BOOK REVIEWS

Ladislav Mišík: FUNKCIONÁLNA ANALÝZA. Alfa, Bratislava 1989

Kniha je vysokoškolskou učebnicí lineární funkcionální analýzy určenou především posluchačům matematiky na matematicko-fyzikálních fakultách univerzit. Je již tradicí, že výklad kurzu funkcionální analýzy začíná přípravnými pasážemi z teorie množin, topologie a lineární algebry. Autor je v úvodních kapitolách důkladnější, než je obvyklé; nespokojil se s naivním množinovým pojetím, ale vykládá Zermelovu axiomatiku teorie množin (v kap. I, která čítá cca 70 stran), probírá pečlivě základy topologie (v kap. II asi na 90 stranách) i potřebné partie z lineární algebry (v kap. III, která zabírá přes 30 stran). Daň za tuto důkladnost je placena tím, že vlastní funkcionální analýza začínající pojmy normovaného prostoru a topologického lineárního prostoru v kap. IV se objeví až na str. 210 a důkaz první základní funkcionálně-analytické věty (Hahnovy-Banachovy) nalezne čtenář až na str. 256 v kap. V. Nicméně se autorovi na následujících přibližně 300 stranách podařilo adekvátně vyložit nejdůležitější poznatky z Hilbertových prostorů (kap. VI), základní aplikace Baireovy věty (princip stejnoměrné ohraničenosti aj. v kap. VII), problematiku duality (kap. VIII) a materiál o prostorech spojitých lineárních zobrazeních s pojmem spektra operátoru (kap. IX). Závěrečná kap. X pojednává o Radonově, Bochnerově a Pettisově integrálu. V textu jsou zařazena cvičení (občas s návody), které někdy slouží i k doplnění základního výkladu; čtenář si na nich může ověřit své zvládnutí látky. Knihu lze doporučit k samostatnému studiu. Výklad je precisní a trpělivý čtenář nalezne v učebnici solidní poučení o probíraném předmětu.

Josef Král, Praha

David W. Kueker, Carl H. Smith (eds.): LEARNING AND GEOMETRY: COMPUTATIONAL APPROACHES. Birkhäuser Verlag, Boston 1995, xiii + 210 pages, ISBN 3-7643-3825-3 (h), DM 118,–

The book is the collection of papers presented at the *Workshop on Learning and Geometry* organized by the Institute for Systems Research of the University of Maryland together with the Center for Night Vision.

The purpose of the *Workshop*, as mentioned by the editors, was to bring together scholars in the fields of computational learning, computational geometry and related fields of science to help to solve (or at least to illuminate the possible ways to the solution of) the problem of interpreting data produced by the variety of sensors for a relevant recognition of the sensed object. Since the current vision techniques appeared unapplicable the researchers were looking for the possible solution in the usage of learning techniques in the geometric manipulation of the sensor data.

The book is divided into two parts, the first of which deals with several aspects of computational learning. The development, as well as the recent results of the essential strategies are described and directed to the learning of the identification of geometrical objects by examples. In one approach to computational learning a probability distribution on the set of data sequences is looked for using MDL (Minimum Description Length) principle. For the PAC (Probably Approximately Correct) model of concept learning the search for the Computationally Efficient Learning Algorithms is characteristic, with efficiency measured on two levels: the number of training examples needed and the amount of computing time spent.

It is also understood that some analogies exist between the formal languages and computational linguistics on the one hand and the computational learning of geometrical patterns on the other, which may provide a methodology and mathematical framework for analyzing the structures of various representations and the resulting syntactical constraints.

The second part of the book is dedicated to computational geometry, of which mainly the machine geometry theorem proving and algebraical representations of geometrical objects are referred to. Some inspiration is being drawn from the historical development of the strategy of geometrical theorem proving—from the time of Euclid until the present computer-time. Variety of recent computer techniques connected with the names of G. Collins, H. Hong, Wen-Tsün Wu and methods now known as a Characteristic Set (CS) method or a Gröbner basis (GB) method are described and illustrated on examples. Enough of the deserved attention is being paid to the problem of the choice of an appropriate representation of geometrical objects, as well as of the choice of the kind of geometry (Euclidean, affine, projective) to be represented.

Jan Troják, Praha

L. A. Sakhnovich: INTEGRAL EQUATIONS WITH DIFFERENCE KERNELS ON FINITE INTERVALS. Birkhäuser Verlag, Basel 1996, 182 pages, DM 118,–

The book is dedicated to equations of the type

$$\mu f(x) + \int_0^{\omega} k(x-t) f(t)\,\mathrm{d}t = \varphi(x),$$

where $\omega < \infty$, $k \in L(-\omega, \omega)$.

The investigations are based on the class of equations

$$Sf = \frac{\mathrm{d}}{\mathrm{d}x} \int_0^{\omega} s(x-t) f(t)\,\mathrm{d}t = \varphi(x)$$

which includes a variety of integral equations with difference kernels on finite intervals. On the basis of the so called operator identity method the inverse operator to S is constructed.

Instructive examples are given and applications (hydrodynamics, contact theory in elasticity, radiation transfer, stochastic communication theory) are presented.

Štefan Schwabik, Praha

Y. M. Berezansky, Z. G. Sheftel, G. F. Us: FUNCTIONAL ANALYSIS (VOL. I AND II). Birkhäuser Verlag, Basel 1996, xix+423 and xvi+293 pages, DM 366,–

This two-volume treatment of functional analysis is a translation from Russian of the original book wich appeared in 1990 in Kiev. The first volume starts with measure theory, measurable functions and integration theory with all necessary prerequisites as measures in product spaces, the Fubini theorem, absolute continuity, the Radon-Nikodym theorem, etc. The functional analysis itself starts in Chapter 6 with linear normed spaces, Hilbert spaces with all the usual examples of function spaces. Continuous linear functionals and dual spaces are dealt with. Linear continuous operators, compact operators and equations with compact operators form the content of Chap. 8 and 9. Spectral decomposition of compact selfadjoint operators, analytic functions of operators and the elements of the theory of distributions close the first volume of the book.

The second volume starts with the general theory of unbounded operators in Hilbert spaces. Selfadjoint operators, rigged spaces, expansion problems and differential operators are dealt with in this volume.

This comprehensive book is a good introduction into the fundamental concepts of functional analysis oriented toward applications in the equation theory. The book is based on lectures of the authors. A great amount of exercises is presented in the book. It is also a useful source of references for researchers.

Štefan Schwabik, Praha

Roman Kałuża: THROUGH A REPORTER'S EYES: THE LIFE OF STEFAN BANACH. Birkhäuser Verlag, Basel 1996, x+137 pages, DM 40,-

The original Polish version of this book appeared in 1992 on the occasion of the 100th anniversary of Banach's birth. The author of this first biography of Stefan Banach is a Polish reporter and journalist.

The life story of the one of the greatest mathematicians of the 20th century is presented in detail and in a very nice and readable form. The book is not a treatise that would be written by a historian of mathematics. Mathematics is mentioned but not analysed in the book. The main topic is Banach's life with all things around him in the first half of the 20th century in Poland and especially in Lvov. The reader is introduced to the extremely fruitful times in Polish mathematics, all the famous mathematicians around Banach are mentioned.

The book is a thorough description of the personality of S. Banach and the unusual milieu in which he worked. It fills the gap in the biographical literature of Banach, being interesting not only to mathematicians.

Štefan Schwabik, Praha

Iven Mareels, Jan Willem Polderman: ADAPTIVE SYSTEMS: AN INTRODUCTION. Birkhäuser Verlag, Basel 1996, xvii+339 pages, DM 108,-

The book presents a first introduction to the modern theory of adaptive systems. It is based on graduate courses of the authors for students with an engineering and mathematics background. The main body of the book is formed by adaptive pole placement, model reference adaptive control and the theory of universal controllers. Discrete time systems are the main topic on which the fundamental concepts of adaptive systems are presented. The book is a good introduction to the topic. It is oriented to students of engineering, based on mathematics.

Štefan Schwabik, Praha

Robert Aebi: SCHRÖDINGER DIFFUSION PROCESSES. Probability and its Applications, Birkhäuser Verlag, Basel 1996, viii+186 pages, ISBN 3-7643-5386-4, DM 98,-

In the mid-sixties, E. Nelson showed that solutions to the Schrödinger equation of quantum mechanics can be represented in terms of random processes which solve a system of stochastic differential equations with singular drift coefficients. Since then, this approach to the interplay between quantum theory and stochastic analysis developed into an independent field of research—stochastic mechanics. A different yet related view of this topic was later proposed by M. Nagasawa (cf. his treatise *Schrödinger equations and diffusion theory*, Birkhäuser Verlag, Basel 1993) who was inspired by E. Schrödinger's ideas (published already at the beginning of the thirties) on the time-reversibility of natural laws. In the book under review a wide spectrum of techniques which are useful for establishing existence and studying properties of diffusion processes that appear in the Nagasawa theory is discussed. Many of the results included are due to the author. Aebi's monograph can be used for getting acquainted with recent achievements in this promising theory; to follow the proofs, however, the reader must have a profound knowledge of various parts of the probability theory.

Jan Seidler, Praha

John C. Morgan II: POINT SET THEORY. Pure and Applied Mathematics 131, Marcel Dekker, New York 1990, viii+279 pages, ISBN 0-8247-8178-3, $ 119,50

To indicate the topic of the monograph under review, let us quote a few definitions introduced at its beginning. A *category base* is a pair $\langle X, \mathscr{C}\rangle$, where $\mathscr{C}$ is a family of subsets of X satisfying

(a) $X = \bigcup \mathscr{C}$.
(b) Let $A \in \mathscr{C}$ and $\mathscr{D} \subset \mathscr{C}$, card $\mathscr{D}$ < card $\mathscr{C}$. If $A \cap \bigcup \mathscr{D}$ contains a set in $\mathscr{C}$ then $A \cap D$ contains a set in $\mathscr{C}$ for a $D \in \mathscr{D}$. On the other hand, if $A \cap \bigcup \mathscr{D}$ contains no set in $\mathscr{C}$ then there exists $B \subset A$ such that $B \in \mathscr{C}$ and B is disjoint from every set in $\mathscr{D}$.

Given a category base $\langle X, \mathscr{C}\rangle$, we say that $A \subset X$ is a *singular* set provided any set in $\mathscr{C}$ has a subset belonging to $\mathscr{C}$ and disjoint from A. A set representable as a countable union of singular sets is called *meager*. The following two examples can be viewed as basic:

1° $X = \mathbb{R}^n$, $\mathscr{C}$ = the family of all closed rectangles;
2° $X = \mathbb{R}^n$, $\mathscr{C}$ = the family of all compacts of positive Lebesgue measure.

In the first case, singular and meager sets are nowhere dense sets and sets of the first category, respectively. In the latter case, singular sets coincide with the sets of zero Lebesgue measure.

Using the concept of the category base the author derives (and generalizes) many classical results of the theory of functions of one real variable concerning e.g. Baire sets, Bernstein sets, difference sets, etc., in a unified manner which emphasizes the analogy between the Baire category and the Lebesgue measure. The book is carefully written and according to author's preface the reader is presupposed to be familiar with the set theory and real analysis only on an undergraduate level. Formally it is probably true, nevertheless, it seems to me that both the subject and the style of presentation make this treatise useful mainly to specialists in the theory of real functions, who may also appreciate the very rich bibliography.

Jan Seidler, Praha

H. Upmeier: TOEPLITZ OPERATORS AND INDEX THEORY IN SEVERAL COMPLEX VARIABLES. Operator Theory: Advances and Applications, vol. 81, Birkhäuser, Basel 1996, 490 pages, ISBN 3-764-35282-5, ISBN 0-817-65282-5, DM 198,–

This is probably the first book to give a systematic treatment of Toeplitz operators on domains in several complex variables, the C^*-algebras they generate, and their index theory. The first chapter recalls the necessary background material from several complex variables, PDEs, and algebra (pseudoconvexity, domains of holomorphy, holomorphic faces and the Shilov boundary, $\overline{\partial}$-Neumann problem, groups of biholomorphic automorphisms, bounded symmetric domains, Jordan triple systems). In the second chapter the author introduces the Hardy and the (weighted) Bergman spaces over domains in $\mathbb{C}^n$ and establishes their basic properties—the existence and description of the reproducing (= Szegö and Bergman) kernel functions, orthogonal decompositions (Peter-Weyl), generalized Paley-Wiener theorem, etc. Chapter 3 studies the multiplier C^*-algebras and their representations. Chapter 4 constitutes the core of the book and is devoted to a systematic study of the C^*-algebras generated by Toeplitz operators, their solvability and their spectra or ideal structure; the discussion of the necessary material from grupoid C^*-algebras and Hopf C^*-algebras and coactions is also included. Using these results the final Chapter 5 treats the index theory of multivariable Toeplitz operators: after reviewing the basics of K-theory of topological spaces and C^*-algebras, the author introduces a refined generalization of the usual Fredholm index (taking values in "virtual" vector bundles) and the exposition culminates by deriving topological index formulas for these analytical Fredholm indices. In each chapter, the discussion is carried out separately for the Hardy and the Bergman cases, and special attention is paid to domains with smooth boundary or with a sufficiently rich automorphism group, for which our understanding is at present most complete: the strictly pseudoconvex domains, tubular domains and Siegel domains, polycircular (= Rienhardt) domains, bounded symmetric (Cartan) domains, and K-circular and S-bicircular domains (generalizations which contain both Reinhardt and bounded symmetric domains as special cases).

The exposition is very lucid and well written. The prerequisites for studying the book are a basic knowledge of Hilbert space operator theory, elementary theory of C^*-algebras, and some familiarity with complex analysis; all necessary additional material is carefully reviewed prior to its usage in order to make the book self-contained. Some background in algebraic topology and K-theory and the basics of C^*-algebra extensions will be helpful for reading the final chapter, though. The book will be a basic monograph for those working actively in multivariable Toeplitz operators, and can just as well be recommended as a good reading to any other analyst interested in this area.

Miroslav Engliš, Praha

Yuri Egorov, Vladimir Kondratiev: ON SPECTRAL THEORY OF ELLIPTIC OPERATORS. Operator Theory: Advances and Applications, Birkhäuser Verlag, Basel 1996, 340 pages, DM 188,–

The book is devoted to the investigation of some classical problems in the spectral theory for elliptic differential equations, its main subjects being estimates of eigenvalues and of eigenfunctions of elliptic operators.

The book is organized in two parts. The first part is meant as an introduction to the topics and describes the basic theory of Hilbert spaces, the theory of Lebesgue and Sobolev spaces, the classical theory of elliptic equations, and the spectral theory. This part consists of the following chapters: Hilbert Spaces, Function Spaces, Elliptic Operators, Spectral Properties of Elliptic Operators. The second part is devoted to the Sturm-Liouville problem, to eingenfunctions of elliptic operators in bounded domains and to negative spectra of elliptic operators, and consists mainly of the authors' results from the last two decades. Some of the results are published here for the first time in English. This part consists of the following chapters: The Sturm-Liouville Problem, Differential Operators of Any Order, Eigenfunctions of Elliptic Operators in Bounded Domains, Negative Spectra of Elliptic Operators.

The book is written in a very clear and lucid way and can be used by specialists as well as by students.

Jan Lang, Praha