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Book Reviews

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BOOK REVIEWS

COMBINATORIAL GEOMETRIES. (Ed.: Neil White). Cambridge University Press, Cambridge 1987, stran 212.

Tato kniha je druhým ze sborníků třísvazkové série článků předních expertů shrnujících základní pojmy a výsledky teorie kombinatorických geometrií (matroidů). Sborník uvádí série tří článků a reprezentovatelnosti kombinatorických geometrií ve vektorových prostorech. Další kapitoly jsou o teorii párování, transversálních a simpliciálních matroidech. Další dvě kapitoly jsou o matroidových invariantech, Möbiově funkci, charakteristických polynomech a Whitneyho číslech. Závěrečná kapitola se zabývá souvislostmi teorie matroidů s kombinatorickou optimalizací.

Jiří Tůma

Matyás Bognár: FOUNDATIONS OF LINKING THEORY. Akadémiai Kiadó, Budapest 1992, 164 stran, cena 20,– USD.

Tato monografie je věnována axiomatické teorii uzlů libovolné konečné dimenze (s více komponentami souvislosti). Celá teorie je budována na základě axiomatické teorie homologií vytvořené S. Eilenbergem a N. Steenrodem.

Jiří Tůma

Michael I. Gil: NORM ESTIMATIONS FOR OPERATOR-VALUED FUNCTIONS AND APPLICATIONS. (Pure and Applied Mathematics: A Series of Monographs and Textbooks, vol. 192.) Marcel Dekker, New York-Basel-Hong Kong, 1995. Hardback, 376 pages, $ 140.

For a normal operator A and a complex number λ, the norm of $(\lambda - A)^{-1}$ is equal to the reciprocal of the distance $d(\lambda, A)$ of λ from the spectrum of A. For nonnormal operators, the situation is much more delicate—as a rule, the norm of the resolvent usually grows more rapidly near the spectrum; two classical upper estimates for the norm $\|(\lambda - A)^{-1}\|$, dating back to 1950's and 1930's, respectively, are due to Gelfand-Shilov and Carleman. These estimates, however, are rather coarse—in particular, they are never attained, even for normal operators. The central topic of the book under review is establishing sharp upper bounds for $\|(\lambda - A)^{-1}\|$, usually in the form of an infinite series in powers of $g(A)/d(\lambda, A)$; here $g(A)$ is a certain quantity which measures how much A deviates from being a normal operator, and the coefficients of the series depend only on the dimension of the underlying space. Most of the material are the results obtained by the author during his extensive many years' systematic work on the subject. As far as the reviewer knows, this is the first time they appear in a book form.

The heart of the book are the first three chapters, where the basic norm estimates are established, first in the finite-dimensional case (matrices), then for compact operators in infinite-dimensional spaces, and for certain classes of noncompact operators as well (operators admitting a triangular representation, certain quasi-hermitian operators, etc.). As corollaries the author obtains e.g. some interesting generalizations of classical Schur's and Brown's inequalities for eigenvalues of matrices, or representations of the resolvent of

an operator as a multiplicative integral. The results are then applied to the perturbation theory of spectra of matrices and operators (Chapters 4–5) and to operators on tensor products of Hilbert spaces (Chapter 6). The second half of the book is devoted to applications, mostly to problems of stability of solutions of integral and differential equations (nonlinear systems of ODE's, Volterra equations, retarded systems, semilinear boundary value problems).

In the reviewer's opinion, the book provides valuable new working tools and is well worth reading for anyone seriously interested in the area of the theory of matrices or operator theory.

Miroslav Engliš

ALGEBRA. PROCEEDINGS OF THE IIIRD INTERNATIONAL CONFERENCE ON ALGEBRA HELD IN KRASNOYARSK, AUGUST 23–28, 1993. (Ed: Yu.L. Ershov, E.I. Knukhro, V.M. Levchuk, N.D. Podutalov). Walter de Gruyter, Berlin, New York, 1996, str. 302.

Sborník obsahuje výběr třiceti přednášek, které tvoří representativní ukázku současných směrů vývoje algebry v zemích bývalého Sovětského svazu. Seznam řečníků naznačuje, že do dnešní doby nebyla smazána velká vzdálenost mezi Sibiří a ostatním světem. S výjimkou sedmi řečníků působí všichni na území bývalého Sovětského svazu. Přes ztížené ekonomické a technické podmínky však je tradičně dosahováno špičkových vědeckých výsledků, o čemž svědčí světový věhlas některých účastníků. Z pěti sekcí, do nichž byla konference rozdělena, jsou ve sborníku zastoupeny zejména konečné grafy, nekonečné grafy a teorie okruhů.

Sborník by neměl chybět v žádné matematické knihovně a může sloužit zdrojem inspirace pro všechny odborníky v oboru obecné algebry.

Zdeněk Vavřín

Gregory F. Lawler: INTERSECTIONS OF RANDOM WALKS. Probability and Its Applications, Birkhäuser, Boston 1996, 226 pages, ISBN 3–7643–3892–X, price DM 68,–.

A random walk on a discrete lattice $\mathbb{Z}^d$ is one of the most basic models in the probability theory; several important problems in statistical physics and chemistry (e.g. in polymer physics) has lead to the investigation of non-intersection properties of sample paths of random walks. G. F. Lawler contributed considerably to this field of research and his monograph, that was first issued in 1991 and now appears in a corrected paperback edition, presents an in-depth survey of many topics in the mathematical theory of non-intersection phenomena for random walks, being, at the same time, accessible to graduate students.

Let us describe briefly the contents of the book. The first chapter is preparatory, including the facts about the simple random walk that will be needed later (the local central limit theorem, discrete harmonic functions, etc.). The next chapter is devoted to harmonic measures, that is, roughly speaking, to the problem of non-intersection of a fixed set with a random walk "starting at infinity". In the last section of the chapter, a growth model called diffusion limited aggregation is treated. In Chapters 3–5, the asymptotic behaviour of probabilities that paths of several independent random walks do not intersect is studied. The results are dimension-dependent, and, in particular, Chapter 4 is devoted to the case of two walks in four dimensions (or three walks in three dimensions), while the following chapter is about the intersection probability in dimensions two and three.

Further, several models of self-avoiding random walks (i.e., random walks conditioned to have no or few self-intersections) are discussed in a non-rigorous manner. One of this

models, the Laplacian (or loop-erased) self-avoiding random walk is then analysed in detail (and rigorously) in the last, seventh chapter.

Bohdan Maslowski

Andrei N. Borodin, Paavo Salminen: HANDBOOK OF BROWNIAN MOTION—FACTS AND FORMULAE. Probability and Its Applications, Birkhäuser, Basel 1996, xiv+462 pages, ISBN 3-7643-5463-1, price DM 168,–.

The book under review has a rather unusual structure. The first one hundred and twenty pages are devoted to a synopsis of definitions and results concerning stochastic processes and stochastic calculus with a particular emphasis on one-dimensional diffusions and their local times. No proofs are given, being replaced with references to standard sources. In the rest of the book, more than 1550 formulae are listed, providing explicit expressions for expectations or distributions of various functionals of Brownian motion and related processes. More precisely, the following seven processes are discussed: Brownian motion, Brownian motion with a drift, reflecting Brownian motion, two- and three-dimensional Bessel process, Bessel process of a general order $\nu > 0$, and the Ornstein-Uhlenbeck process. For each of these processes, 28 functionals, like e.g.

$$\sup_{0\leqslant s\leqslant t} X_s, \quad \int_0^T (p\mathbf{1}_{(-\infty,r)}(X_s) + q\mathbf{1}_{[r,\infty)}(X_s))\,\mathrm{d}s, \quad \inf\{t\colon X_t = z\},$$

and four types of stopping (exponential stopping, stopping at the first hitting time, at the first exit time and at the inverse local time) are considered. Obviously, no proofs of the formulae are contained in the book, but some references are given and the general strategy of obtaining these identities based on the Feynman-Kac formula is sketched.

Bohdan Maslowski

Iven Mareels, Jan Willem Polderman: ADAPTIVE SYSTEMS: AN INTRODUCTION. Systems & Control: Foundations & Applications, Birkhäuser, Boston 1996, xvii + 339 pages, ISBN 0–8176–3877–6, price DM 108,–.

Roughly speaking, adaptive systems are control systems that are able to adapt to changing environmental conditions; e.g. adaptive controllers are capable of adjusting themselves to changing values of parameters (which are unknown and are to be identified). The book under review is intended as a text providing a first introduction to the theory of (deterministic) adaptive systems to readers with only basic knowledge of linear algebra and multivariable calculus (hence including readers with an engineering background).

The first chapters of the book are preparatory, being devoted to the representation of linear deterministic systems (in the so called behavioral approach) and to identification algorithms. In Chapters 4 to 6, the fundamental procedures of the theory of adaptive systems are treated: adaptive pole placements, model reference adaptive control, and the theory of universal controllers. With the exception of the last topic, only discrete time systems are considered. In the last three chapters, more refined problems and techniques are discussed: the pole/zero cancellation problem, averaging analysis, and the global dynamics of adaptive systems. All chapters are amended with exercises; additional exercises are provided by the authors on the Web.

Bohdan Maslowski

Amália Iványi: HYSTERESIS MODELS IN ELECTROMAGNETIC COMPUTATION. Akadémiai Kiadó, Budapest 1997; pp. 229.

Theory of various electromagnetic systems, which was till recently limited to linear systems, has lately been successfully developed for even the nonlinear ones. But in practice the solution of systems with elements that show nonlinearities with magnetic hysteresis occur only rarely. The theme of the reviewed book is thus very relevant: It represents a sophisticated survey of various models of hysteresis and their critical analysis.

The book is divided into two parts. In the first theory of various hysteresis models of magnetic materials is given and in the second part some of their applications to the solution of the electromagnetic field are presented.

In the short preface the history of hysteresis models is described, including their main authors. The first chapter describes the physical explanation of hysteresis from the point of view of contemporary theory of ferromagnetics. The following chapters are devoted to particular types of hysteresis models. One separate chapter is devoted to analytical models. The Rayleigh model, that is probably one of the oldest analytical models, is presented there along with other, more simple hysteresis models (e.g. rectangular hysteresis, parallelogram representation of hysteresis loop, so called method of auxiliary function etc.) and a survey of ways of mathematical approximation of anhysteristic magnetisation curve (e.g. approximation by power series, the Frohlich model etc.). The following chapter deals with dynamic models, respecting the influence of the time rate of the applied field on the magnetisation process—the Duhem model and the Hodgdon model are explained. It follows the investigation of mathematic models of magnetisation of characteristics, based on the micro structures of the materials. They originate in Langevin theory of paramagnetism complemented with Weiss correction for ferromagnetic materials. Further on the Jiles model for ferromagnetic hysteresis is presented and some other models. The separate and important chapter is devoted to Preisach hysteresis models. It starts with the classical Preisach model and goes on with the generalized Preisach model for reversible and irreversible magnetization. These Preisach models that simulate the static hysteresis characteristics are further generalized on the dynamic Preisach model and later on the vector Preisach model of hysteresis. In conclusion the application of the Preisach models to the solution of the magnetic field of hysteresis motor by finite element method is given. In the following chapter the readers get acquainted with less common hysteresis models, like e.g. the Stoner-Wohlfarth model, that enables an easy representation of the anisotropy or the Chua-type models, developed for application in the electric circuit theory.

In the application part of this book several problems are solved by which the usefulness of described methods is demonstrated. Hysteresis losses in oriented lamination, magnetic shielding of the single phase conductors as well as magnetic shielding of the three phase conductors and also the anisotropic magnetic materials and their behaviour under the rotational magnetic field are discussed there.

The book is completed with a very comprehensive list of references, totalling 321 items.

The high value of the reviewed book lies above all in the fact that it provides the reader with a very wide variety of information about the hysteresis modelling. The discussed matter is intelectually mature and exactly formulated. The understandable form of writing, ideal width and depth of the compilation of the chapters and also the perfect lay-out contribute to this comprehensibility. In my opinion the reviewed book is so far the only work dealing with the given topic in the world literature. Presumably it will become a popular aid for the wide range of applied mathematicians and technicians who are active in the theory of systems with magnetic hysteresis.

Daniel Mayer

A. M. Khludnev, J. Sokolowski: MODELLING AND CONTROL IN SOLID MECHANICS. Internat. Series of Numerical Mathematics, Vol. 122, Birkhäuser, 1997, Basel. 366 pp., 178 DM

A more suitable title of this monograph could be: Variational inequalities and optimal design of beams, plates and shells. It is a successful work of two prominent mathematicians about topical unilateral problems from the technical theory of elasticity and plasticity. The authors consider always linear stress-strain relations and both small and finite strain tensors. The book has five chapters: the first contains a survey of mathematical tools of functional and convex analysis, the second is devoted to contact problems in elasticity, the third to variational inequalities in plasticity, the fourth to the optimal design for some problems of the preceding chapters and the fifth to the sensitivity analysis for problems of the fourth chapter.

The unilateral contact problems concern mostly inner obstacles (punches), but also e.g. unilateral cracks in a plate.

Two models of the theory of plasticity are treated: the Hencky model and the flow model with a perfectly plastic domain.

The existence of a solution is proved for all problems considered and regularity questions are discussed also in the second chapter. The authors use modern mathematical tools such as the Korn's inequality in L_1-norm, the space BD of bounded deformations, the directional differentiability of metric projections, material derivatives etc.

The authors do not present any derivation of mathematical models. They restrict themselves to a brief description of quantities and relations. Therefore, the readers would appreciate at least referring to the literature, which is very rare in the whole book, however. One should also point out, that most of the papers of the first author have been published in Russian and these results appear here in English first time, obviously. Although the list of references has more than 200 titles, I miss there some important papers and monographs, published both in English and Russian. The reader will not find in the book also e.g. approximate solutions of the problems under consideration, semicoercive problems and contact problems with friction. I don't like, that the optimization of the plate thickness is formulated irrespective of the validity of the Kirchhoff model only for mildly variable thickness. The cost functional in optimal design is defined mostly as a distance in L_2-norm from a given function.

In spite of all these minor reproaches, I believe that the book will be useful for postgraduates, scientists and research workers, who have already appropriated sufficient mathematical background.

Ivan Hlaváček

R.P. Kanwal: LINEAR INTEGRAL EQUATIONS. Birkhäuser Verlag Basel 1996, 328 p., sFr. 124.–

The book represents a nice introductory text for linear integral equations at the level of a beginning graduate course.

After an introductory chapter concerning classification and basic concepts integral equations with separable kernels, methods of solving by successive approximation and the classical Fredholm theory are presented.

This is followed by some classical applications to ordinary and partial differential equations (boundary value problems, Green's functions, representation for the solution of the Laplace and Poisson equations, Helmholtz equation, ...).

Equations with symmetric kernel are described, singular integral equations with various types of the kernel are presented.

The method of integral transform is described and some other interesting applications are presented at the end of the book.

This volume presents the basics of linear integral equations theory in a very comprehensive way. The most valuable part of the book is in its richness in examples and applications. This makes the book extremely useful for teachers and also researchers using techniques of integral equations.

Štefan Schwabik

M. Willem: MINIMAX THEOREMS. Birkhäuser Verlag Basel 1996, 176 p., sFr. 78.–

Some interesting boundary value problems for partial differential equations can be written in the abstract form

$$Au = 0$$

with a mapping $A : X \to Y$ where X and Y are Banach spaces. In the case of a variational problem there is a differentiable $\varphi : X \to \mathbb{R}$ such that the original problem can be written in the form $\varphi'(u) = 0$. A critical point of φ is a solution of this equation and conversely the value of φ at a solution of $\varphi'(u) = 0$ is a critical value of φ. The problem therefore is to find critical values of φ.

The present book is devoted to techniques of finding critical values. In a nicely presented unified way the author describes various aspects of minimax theorems and gives many important applications of this field of nonlinear functional analysis.

Basic knowledge of Sobolev spaces, partial differential equations and functional analysis is required. The book can serve for lectures on partial differential equations at an advanced level and it will surely represent a relevant source book for scientists working in the field of variational techniques used in the theory of partial differential equations.

Štefan Schwabik