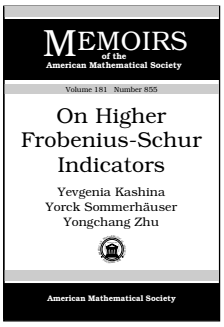
New Publications Offered by the AMS

Algebra and Algebraic Geometry



On Higher Frobenius-Schur Indicators

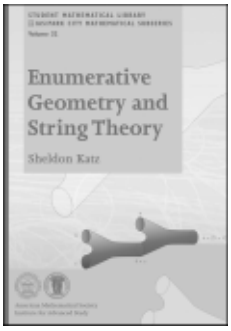
Yevgenia Kashina, *DePaul University, Chicago, IL*, **Yorck Sommerhäuser**, *Universität München, Munich, Germany*, and **Yongchang Zhu**, *Hong Kong University of Science and Technology, Kowloon, Hong Kong*

Contents: Introduction; The calculus of Sweedler powers; Frobenius-Schur indicators; The exponent; The order; The index; The Drinfel'd double; Examples; Bibliography; Subject index; Symbol index.

Memoirs of the American Mathematical Society, Volume 181, Number 855

April 2006, 65 pages, Softcover, ISBN 0-8218-3886-5, LC 2006040679, 2000 *Mathematics Subject Classification*: 16W30; 17B35, **Individual member US$30**, List US$50, Institutional member US$40, Order code MEMO/181/855

COURSE ADOPTION



Enumerative Geometry and String Theory

Sheldon Katz

Perhaps the most famous example of how ideas from modern physics have revolutionized mathematics is the way string theory has led to an overhaul of enumerative geometry, an area of mathematics that started in the eighteen hundreds. Century-old problems of enumerating geometric configurations have now been solved using new and deep mathematical techniques inspired by physics!

The book begins with an insightful introduction to enumerative geometry. From there, the goal becomes explaining the more advanced elements of enumerative algebraic geometry. Along the way, there are some crash courses on intermediate topics which are essential tools for the student of modern mathematics, such as cohomology and other topics in geometry.

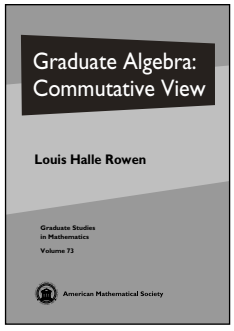
The physics content assumes nothing beyond a first undergraduate course. The focus is on explaining the action principle in physics, the idea of string theory, and how these directly lead to questions in geometry. Once these topics are in place, the connection between physics and enumerative geometry is made with the introduction of topological quantum field theory and quantum cohomology.

Contents: Warming up to enumerative geometry; Enumerative geometry in the projective plane; Stable maps and enumerative geometry; Crash course in topology and manifolds; Crash course in C^∞ manifolds and cohomology; Cellular decompositions and line bundles; Enumerative geometry of lines; Excess intersection; Rational curves on the quintic threefold; Mechanics; Introduction to supersymmetry; Introduction to string theory; Topological quantum field theory; Quantum cohomology and enumerative geometry; Bibliography; Index.

Student Mathematical Library, Volume 32

May 2006, approximately 215 pages, Softcover, ISBN 0-8218-3687-0, 2000 *Mathematics Subject Classification*: 14N10, **All AMS members US$28**, List US$35, Order code STML/32

COURSE ADOPTION



Graduate Algebra: Commutative View

Louis Halle Rowen

This book is an expanded text for a graduate course in commutative algebra, focusing on the algebraic underpinnings of algebraic geometry and of number theory. Accordingly, the theory of affine algebras is featured, treated both directly and via the theory of Noetherian and Artinian modules, and the theory of graded algebras is included to

provide the foundation for projective varieties. Major topics include the theory of modules over a principal ideal domain, and its applications to matrix theory (including the Jordan decomposition), the Galois theory of field extensions, transcendence degree, the prime spectrum of an algebra, localization, and the classical theory of Noetherian and Artinian rings. Later chapters include some algebraic theory of elliptic curves (featuring the Mordell-Weil theorem) and valuation theory, including local fields.

One feature of the book is an extension of the text through a series of appendices. This permits the inclusion of more advanced material, such as transcendental field extensions, the discriminant and resultant, the theory of Dedekind domains, and basic theorems of rings of algebraic integers. An extended appendix on derivations includes the Jacobian conjecture and Makar-Limanov's theory of locally nilpotent derivations. Gröbner bases can be found in another appendix.

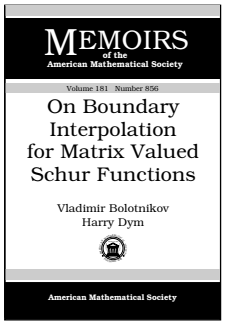
Exercises provide a further extension of the text. The book can be used both as a textbook and as a reference source.

Contents: Introduction and prerequisites; Exercises–Chapter 0; *Part I. Modules:* Introduction to modules and their structure theory; Finitely generated modules; Simple modules and composition series; Exercises–Part I; *Part II. Affine algebras and Noetherian rings:* Part II. Introduction; Galois theory of fields; Algebras and affine fields; Transcendence degree and the Krull dimension of a ring; Modules and rings satisfying chain conditions; Localization and the prime spectrum; The Krull dimension theory of commutative Noetherian rings; Exercises–Part II; *Part III. Applications to geometry and number theory:* Part III. Introduction; The algebraic foundations of geometry; Applications to algebraic geometry over the rationals — Diophantine equations and elliptic curves; Absolute values and valuation rings; Exercises–Part III; References; Index.

Graduate Studies in Mathematics, Volume 73

May 2006, approximately 399 pages, Hardcover, ISBN 0-8218-0570-3, 2000 *Mathematics Subject Classification*: 28–XX; 26–XX, 31–XX, 42–XX, 46–XX, 49–XX, 81–XX, **All AMS members US$52**, List US$65, Order code GSM/73

Analysis



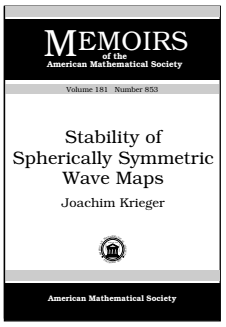
On Boundary Interpolation for Matrix Valued Schur Functions

Vladimir Bolotnikov, *The College of William and Mary, Williamsburg, VA*, and **Harry Dym**, *Weizmann Institute of Science, Rehovot, Israel*

Contents: Introduction; Preliminaries; Fundamental matrix inequalities; On $\mathcal{H}(\Omega)$ spaces; Parametrizations of all solutions; The equality case; Nontangential limits; The Nevanlinna-Pick boundary problem; A multiple analogue of the Carathéodory-Julia theorem; On the solvability of a Stein equation; Positive definite solutions of the Stein equation; A Carathéodory-Fejér boundary problem; The full matrix Carathéodory-Fejér boundary problem; The lossless inverse scattering problem; Bibliography.

Memoirs of the American Mathematical Society, Volume 181, Number 856

April 2006, 107 pages, Softcover, ISBN 0-8218-4047-9, LC 2006040674, 2000 *Mathematics Subject Classification*: 30E05, 47A57, **Individual member US$35**, List US$59, Institutional member US$47, Order code MEMO/181/856



Stability of Spherically Symmetric Wave Maps

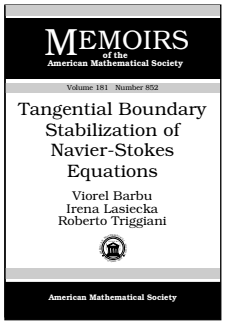
Joachim Krieger, *Harvard University, Cambridge, MA*

Contents: Introduction, controlling spherically symmetric wave maps; Technical preliminaries. Proofs of main theorems; The proof of Proposition 2.2; Proof of theorem 2.3; Bibliography.

Memoirs of the American Mathematical Society, Volume 181, Number 853

April 2006, 80 pages, Softcover, ISBN 0-8218-3877-6, LC 2006040673, 2000 *Mathematics Subject Classification*: 35L05, 35L70, **Individual member US$33**, List US$55, Institutional member US$44, Order code MEMO/181/853

Differential Equations



Tangential Boundary Stabilization of Navier-Stokes Equations

Viorel Barbu and **Irena Lasiecka**, *University of Virginia, Charlottesville, VA*, and **Roberto Triggiani**

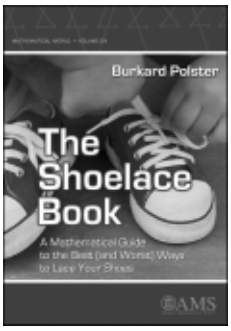
Contents: Introduction; Main results; Proof of Theorems 2.1 and 2.2 on the linearized system (2.4): $d = 3$; Boundary feedback uniform stabilization of the linearized system (3.1.4) via an optimal control problem and corresponding Riccati theory. Case $d = 3$;

Theorem 2.3(i): Well-posedness of the Navier-Stokes equations with Riccati-based boundary feedback control. Case $d = 3$; Theorem 2.3(ii): Local uniform stability of the Navier-Stokes equations with Riccati-based boundary feedback control; A PDE-interpretation of the abstract results in Sections 5 and 6; Appendix A. Technical material complementing Section 3.1; Appendix B. Boundary feedback stabilization with arbitrarily small support of the linearized system (3.1.4a) at the $(H^{\frac{3}{2}-\epsilon}(\Omega))^d \cap H$-level, with I.C. $y^0 \in (H^{\frac{1}{2}-\epsilon}(\Omega))^d \cap H$. Cases $d = 2, 3$. Theorem 2.5 for $d = 2$; Appendix C. Equivalence between unstable and stable versions of the optimal control problem of Section 4; Appendix D. Proof that $FS(\cdot) \in \mathcal{L}(W; L^2(0, \infty; (L^2(\Gamma))^d)$; Bibliography.

Memoirs of the American Mathematical Society, Volume 181, Number 852

April 2006, 128 pages, Softcover, ISBN 0-8218-3874-1, LC 2006040678, 2000 *Mathematics Subject Classification*: 76D05, 35B40, 35Q30, **Individual member US$36**, List US$60, Institutional member US$48, Order code MEMO/181/852

Discrete Mathematics and Combinatorics



The Shoelace Book

A Mathematical Guide to the Best (and Worst) Ways to Lace Your Shoes

Burkard Polster, *Monash University, Clayton, Vic, Australia*

Crisscross, zigzag, bowtie, devil, angel, or star: which are the longest, the shortest, the strongest, and the weakest lacings? Pondering the mathematics of shoelaces, the author paints a vivid picture of the simple, beautiful, and surprising characterizations of the most common shoelace patterns. The mathematics involved is an attractive mix of combinatorics and elementary calculus. This book will be enjoyed by mathematically minded people for as long as there are shoes to lace.

Burkard Polster is a well-known mathematical juggler, magician, origami expert, bubble-master, shoelace charmer, and "Count von Count" impersonator. His previous books include *A Geometrical Picture Book*, *The Mathematics of Juggling*, and *QED: Beauty in Mathematical Proof*.

This item will also be of interest to those working in general and interdisciplinary areas.

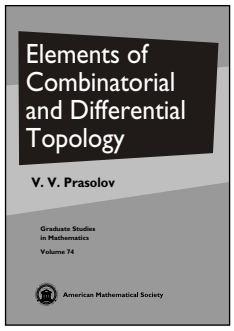
Contents: Setting the stage; One-column lacings; Counting lacings; The shortest lacings; Variations on the shortest lacing problem; The longest lacings; The strongest lacings; The weakest lacings; Related mathematics; Loose ends; References; Index.

Mathematical World, Volume 24

June 2006, 125 pages, Softcover, ISBN 0-8218-3933-0, LC 2006040733, 2000 *Mathematics Subject Classification*: 00A05, 90C27, 05A15, **All AMS members US$23**, List US$29, Order code MAWRLD/24

Geometry and Topology

COURSE ADOPTION



Elements of Combinatorial and Differential Topology

V. V. Prasolov, *Independent University of Moscow, Russia*

Modern topology uses very diverse methods. This book is devoted largely to methods of combinatorial topology, which reduce the study of topological spaces to investigations of their partitions into elementary sets, and to methods of differential topology, which deal with smooth manifolds and smooth maps. Many topological problems can be solved by using either of these two kinds of methods, combinatorial or differential. In such cases, both approaches are discussed.

One of the main goals of this book is to advance as far as possible in the study of the properties of topological spaces (especially manifolds) without employing complicated techniques. This distinguishes it from the majority of other books on topology.

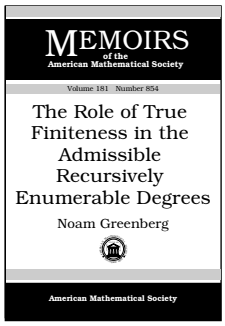
The book contains many problems; almost all of them are supplied with hints or complete solutions.

Contents: Graphs; Topology in Euclidean space; Topological spaces; Two-dimensional surfaces, coverings, bundles, and homotopy groups; Manifolds; Fundamental groups; Hints and solutions; Bibliography; Index.

Graduate Studies in Mathematics, Volume 74

July 2006, approximately 342 pages, Hardcover, ISBN 0-8218-3809-1, 2000 *Mathematics Subject Classification*: 57–01; 57Mxx, 57Rxx, **All AMS members US$47**, List US$59, Order code GSM/74

Logic and Foundations



The Role of True Finiteness in the Admissible Recursively Enumerable Degrees

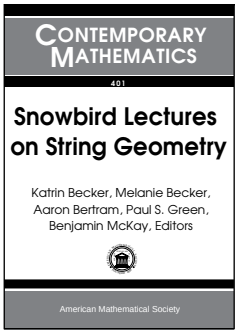
Noam Greenberg, *University of Notre Dame, IN*

Contents: Introduction; Coding into the R. E. degrees; Coding effective successor models; A negative result concerning effective successor models; A nonembedding result; Embedding the 1-3-1 lattice; Appendix A. Basics; Appendix B. The jump; Appendix C. The projectum; Appendix D. The admissible collapse; Appendix E. Prompt permission; Appendix. Bibliography.

Memoirs of the American Mathematical Society, Volume 181, Number 854

April 2006, 99 pages, Softcover, ISBN 0-8218-3885-7, LC 2006040677, 2000 *Mathematics Subject Classification*: 03D60; 03D25, 03D30, **Individual member US$35**, List US$58, Institutional member US$46, Order code MEMO/181/854

Mathematical Physics



Snowbird Lectures on String Geometry

Katrin Becker, **Melanie Becker**, **Aaron Bertram**, **Paul S. Green**, and **Benjamin McKay**, Editors

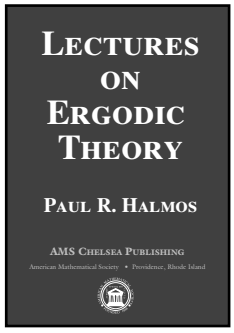
The interaction and cross-fertilization of mathematics and physics is ubiquitous in the history of both disciplines. In particular, the recent developments of string theory have led to some relatively new areas of common interest among mathematicians and physicists, some of which are explored in the papers in this volume. These papers provide a reasonably comprehensive sampling of the potential for fruitful interaction between mathematicians and physicists that exists as a result of string theory.

Contents: P. S. Aspinwall, D-branes, Π-stability and θ-stability; **K. Becker**, **M. Becker**, **K. Dasgupta**, and **R. Tatar**, Geometric transitions, non-Kahler geometries and string vacua; **L. A. Borisov** and **R. P. Horja**, On the K-theory of smooth toric DM stacks; **S. Katz**, Gromov-Witten, Gopakumar-Vafa, and Donaldson-Thomas invariants of Calabi-Yau threefolds; **A. Krause**, Flux compactification geometries and de Sitter vacua in M-theory; **R. Roiban**, $N = 4$ super-Yang-Mills theory and integrable spin chains; **R. Roiban**, **M. Spradlin**, and **A. Volovich**, Yang-Mills amplitudes from twistor string theory; **E. Sharpe**, Notes on correlation functions in (0,2) theories.

Contemporary Mathematics, Volume 401

May 2006, 104 pages, Softcover, ISBN 0-8218-3663-3, LC 2005058917, 2000 *Mathematics Subject Classification*: 14D22, 14F05, 14N10, 14N35, 14Q05, 18E30, 53C80, 81Q30, 81Q60, 81Q70, 81T13, 81T45, 81T30, 81T60, **All AMS members US$31**, List US$39, Order code CONM/401

Number Theory



Lectures on Ergodic Theory

Paul Halmos, *Santa Clara University, Santa Clara, CA*

This classic book is based on lectures given by the author at the University of Chicago in 1956. The topics covered include, in particular, recurrence, the ergodic theorems, and a general discussion of ergodicity and mixing properties. There is also a general discussion of the relation between conjugacy and equivalence. With minimal prerequisites of some analysis and measure theory, this work can be used for a one-semester course in ergodic theory or for self-study.

Contents: Introduction; Examples; Recurrence; Mean convergence; Pointwise convergence; Comments on the ergodic theorem; Ergodicity; Consequences of ergodicity; Mixing; Measure algebras; Discrete spectrum; Automorphisms of compact groups; Generalized proper values; Weak topology; Weak approximation; Uniform topology; Uniform approximation; Category; Invariant measures; Invariant measures: the solution; Invariant measures: the problem; Generalized ergodic theorems; Unsolved problems; References.

AMS Chelsea Publishing

April 2006, 99 pages, Hardcover, ISBN 0-8218-4125-4, LC 60-8964, 2000 *Mathematics Subject Classification*: 37–XX, **All AMS members US$23**, List US$25, Order code CHEL/142.H

New AMS-Distributed Publications

Algebra and Algebraic Geometry

One Semester of Elliptic Curves

Torsten Ekedahl, *University of Stockholm, Sweden*

These lecture notes grew out of a one semester introductory course on elliptic curves given to an audience of computer science and mathematics students, and assume only minimal background knowledge. After having covered basic analytic and algebraic aspects, putting special emphasis on explaining the interplay between algebraic and analytic formulas, they go on to some more specialized topics. These include the *j*-function from an algebraic and analytic perspective, a discussion of elliptic curves over finite fields, derivation of recursion formulas for the division polynomials, the algebraic structure of the torsion points of an elliptic curve, complex multiplication, and modular forms.

In an effort to motivate basic problems the book starts very slowly, but considers some aspects such as modular forms of higher level which are not usually treated. It presents more than 100 exercises and a Mathematica™ notebook that treats a number of calculations involving elliptic curves.

The book is aimed at students of mathematics with a general interest in elliptic curves but also at students of computer science interested in their cryptographic aspects.

A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: Elliptic integrals; Elliptic curves; Elliptic functions; A projective interlude; The group structure on an elliptic curve; Equivalence; Formulaire; Finite fields; Division polynomials; Torsion points; Lattice inclusions; Modular forms; Hints to exercises; Solutions to exercises.

ESI Lectures in Mathematics and Physics

March 2006, 140 pages, Softcover, ISBN 3-03719-015-9, 2000 *Mathematics Subject Classification*: 14K25, **All AMS members US$30**, List US$38, Order code EMSSERLEC/2

Locally Compact Groups

Markus Stroppel, *University of Stuttgart, Germany*

Locally compact groups play an important role in many areas of mathematics as well as in physics. The class of locally compact groups admits a strong structure theory, which allows to reduce many problems to groups constructed in various ways from the additive group of real numbers, the classical linear groups and from finite groups. The book gives a systematic and detailed introduction to the highlights of that theory.

In the beginning, a review of fundamental tools from topology and the elementary theory of topological groups and transformation groups is presented. Completions, Haar integral, applications to linear representations culminating in the Peter-Weyl Theorem are treated. Pontryagin duality for locally compact Abelian groups forms a central topic of the book. Applications are given, including results about the structure of locally compact Abelian groups, and a structure theory for locally compact rings leading to the classification of locally compact fields. Topological semigroups are discussed in a separate chapter, with special attention to their relations to groups. The last chapter reviews results related to Hilbert's Fifth Problem, with the focus on structural results for non-Abelian connected locally compact groups that can be derived using approximation by Lie groups.

The book is self-contained and is addressed to advanced undergraduate or graduate students in mathematics or physics. It can be used for one-semester courses on topological groups, on locally compact Abelian groups, or on topological algebra. Suggestions on course design are given in the preface. Each chapter is accompanied by a set of exercises that have been tested in classes.

A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: Preliminaries; Topological groups; Topological transformation groups; The Haar integral; Categories of topological groups; Locally compact Abelian groups; Locally compact semigroups; Hilbert's fifth problem; Bibliography; Index of symbols; Subject index.

EMS Textbooks in Mathematics

February 2006, 312 pages, Hardcover, ISBN 3-03719-016-7, 2000 *Mathematics Subject Classification*: 22D05, 22–01, 20E18, 22A25, 22B05, 22C05, 22D10, 22D45, 22F05, 12J10, 43A05, 54H15, 22A15, **All AMS members US$46**, List US$58, Order code EMSTEXT/3

Differential Equations

Dynamics on the Riemann Sphere

A Bodil Branner Festschrift

Poul Hjorth, *Technical University of Denmark, Lyngby, Denmark*, and **Carsten Lunde Petersen**, *Roskilde University, Denmark*, Editors

Dynamics on the Riemann Sphere presents a collection of original research articles by leading experts in the area of holomorphic dynamics. These papers arose from the symposium *Dynamics in the Complex Plane*, held on the occasion of the 60th birthday of Bodil Branner. Topics covered range from Lattès maps to cubic polynomials over rational maps with Sierpinsky Carpets and Gaskets as Julia sets, as well as rational and entire transcendental maps with Herman rings.

This item will also be of interest to those working in analysis.

A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: J. Milnor, On Lattès maps; **C. L. Petersen** and **T. Lei**, Branner-Hubbard motions and attracting dynamics; **A. Avila** and **M. Lyubich**, Examples of Feigenbaum Julia sets with small Hausdorff dimension; **A. Che'ritat**, Parabolic explosion and the size of Siegel disks in the quadratic family; **P. Blanchard**, **R. L. Devaney**, **D. M. Look**, **M. Rocha**, **P. Seal**, **S. Siegmund**, and **D. Uminsky**, Sierpinski carpets and gaskets as Julia sets of rational maps; **P. Roesch**, On capture zones for the family $f(z) = z^2 + \lambda/z^2$; **T. Kawahira**, Semiconjugacies between the Julia sets of geometrically finite rational maps II; **W. Jung**, Homeomorphisms of the Mandelbrot set; **N. Fagella** and **C. Henriksen**, Arnold disks and the moduli of Herman rings of the complex standard family; **T. Lei**, Stretching rays and their accumulations, following Pia Willumsen; **A. Douady**, Conjectures about the Branner-Hubbard motion of Cantor sets in C.

January 2006, 240 pages, Hardcover, ISBN 3-03719-011-6, 2000 *Mathematics Subject Classification*: 37F45, **All AMS members US$63**, List US$79, Order code EMSDRS

Differential-Algebraic Equations

Analysis and Numerical Solution

Peter Kunkel, *University of Leipzig, Germany*, and **Volker Mehrmann**, *Technical University of Berlin, Germany*

Differential-algebraic equations are a widely accepted tool for the modeling and simulation of constrained dynamical systems in numerous applications, such as mechanical multibody systems, electrical circuit simulation, chemical engineering, control theory, fluid dynamics and many others.

This is the first comprehensive textbook that provides a systematic and detailed analysis of initial and boundary value problems for differential-algebraic equations. The analysis is developed from the theory of linear constant coefficient systems via linear variable coefficient systems to general nonlinear systems. Further sections on control problems, generalized inverses of differential-algebraic operators, generalized solutions, and differential equations on manifolds complement the theoretical treatment of initial value problems. Two major classes of numerical methods for differential-algebraic equations (Runge–Kutta and BDF methods) are discussed and analyzed with respect to convergence and order. A chapter is devoted to index reduction methods that allow the numerical treatment of general differential-algebraic equations. The analysis and numerical solution of boundary value problems for differential-algebraic equations is presented, including multiple shooting and collocation methods. A survey of current software packages for differential-algebraic equations completes the text.

The book is addressed to graduate students and researchers in mathematics, engineering and sciences, as well as practitioners in industry. A prerequisite is a standard course on the numerical solution of ordinary differential equations. Numerous examples and exercises make the book suitable as a course textbook or for self-study.

This item will also be of interest to those working in applications.

A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: *I. Analysis of differential-algebraic equations:* Introduction; Linear differential-algebraic equations with constant coefficients; Linear differential-algebraic equations with variable coefficients; Nonlinear differential-algebraic equations; *II. Numerical solution of differential-algebraic equations:* Numerical methods for strangeness-free problems; Numerical methods for index reduction; Boundary value problems; Software for the numerical solution of differential-algebraic equations; Final remarks; Bibliography; Index.

EMS Textbooks in Mathematics

February 2006, 392 pages, Hardcover, ISBN 3-03719-017-5, 2000 *Mathematics Subject Classification*: 34A09, 65L80, **All AMS members US$54**, List US$68, Order code EMSTEXT/2