutions of operator equations in Banach or Hilbert space setting are discussed in Chapter 2 for compact linear operators and in Chapter 3 for other linear operators (including densely defined operators).

Applications to Fredholm integral equations and to boundary value problems for ordinary and partial differential equations are included.

Topological degree and fixed point theorems, comprising approximate solutions of nonlinear fixed point equations, are discussed in the fourth chapter.

Chapter 5 deals with monotone and K-monotone nonlinear operator equations and their approximate solutions. Perturbed equations together with some applications to typical nonlinear differential equations are included, too.

The final chapter is concerned with operator evolution equations and their projective approximate solution. Continuous-time and discrete-time projection methods for first and second order abstract evolution equations are considered.

Two appendices, one on fundamental results from functional analysis and the other on Sobolev spaces, help the reader find quickly references to notions and results used throughout the book.

The volume is an expanded, revised and updated version of a Chinese text published by the first two authors at the Guangdong Scientific Publishing Co. in 1992. It is very well written, with clear and simple proofs and many concrete numerical examples, providing, in a relatively small number of pages, a fairly complete introduction to the subject.

It can be recommended as a textbook for graduate students as well as a reference book for researchers and professionals working in approximation theory, numerical analysis, applied mathematics and engineering.

S. Cobzaş and I. Păvăloiu

Progress in Systems and Control Theory, edited by I. CSISZÁR and Gy. MICHALETZKY, Vol. 23, Birkäuser, Boston–Basel–Berlin, 1997, 354 pp.

The volume contains 28 research papers presented at the Conference on Stochastic Differential and Difference Equations, held at Győr, Hungary, on August 21–24, 1996, organized jointly by Eötvös Loránd University, Budapest, and Kossuth Lajos University, Debrecen, as a satellite event to the 4th World Congress of the Bernoulli Society, August 26–31, 1996, Vienna, Austria.

A great variety of stochastic equations are presented in this volume. The existence and uniqueness of solutions of some particular SDE are analyzed in the papers of G. N. Boshnakov and J. Xiong. Existence and uniqueness theorems for some SPDE are presented in other three papers (J. Gyöngy, K. Twardowska, A. S. Üstünel and M. Zakai). The convergence in law of discrete approximation to the weak solution of Ito-Volterra equation (A. Kolodii) and temporally inhomogeneous convolution semigroups on a Lie group and the associated stochastic processes with independent increments (H. Kunita) are also presented.

The stationary solutions of SDE are studied in six papers in relation with Oseledets spaces for linear SDE (P. Imkeller), the additive bilinear state space stochastic system (M. Ispány, E, Iglói and Gy. Terdik) and the Fisher information matrix (A. Klein and P. Spreij). A parallel implementation for the numerical solution of the stationary equations of the general state space Markov chain is described by G. Heber and C. Lindemann. T. S. Rao presents a review of the recent methods for the analysis of stationary nonlinear time series.

The application of SDE to diffusion processes is considered in seven papers. The main topics of these papers are: the projection of the density evolution of a diffusion process onto an exponential manifold (D. Brigo), the support theorem, the Skorohod integral, the creation of a big Gel'faud triple (I. Kubo), and B. Lévy's Brownian movement in an observation domain with infinitesimal deformations (L. Márkus). X. Zhao analyzes the moments and the absolute continuity of measure-valued branching processes with interactions relative to the reference measure.

Some papers deal with the problem of the control of stochastic systems. For instance, A. Lindquist and V. A. Vakubovich present the optimal control by output feedback of a linear discrete-time system corrupted by an additive harmonic vector disturbance with known frequencies but unknown amplitudes and phases. The implications of the SDE in quantum physics are discussed in three papers.

This volume is of great interest to all those who use the methods of stochastic equations in their scientific activity.

C. Vamoş

H. ENNS RICHARD, GEORGE McGUIRE, *Nonlinear Physics with Maple for Scientists and Engineers*, Birkäuser, 1997, 390 pp., hardbound, ISBN 0-8176-3838-5.
H. ENNS RICHARD, GEORGE McGUIRE, *A Laboratory Manual for Nonlinear Physics with Maple for Scientists and Engineers*, Birkäuser, 1997, 136 pp., Softcover, ISBN 0-8176-3841-5.

The book under review is an introduction to some of the main topics of nonlinear dynamics, by using the very powerful computer algebra program Maple. The book consists of three items: the textbook, the laboratory manual and an 1.44M MS-DOS diskette, including the files with the Maple examples from the textbook and the laboratory manual. The paper items include references to the files from the magnetic support.

The topics touched in the textbook are rather standard for a book of nonlinear dynamics. The first eight chapters of the book are devoted to some basic material in the study of nonlinear systems. After an introduction, where the authors emphasize the importance of nonlinear effects in nature, they give examples of nonlinear systems, chosen from a very wide area (biology, mechanics, electrical and chemical phenomena and many others). The following three chapters are concerned with the available methods of investigation: topological analysis, analytical methods and the numerical approach. In parallel, the reader is familiarized with the using of Maple, because, in order to illustrate the features of solutions, one is invited to use Maple codes.

Some characteristics of nonlinear systems behavior could be obtained by studying the right-hand side of an ordinary differential equation. Thus, Chapters 6 to 8 are devoted to the qualitative study of a nonlinear ODE system (limit cycles, forced oscillations, nonlinear maps).

The remaining chapters discuss somewhat higher-level topics, namely: nonlinear phenomena in partial differential equations, numerical simulations and inverse scattering method.

As we have said before, the book includes the Maple files and statements allowing the reader to obtain the solutions and the graphs found in the text. What he needs is a computer with Maple V Release 4 installed, in order to obtain all the results by himself. If he is interested in practical experiments, and if he is an engineer or a physicist, the laboratory manual provides 28 experimental activities in which one of the phenomena described in the textbook is met. Each activity includes a reference to the corresponding section in the textbook or to another bibliographical reference, a theoretical part, the description of the experiment and a list of things to be investigated.

Performing nonlinear mechanics is somehow frustrating, because most of the problems encountered are non-integrable, or they are integrable, but the solution doesnot look very friendly. Most people are not very familiar with computer programming and not anyway, it is not very comfortable to write programs in C or Pascal or whatever to integrate a system or to make a graphic. This is the power of Maple, which is a very friendly computer program allowing symbolic, numeric and graphic investigations, without too much effort.

This book is an invaluable resource for both students and teachers, and we think it will be adopted as a textbook in many universities. Of course, it can be used for individual study as well.

A special mention has to be made regarding the excellent graphical aspect of the book, which includes many line diagrams (most of them produced by Maple), as well as some very witty and funny illustrations.

Cristina Blaga

J. M. AYERBE, T. DOMINGUEZ BENAVIDES, G. LÓPEZ ACEDO, *Measures of Noncompactness in Metric Fixed Point Theory*, Operator Theory. Advances and Applications, Vol. 99, Birkhäuser, Basel–Boston–Berlin, 1997, vii+212 pp., ISBN 3-7643-5794-0.

This book is written as a monograph on some topics from the theory of measures of noncompactness and fixed point theory. The authors assume that the reader is familiar with the basic results of real analysis, functional analysis and Banach space geometry. The book is divided into ten chapters headed as follows: *I. The Fixed Point Theorems of Brouwer and Schauder. II. Measures of*

Noncompactness. III. Minimal Sets for Measures of Noncompactness. IV. Convexity and Smoothness. V. Nearly Uniform Convexity and Nearly Uniform Smoothness. VI. Fixed Points of Nonexpansive Mappings and Normal Structure. VII. Fixed Point Theorems in the Absence of Normal Structure. VIII. Uniformly Lipschitzian Mappings. IX. Asymptotically Regular Mappings. X. Packing Rates and ϕ-Contractiveness Constants.

Each chapter contains a biographical sketch of a prominent mathematician with outstanding contributions to the subject treated in that chapter. These are (respecting the order of the chapters): L. E. J. Brouwer, K. Kuratowski, F. Hausdorff, J. Schauder, Z. Opial, S. Banach, S. Mazur, R. O. S. Lipschitz, D. Hilbert and H. L. Lebesgue.

Being based on discussions in the seminars on Nonlinear Functional Analysis held at the University of Seville, the book contains many results obtained by the authors over the last ten years. In order to make the book self-contained, related results on Banach space geometry and measures of compactness are also included.

The book is clearly written, very well organized, and we recommend it warmly to all those who are interested in nonlinear analysis and its applications.

Ioan A. Rus

WALTER GAUTSCHI, *Numerical Analysis. An Introduction*, Birkhäuser, Basel–Berlin–Boston, 1997, hardbound, 506 pp., ISBN 3-7643-3895-4, DM. 118. 00.

The book is, as its title suggests, a textbook on *Numerical Analysis*. It is *An Introduction* because the subjects covered are discussed as simply as possible and in a teaching-oriented form. For the topics that need more technical constructions, that transcend the simplicity of the book, there are offered bibliographical references at the end of each chapter. The author wrote the book on the basis of course notes, used for the last 30 years at the Purdue University. During the time he has tested this material on a large and variate student population and has made a selection of what is really important and deserves to be a part of a basic introductory course in Numerical Analysis for a graduate program.

The first four chapters deal with the basic facts of this topic and the last three come, at some higher level, with more complicate things. In fact, the book has eight chapters. The first one (Chapter 0) contains an overview of the main subject of the book and reminds us the connections with other domains, a list of the software packages available, the main monographs and textbooks on this topic and the major journals on this area. In Chapter 1, the author discusses basic facts related to the representation numbers in a computer, machine numbers and machine arithmetic. The reader is faced with the very delicate problem of errors. Chapter 2 is devoted to approximation and interpolation. The approximations of functions are made by simpler functions polynomials or piecewise polynomial functions and using the least square techniques by orthogonal functions. The last part of this chapter contains the approximation and interpolation using spline functions. At each step the author analyzes the convergence and errors of the method. Chapter 3 contains some recipes used to compute numerical derivatives and definite integrals. The tools used to evaluate these quantities are provided by the theory of polynomial interpolation. The main goal of the fourth chapter is to discuss the systems of nonlinear equations. The chapter begins with some examples of equations or problems that could be reduced to nonlinear systems. Then there are described the methods of bisection, Sturm sequences, false position, and so on. This description is preceded by a discussion about iteration, convergence and efficiency.

The last three chapters of the book are devoted to numerical solutions for ordinary differential equations. Chapter 5 contains one-step methods for initial value problems of ODEs. Among others there are described the Euler method, the method of Taylor expansion and the Runge-Kutta method. There are also discussed the stiff equations and some special methods for solving them. The next chapter offers us solutions for initial value problems of ODEs using multi-step methods. The author compares them with the one-step methods. He estimates the differences between them and the advantages of one to another. The last chapter contains numerical solutions for two-point boundary value problems for ODEs by shooting, finite difference and variational methods.

At the end of each chapter there are notes concerning bibliographical sources in which the reader could find more details about the subject discussed in each paragraph and exercises. This separate paragraph of exercises contains not only theoretical exercises, but also problems for a laboratory on Numerical Analysis, the so-called machine assignments. We want to mention that it has also historical notes about those who obtained the formulas or methods described.

The book is recommended to graduate students, who have a basic knowledge on advanced calculus and on linear algebra and ordinary differential equations. It ends with a long list of bibliographical references and a detailed index of subjects. It is written in a very clear and pedagogical style and can be used both by teachers, to prepare their courses, and by self-training graduate students or researchers, to accumulate new information. So, we recommend it to graduate students and to researchers in applied mathematics, physics and engineering, who need to solve numerically nonlinear equations or differential equations in their scientific work.

Cristina Blaga

Topics in Interpolation Theory, edited by H. DYM, B. FRITZSCHE, V. KATSNELSON, B. KIRSTEIN, Operator Theory. Advances and Applications Vol. 95, Birkhäuser, Boston–Basel–Berlin, 1997, 494 pp., ISBN 3-7643-5723-1.

In August 1994 the University of Leipzig organized the Conference "Recent Developments in Schur Analysis. A Workshop in Honour of the 80th Birthday of V. P. Potapov". Vladimir Petrovich Potapov was a professor at the Faculty of Mathematics of the Odessa State University with important contributions to complex function theory and operator theory – factorization theory for J-contractive matrix functions, matrix versions of the Nevanlinna-Pick interpolation theory and Hamburger moment problem, operator theory in rigged spaces.

The conference was attended by mathematicians from North America, Asia and Europe (including many from the former Soviet Union), some of them former students or colleagues of Professor Potapov. The volume contains reminiscences from M. S. Livšic (Ben Gurion University), Damir Z. Arov, Lev. A. Sakhnovich, A. A. Nudelman (all from Odessa), V. K. Dubovoj (Kharkov), and V. E. Katsnelson (Weizmann Institute).

Two survey papers were specially written for this volume – one by V. E. Katsnelson on Potapov's fundamental matrix inequality and its relevance for interpolation theory, and the other by V. E. Katsnelson and B. Kirstein on the theory of analytic matrix-valued functions belonging to Smirnov class.

Besides original papers presented at the conference, the volume also contains translations of some Russian papers less known in the West, including a paper by M. G. Krein on entire matrix-functions, one by N. I. Akhiezer on some minimum problems in function theory and Smirnov's paper on boundary values of functions regular in the unit disk.

The research papers deal with topics related to Potapov's work, such as multiplicative decompositions for operator and matrix functions, fundamental matrix inequalities, canonical systems of differential equations, abstract interpolation problems, spaces with indefinite metric.

Together with the volume *Matrix and Operator Valued Functions. The V. P. Potapov Memorial Volume*, I. Gohberg and L. A. Sakhnovich (Eds), OT 72, Birkhäuser, Basel, 1994, the present book is recommended to a large audience including mathematicians interested in operator theory and function theory (in abstract setting) and their applications, and engineers interested in systems theory and control.

S. Cobzaş

JEAN-MICHEL MULLER, *Elementary Functions. Algorithms and Implementation*, Birkhäuser, Boston – Basel – Berlin, 1997.

The book is dedicated to a challenging goal of modern Computer Science, namely to compute quickly and accurately the usual math functions (sin, cos, tan, exp and their inverses).

Chapters 1 and 2 are introductory and present the problem and computer arithmetic (with emphasis on IEEE 754 Floating Point Standard).

Part I is on polynomial approximations (Chapter 3) and on table look-up methods (Chapter 4). Table look-up methods allow an efficient and accurate implementation of polynomial approximation methods storing remarkable floating-point values of functions and coefficients of low-degree polynomial approximations.

Part II, with three chapters, treats shift-add algorithms, that is, algorithms based only on shift, add and multiple operations. The most important algorithm of this class is CORDIC (Chapter 6).

Part III has three chapters: 8 – *Range Reduction* (that is, argument transformation in order to obtain efficient and accurate approximation); 9 – *Final Rounding;* 10 – Miscellaneous, dedicated to exceptions and multiple precision.

Bibliography contains 201 titles, some of them available through the Internet.

Target audience: computer scientists and researchers, software and hardware engineers, specialist in numerical analysis.

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