

QUARTERLY
OF
APPLIED MATHEMATICS

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VOLUME LIV

JUNE • 1996

NUMBER 2

QUARTERLY OF APPLIED MATHEMATICS

The QUARTERLY prints original papers in applied mathematics which have an intimate connection with applications. It is expected that each paper will be of a high scientific standard; that the presentation will be of such character that the paper can be easily read by those to whom it would be of interest; and that the mathematical argument, judged by the standard of the field of application, will be of an advanced character.

Manuscripts (two copies) submitted for publication in the QUARTERLY OF APPLIED MATHEMATICS should be sent to the Editorial Office, Box F, Brown University, Providence, RI 02912, either directly or through any one of the Editors. The final decision on acceptance of a manuscript for publication is made by the Managing Editor. Once a manuscript has been accepted for publication, an electronic manuscript can be submitted. To this end, author packages, which will simplify the work of authors and of production staff, have been prepared. Author packages include instructions for preparing electronic manuscripts, the *AMS Author Handbook*, samples, and a style file for both \LaTeX and \LaTeX . When choosing a style file for the *Quarterly of Applied Mathematics*, choose the generic journal package, made available by the American Mathematical Society. Authors who make use of these style files from the beginning of the writing process will further reduce their own effort.

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In accordance with their general policy, the Editors welcome particularly contributions which will be of interest both to mathematicians and to scientists or engineers. Authors will receive galley proof only. The author's institution will be requested to pay a publication charge of \$30 per page which, if honored, entitles the author to 100 free reprints. Detailed instructions will be sent with galley proofs.

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This journal is indexed in *Science Citation Index*[®], *SciSearch*[®], *Research Alert*[®], *CompuMath Citation Index*[®], *Current Contents*[®]/*Physical, Chemical & Earth Sciences*, *Current Contents*[®]/*Engineering Computing & Technology*.

 Printed on recycled paper

Second-class postage paid at Providence, Rhode Island.

Publication number 808680 (ISSN 0033-569X).

SUGGESTIONS CONCERNING THE PREPARATION OF MANUSCRIPTS FOR THE QUARTERLY OF APPLIED MATHEMATICS

The editors will appreciate the authors' cooperation in taking note of the following directions for the preparation of manuscripts. These directions have been drawn up with a view toward eliminating unnecessary correspondence, avoiding the return of papers for changes, and reducing the charges made for "author's corrections."

Manuscripts: Manuscripts should be typewritten double-spaced on one side only. Marginal instructions to the typesetter should be written in pencil to distinguish them clearly from the body of the text. The author should keep a complete copy.

The papers should be submitted in final form. Only typographical errors should be corrected in proof; composition charges for any major deviations from the manuscript will be passed on to the author.

Titles: The title should be brief but express adequately the subject of the paper. The name and initials of the author should be written as he/she prefers; all titles and degrees or honors will be omitted. The name of the organization with which the author is associated should be given in a separate line following his/her name.

Mathematical Work: As far as possible, formulas should be typewritten; Greek letters and other symbols not available on the average typewriter should be inserted using either instant lettering or by careful insertion in ink. Manuscripts containing pencilled material other than marginal instructions to the typesetter will not be accepted.

The difference between capital and lower-case letters should be clearly shown; care should be taken to avoid confusion between zero (0) and the letter O, between the numeral one (1), the letter l and the prime ('), between alpha and a, kappa and k, mu and u, nu and v, eta and n.

The level of subscripts, exponents, subscripts to subscripts, and exponents to exponents should be clearly indicated.

Single embellishments over individual letters are allowed; the only embellishment allowed above groups of letters is the overbar.

Double embellishments are not allowed. These may be replaced by superscripts following the symbols.

Complicated exponents and subscripts should be avoided. Any complicated expression that recurs frequently should be represented by a special symbol.

For exponentials with lengthy or complicated exponents the symbol exp should be used, particularly if such exponentials appear in the body of the text. Thus,

$$\exp[(a^2 + b^2)^{1/2}] \text{ is preferable to } e^{(a^2 + b^2)^{1/2}}.$$

Fractions in the body of the text and fractions occurring in the numerators or denominators of fractions should be written with the solidus. Thus,

$$\frac{\cos(x/2b)}{\cos(a/2b)} \text{ is preferable to } \frac{\cos \frac{x}{2b}}{\cos \frac{a}{2b}}.$$

In many instances the use of negative exponents permits saving of space. Thus,

$$\int u^{-1} \sin u \, du \text{ is preferable to } \int \frac{\sin u}{u} \, du.$$

Whereas the intended grouping of symbols in handwritten formulas can be made clear by slight variations in spacing, this procedure is not acceptable in typeset formulas. To avoid misunderstanding, the order of symbols should therefore be carefully considered. Thus,

$$(a + bx) \cos t \text{ is preferable to } \cos t(a + bx).$$

Figures: Figures should be drawn in black ink with clean, unbroken lines; do not use ball point pen. The paper should be of a nonabsorbant quality so that the ink does not spread and produce fuzzy lines. If the figures are intended for reduction, they should be drawn with heavy enough lines so that they do not become flimsy at the desired reduction. The notation should be of professional quality and in proportion for the expected reduction size. Figures that are unsuitable for reproduction will be returned to the author for redrawing. Legends accompanying figures should be written on a separate sheet.

Bibliography: References should be grouped together in a Bibliography at the end of the manuscript. References in text to the Bibliography should be made by numerals between square brackets.

The following examples show the desired arrangements: (*for books* - S. Timoshenko, *Strength of Materials*, vol. 2, Macmillan and Co., London, 1931, p. 237; *for periodicals* - Lord Rayleigh, *On the flow of viscous liquids, especially in three dimensions*, Phil. Mag. (5) 36, 354-372 (1893)). Note that the number of the series is not separated by commas from the name of the periodical or the number of the volume.

Authors' initials should precede their names rather than follow them.

In quoted titles of books or papers, capital letters should be used only where the language requires this. Thus, *On the flow of viscous fluids* is preferable to *On the Flow of Viscous Fluids*, but the corresponding German title would have to be rendered as *Über die Stromung zaher Flüssigkeiten*.

Titles of books or papers should be quoted in the original language (with an English translation added in parentheses, if this seems desirable), but only English abbreviations should be used for bibliographical details such as ed., vol., no., chap., p.

Footnotes: As far as possible, footnotes should be avoided. Footnotes containing mathematical formulas are not acceptable.

Abbreviations: Much space can be saved by the use of standard abbreviations such as Eq., Eqs., Fig., Sec., Art., etc. These should be used, however, only if they are followed by a reference number. Thus, "Eq. (25)" is acceptable but not "the preceding Eq." Moreover, if any one of these terms occurs as the first word of a sentence, it should be spelled out.

Special abbreviations should be avoided. Thus "boundary conditions" should always be spelled out and not be abbreviated as "b.c." even if this special abbreviation is defined somewhere in the text.

CONTENTS

Vol. LIV, No. 2

June 1996

JOHN G. FIKIORIS, Electromagnetic field in the source region of continuously varying current density	201
RADHAKRISHNAN SRINIVASAN, Unsteady asymptotic solutions of the two-dimensional Euler equations	211
M. GARBEY, A. TAIK, AND V. VOLPERT, Linear stability analysis of reaction fronts in liquids	225
H. T. BANKS, G. PROPST, AND R. J. SILCOX, A comparison of time domain boundary conditions for acoustic waves in wave guides	249
DEBORAH BRANDON AND ROBERT C. ROGERS, Analysis of a rigid ferromagnetic body under applied magnetic fields	267
THIERRY CAZENAVE AND FRED B. WEISSLER, Unstable simple modes of the nonlinear string	287
M. G. HILGERS AND A. C. PIPKIN, Bending energy of highly elastic membranes II	307
PAUL G. WARNE AND DEBRA A. POLIGNONE, Solutions for an infinite compressible nonlinearly elastic body under a line load	317
M. MIHĂILESCU-SULICIU, I. SULICIU, T. WIERZBICKI, AND M. S. HOO FATT, Transient response of an impulsively loaded plastic string on a plastic foundation	327
J. P. PASCAL AND H. PASCAL, Similarity solutions to rotating Couette flow of non-Newtonian fluids in the presence of a magnetic field	345
MARK T. HANSON AND IGUSTI W. PUJA, Love's circular patch problem revisited: Closed form solutions for transverse isotropy and shear loading	359
STEVEN NERNEY, EDWARD J. SCHMAHL, AND Z. E. MUSIELAK, Limits to extensions of Burgers' equation	385
D. A. POLIGNONE AND C. O. HORGAN, Errata: Pure azimuthal shear of compressible nonlinearly elastic circular tubes	395
NEW BOOKS	210, 224, 248, 266, 286, 306, 344, 394, 396-400



0033-569X(199606)54:2;1-B

Correspondence Analysis Handbook. By J. P. Benzecri, Marcel Dekker, Inc., 1992, xii+688 pp., \$135.00 (\$59.75 on orders of five or more copies, for classroom use only)

This is volume 125 in the series *Statistics: Textbooks and Monographs*. The basic idea considered is a correspondence table between two finite sets I and J , i.e., a rectangular table of positive numbers in which I is the set of the rows and J is the set of the columns. The aim is to give a geometric representation to the sets I and J that will show the associations between the elements constituting the table. The book consists of five parts. Part I contains 12 chapters, divided into four groups: Chapters 1 to 6 introduce the reader to the geometrical language used in correspondence analysis of multidimensional data; Chapters 7 and 8 explain the formulae of correspondence analysis; Chapters 9 and 10 contain a review of linear algebra and multidimensional Euclidean geometry; Chapters 11 and 12 contain proofs of the results described in Chapters 7 and 8. The other parts are entitled: II. Exercise illustrating the theory; III. Reading and interpreting the listings; IV. Analysis and interpretation; V. Cluster analysis; agglomerative hierarchical clustering. There is also a glossary of indexed terms; the original French is given when an English translation would be confusing.

Chaotic Behaviour of Deterministic Dissipative Systems. By Milos Marek and Igor Schreiber, Cambridge University Press, 1991, \$79.50

This is an introductory text, addressed to students and research workers from diverse fields, that surveys both theoretical and experimental aspects of chaotic behaviour. The introductory chapter discusses the significance of chaos as a model of many seemingly random processes in nature and a definition of the class of dissipative systems to be studied. The second chapter considers basic notions of the theory of dynamical systems; the third chapter ("transition from chaos to order") deals with qualitative changes of asymptotic behaviour as a chosen parameter is varied. These changes ("bifurcations") may lead to chaos in several well-defined routes. A review of the numerical methods used both in the treatment of mathematical models and in the interpretation of experimental data is provided in the fourth chapter. The fifth chapter surveys some characteristic experimental situations of chaotic behaviour and includes data from mechanical systems, electronics, lasers, semiconductors, chemical and biological systems, and hydrodynamics. The sixth chapter is based on the authors' own experimental and numerical work and illustrates an interpretation of chaotic experimental data on the basis of one-dimensional mappings. In the final chapter, the authors survey ways to approach the modeling of spatio-temporal chaotic behaviour in distributed systems. The results of analysis of cellular automata, coupled map lattices, and partial differential equations are briefly reviewed, and generally applicable methods are stressed.

Differential Equations and Mathematical Physics. Edited by Christer Bennowitz, Academic Press, 1991, xxx+365 pp., \$49.95

This is volume 86 in the series *Mathematics in Science and Engineering*, and contains 17 of the lectures given at the International Conference held at the University of Alabama at Birmingham, March 15–21, 1990. The speakers at the special sessions came from 19 countries, and the meeting was attended by over 200 mathematicians from 25 countries. The main purpose of the conference was to provide a forum for the discussion of recent developments in the theory of ordinary and partial differential equations, both linear and nonlinear, with particular reference to work relating to the problems of mathematical physics.

Mathematics in Industrial Problems. Part 4. By Avner Friedman, Springer-Verlag, 1991, xiv+197 pp., \$26.00

This is volume 38 of *The IMA Volumes in Mathematics and its Applications*. The motivation of this fourth volume, like the previous volumes in this series, is to foster interaction between industry and mathematics at the grass roots, that is, at the level of specific problems. There are 20 chapters in this volume, discussing problems from areas such as: boundary problems, polymer chains, colloidal magnetically switchable particles, semiconductor devices, catalytic converter performance, titanium silicide film growth, gel electrophoresis, coalescence, signal design, head-disk interface in magnetic storage devices, megastructures, aerodynamic design, robot control, and others.

Code Recognition and Set Selection with Neural Networks. By Clark Jeffries, Birkhäuser, 1991, viii+166 pp., \$49.50

This is volume 7 in the series *Mathematical Modeling*. It is concerned with problem solving with dynamical system neural networks, where the input vector becomes an initial state of a dynamical system. The system iterates with time and converges to a state that can be interpreted as a decision. Much of the book is devoted to a neural network method for recognizing binary strings that have been corrupted by noise in transmission.

Introduction to the Thermodynamics of Solids. By J. L. Ericksen, Chapman and Hall, 1991, xii+204 pp., \$49.95

This is volume 1 in the series *Applied Mathematics and Mathematical Computation*. The first nine chapters of this book arose out of lecture notes for a course to seniors and beginning graduate students from various engineering and scientific departments at the University of Minnesota. The basic requirement is a mastery of calculus. Chapter 10 is not so elementary since it deals with matters that are unsettled and controversial. The author does not intend the book to be a replacement for other elementary books on thermodynamics and assumes that readers have a little familiarity with the subject. The scope of the text is indicated by the chapter headings: 1. Generalities; 2. Constitutive theory of heat transfer for bars and plates; 3. Equilibrium theory of bars; 4. Equilibrium theory of plates; 5. Balloon problems; 6. Biaxial stretch of rubber sheets; 7. Moving discontinuities; 8. Mixture theory; 9. Equilibrium of liquid crystals and rods; 10. Reconsideration of generalities.

Order Stars: Theory and Applications. By A. Iserles and S. P. Norsett, Chapman and Hall, 1991, xi+248 pp., \$49.95

This is volume 2 in the series *Applied Mathematics and Mathematical Computation*. The authors' aim is to demonstrate that the scope of order stars—originally introduced in 1978 in the context of numerical solution of ordinary differential equations—ranges considerably wider and that the cornerstone of order star theory is a function-theoretic interpretation of complex approximation theory by using a simple geometric language. There are ten chapters: 1. Introduction. 2. General order stars. 3. Rational approximants to the exponential; 4. A-acceptability barriers; 5. Multistep methods; 6. The advection equation; 7. The diffusion equation; 8. Padé approximants; 9. Contractive approximation; 10. Open problems.

Asymptotics Beyond All Orders. Edited by Harvey Segur, Saleh Tanveer, and Herbert Levine, Plenum Press, 1991, xiii+389 pp., \$105.00

This book, published in cooperation with the NATO Scientific Affairs Division, is volume 284 of Series B: Physics, of the NATO ASI Series. It constitutes the Proceedings of a NATO Advanced Research Workshop held January 7–11, 1991, in La Jolla, California. The 31 papers are divided into nine groups, corresponding to the subject areas into which the workshop was organized: Asymptotology and Borel summation; the geometric model of crystal growth; dendritic crystal growth; directional solidification of solids; flow in a Hele-Shaw cell (also known as viscous fingering); the rapidly forced pendulum; ordinary differential equations; solitary water waves in the presence of small surface tension; problems in optics; potpourri.

Handbook of Applied Mathematics: Selected Results and Methods. Second Edition. Edited by Carl E. Pearson, Van Nostrand Reinhold, 1990, xiii+1307 pp., \$41.95, soft cover

In this second edition, some material less directly concerned with technique has been omitted. Two new chapters, on integral equations and mathematical modeling, have been added. Several other chapters have been revised or extended. There are now 21 chapters, including, for instance, chapters on asymptotic methods, oscillations, perturbation methods, wave propagation, functional approximation, optimization techniques, probability and statistics, by various authorities in their fields.

Hypergeometric Functions and Their Applications. By James B. Seaborn, Springer-Verlag, 1991, xiv+250 pp., \$39.00

This is volume 8 in the series *Texts in Applied Mathematics*. The author follows the following track in defining special functions. Each special function arises in one or more physical contexts as a solution of a differential equation that can be transformed into the hypergeometric equation. The special function is then *defined* in terms of a generalized hypergeometric function. From this definition, many of the interesting and important properties are derived and the equivalence of this definition to other definitions is established. Chapter headings: 1. Special functions in applied mathematics; 2. Differential equations and special functions; 3. The confluent hypergeometric function; 4. Problems in two dimensions; 5. The central force problem in quantum mechanics; 6. The radial equation for central force fields; 7. Complex analysis; 8. Applications of contour integrals; 9. Alternate forms of special functions; 10. Integral representations of special functions; 11. Generating functions and recursion formulas; 12. Orthogonal functions.

Patterns and Waves: The Theory and Applications of Reaction-Diffusion Equations. By Peter Grindrod, Oxford University Press, 1991, viii+239 pp., \$39.95

This is a volume in the *Oxford Applied Mathematics and Computing Science* series. The author's aim is to present an introduction to the theory of the class of nonlinear partial differential equations known as reaction-diffusion equations, to provide a compendium of useful techniques for their analysis, and to show how these find application in a variety of settings, notably in pattern formation and nonplanar wave-like structures. Chapter headings: 1. Basic considerations; 2. Pattern formation; 3. Plane waves; 4. A geometrical theory for waves; 5. Nonlinear dispersal mechanisms.

Operator Algebras in Dynamical Systems: The Theory of Unbounded Derivations in C^ -Algebras.* By Shôichirô Sakai, Cambridge University Press, 1991, xii+219 pp., \$59.50

This is volume 41 in the series *Encyclopedia of Mathematics and its Applications*, edited by G.-C. Rota. The subject was motivated by questions in quantum physics and statistical mechanics. One of the most ambitious aims of the theory is to develop quantum statistical mechanics within the framework of C^* -theory, to the exploration of which the book addresses itself. There are four chapters: preliminaries, bounded derivations, unbounded derivations, and C^* -dynamical systems.

The Linear Complementarity Problem. By Richard W. Cottle, Jong-Shi Pang, and Richard E. Stone, Academic Press, 1992, xxiv+762 pp., \$59.95

This is a volume in the series *Computer Science and Scientific Computing*. The title problem (LCP) of which concentrated study began in the mid 1960's refers to an inequality system with a rich mathematical theory, a variety of algorithms, and a wide range of applications in applied science and technology. The book is self-contained and includes an extensive discussion of background material (in Chapter 2). Chapter 1 sets forth a precise statement of the LCP and then offers a selection of settings in which such problems arise (quadratic programming, bimatrix games, market equilibrium, optimal invariant capital stock, optimal stopping, convex hulls in the plane, nonlinear complementarity and variational inequality problems). Chapter 3 is concerned with questions on the existence and multiplicity of solutions to LCP's. Chapter 4 covers the better-known pivoting algorithms (direct methods), notably principal pivoting methods and Lemke's method, and Chapter 5 discusses iterative methods (indirect methods), for instance matrix-splitting methods, a damped Newton method, and interior point methods. Chapter 6 offers a geometric view of the LCP. The seventh and concluding chapter focuses on sensitivity and stability analysis.

Finite Plastic Deformation of Crystalline Solids. By K. S. Havner, Cambridge University Press, 1992, xiv+235 pp.

This is a volume in the series *Cambridge Monographs on Mechanics and Applied Mathematics*. The author recalls that in 1950 both Rodney Hill's treatise on the macroscopic theory of plasticity, and the English translation of E. Schmid and W. Boas's classic *Kristallplastizität* were published in Cambridge, but that there existed no contemporary work that integrated these two ways of looking at the same phenomenon. The author—although taking much of his inspiration from Hill's work—restricts himself to aspects of crystalline plasticity, a subject inaugurated by G. I. Taylor's 1923 Bakerian Lecture to the Royal Society. He reviews and interrelates a large number of theoretical and experimental contributions to research on finite plastic deformation of single crystals and polycrystalline metals made during the past quarter century. An overall theoretical framework for investigation of large strains is presented that enables the blending of contemporary and earlier experimental research with modern concepts in solid mechanics. Chapter headings: 1. An historical introduction; 2. The kinematics of double slip; 3. A general theory of elastoplastic crystals; 4. Axial-load experiments and latent hardening in single crystals; 5. Analysis of crystals in channel die compression; 6. Theoretical connections between crystal and aggregate behavior; 7. Approximate polycrystal models. There is an appendix on the general theory of work-conjugate stress and strain.

Measurement Errors in Surveys. Edited by Paul P. Biemer, Robert M. Groves, Lars E. Lyberg, Nancy A. Mathiowetz, and Seymour Sudman, John Wiley and Sons, 1991, xxi+760 pp., \$75.00

This is a volume in the Wiley series in *Probability and Mathematical Statistics*. It summarizes the International Conference on Measurement Errors in Surveys, held in November 1990 in Tucson, Arizona. The opening speaker was William Kruskal, whose remarks provide the introduction to the volume. In designing the book the conference committee did not intend merely to publish a conference proceedings volume. Rather the aim was to write collectively a book dealing with the most important issues in the field of survey measurement error, attempting whenever possible to integrate diverse perspectives. Thus, each chapter has undergone extensive editing, review, and revision. There are 32 papers, grouped into five sections whose titles and their editors are: A. The questionnaire (Seymour Sudman); B. Respondents and responses (Nancy A. Mathiowetz); C. Interviewers and other means of data collection (Lars Lyberg); D. Measurement errors in the interview process (Robert M. Groves); E. Modeling measurement errors and their effects on estimation and data analysis (Paul P. Biemer).

Nonlinear Diffusion Equations and Their Equilibrium States. 3. Edited by N. G. Lloyd, W. M. Ni, L. A. Peletier, and J. Serrin, Birkhäuser, 1992, x+572 pp., \$120.00

This is volume 7 in the series *Progress in Nonlinear Differential Equations and Their Applications*. It constitutes the Proceedings of a Conference held August 20–29, 1989 in Gregynog, Wales. There are 39 papers in this volume, representing a broad spectrum of work at the cutting edge of the theories of the title subject, which go back to problems in ordinary differential equations discussed at the beginning of this century, as in the classical Emden-Fowler theory.

Group Theoretical Methods and Their Applications. By A. Fässler and E. Stiefel with English translation by Baoswan Dzung Wong, Birkhäuser, 1992, xii+296 pp., \$49.50

This is a revised translation of the German monograph published in 1978. Several topics have been added to the German version, e.g., an introductory example from economics, the Fast Fourier Transform algorithm on finite groups, a probabilistic application to the Bernoulli-Laplace diffusion model, and bifurcation. The chapter headings are: 1. Preliminaries; 2. Linear operators with symmetries; 3. Symmetry adapted basis functions; 4. Continuous groups and representations; 5. Symmetry adapted vectors, characters; 6. Various topics of application; 7. Lie algebras; 8. Applications to solid state physics; 9. Unitary and orthogonal groups.

Painlevé Transcendents—Their Asymptotics and Physical Applications. Edited by Decio Levi and Pavel Winternitz, Plenum Press, 1992. Published in cooperation with NATO Scientific Affairs Division, xxvi+446 pp., \$125.00

This is volume 278 of Series B: Physics, in the NATO ASI Series. It contains the proceedings of a NATO Advanced Research Workshop held September 3–7, 1990, in Sainte-Adèle, Québec, Canada. There were 41 participants from 14 countries and 27 lectures were presented, all included in this volume. The result is a volume which, though multiauthored, has the character of a monograph on a single topic: the theory of nonlinear ordinary differential equations, the solutions of which have no movable singularities, other than poles, and the extension of this theory to partial differential equations. Such systems are called “equations with the Painlevé property”, and the search for such equations goes back to the 19th century. The papers are arranged according to subject matter, into four groups: I. Asymptotics of Painlevé transcendents, connection formulas, new mathematical features; II. Painlevé analysis and integrability; III. Classification, symmetries, geometry; IV. Applications.

Seminar on Stochastic Processes. 1991. Edited by E. Cinlar, K. L. Chung, and M. J. Sharpe, Birkhäuser, 1992, 243 pp., \$70.00

This is volume 29 of the series *Progress in Probability*. These are the proceedings of the eleventh in a series of annual meetings, held at UCLA from March 23 through 25, 1991. There are 16 papers.

The Dynamics of Cellular Motility. By Masatoshi Murase, John Wiley and Sons, 1992, xv+357 pp.

This is a volume in the series *Nonlinear Science: Theory and Applications*. It presents new ideas and theories that account for oscillatory contraction in muscle and the various modes of flagellar and ciliary movements. Part I (Chapters 2-3) deals with the mechanical properties of vertebrate skeletal muscle and insect flight muscle. Part II (Chapters 4-10) sketches the self-organization of flagellar and ciliary bending patterns. The chapter headings are: 1. Introduction; 2. Oscillatory contraction in muscle; 3. Models for muscle contraction; 4. Hierarchy in structure and function; 5. Models of flagella and cilia exhibiting regular behaviour; 6. Molecular mechanism for excitability and oscillations; 7. Simplified models for flagellar dynamics; 8. Simplified models for ciliary dynamics; 9. Large-amplitude oscillations and bend propagation; 10. From simple to complex dynamical behaviours in mechano-chemical cycles: hyperoscillations, bursting and chaos.

Random Surfaces and Quantum Gravity. Edited by Orlando Alvarez, Enzo Marinari, and Paul Windey, Plenum Press, 1991. Published in cooperation with NATO Scientific Affairs Division, viii+407 pp., \$110.00

This is volume 262 of Series B: Physics in the NATO ASI Series. It is the proceedings of a NATO Advanced Research Workshop held May 27-June 2, 1990, in Cargèse, France. They are organized in three parts reflecting the main themes treated at the conference: 1. 2D gravity and nonperturbative effects; $D = 1$ strings and string field theory; 3. Liouville theory and $D > 1$.

Matroid Applications. Edited by Neil White, Cambridge University Press, 1992, xii+363 pp., \$79.95

This is volume 40 of the *Encyclopedia of Mathematics and its Applications*, edited by G.-C. Rota. It is the third volume of a series that began with *Theory of Matroids* and continued with *Combinatorial Geometries*. There are eight chapters, by various authors: 1. Matroids and rigid structures; 2. Perfect matroid designs; 3. Infinite matroids; 4. Matroidal families of graphs; 5. Algebraic aspects of partition lattices; 6. The Tutte polynomial and its applications; 7. Homology and shellability of matroids and geometric lattices; 8. Introduction to greedoids.

Singular Perturbation Methods for Ordinary Differential Equations. By Robert E. O'Malley, Jr, Springer-Verlag, 1991, viii+225 pp., \$39.00

This is volume 89 in the series *Applied Mathematical Sciences*. It resulted from various lectures given by the author in recent years. It seeks to convey the basic ideas and methods used to solve successfully singularly perturbed boundary value problems at a level accessible to students and researchers in mathematics, the sciences and engineering. The text limits its coverage to ordinary differential equations and to specific applications, including stiff computation, combustion theory, optimal control, and semiconductor modeling.

The Universal Man: Theodore von Kármán's Life in Aeronautics. By Michael H. Gorn, Smithsonian Institution Press, 1992, xii+202 pp., \$24.95

This is a volume in the *Smithsonian History of Aviation* series, and recounts the life and work of the pioneering aerospace engineer and applied mathematician.

Pattern Recognition and Image Preprocessing. By Sing-Tze Bow, Marcel Dekker, 1992, xi+584 pp., \$15.00

This is volume 77 in *Electrical Engineering and Electronics, A Series of Reference Books and Textbooks*. The material in this book is grouped into four parts. Part One (Chapters 1–7) presents the fundamental concepts of pattern recognition and its system configuration. Part Two (Chapters 8–10) deals with data preprocessing for pictorial pattern recognition. Part Three consists of Chapter 11, in which several military, medical and industrial applications are discussed. In Part Four (Chapter 12) the author discusses various computer architectures appropriate for image preprocessing and pattern recognition. The chapter headings are: 1. Introduction; 2. Nonparametric decision theoretic classification; 3. Nonparametric (distribution-free) training of discriminant functions; 4. Statistical discriminant functions; 5. Clustering analysis and nonsupervised learning; 6. Dimensionality reduction and feature selection; 7. Neural networks and their applications in pattern recognition; 8. Image transform and preprocessing in the transform domain; 9. Preprocessing in the spatial domain; 10. Pictorial data preprocessing and shape analysis; 11. Exemplary applications; 12. Computer system architectures for image processing and pattern recognition.

The Global Geometry of Turbulence: Impact of Nonlinear Dynamics. Edited by Javier Jiménez, Plenum Press, 1991. Published in cooperation with NATO Scientific Affairs Division, xiii+372 pp., \$105.00

This is volume 268 of Series B: Physics, in the NATO ASI Series. It contains the proceedings of a NATO Advanced Research Workshop held July 8–14, 1990, in Rota, Spain. The invited talks published here are: The mixing transition in free shear flow (A. Roshko), Vortex dynamics and turbulence (P. G. Saffman), and Bifurcations and subcritical instabilities (Y. Pomeau). The 29 papers are grouped under the headings: shear flow (experimental observations); shear flow (control experiments); closed flows (experiments); theoretical models (the Navier-Stokes and related equations). There is also an account of three panel discussions moderated by A. Roshko, C. Van Atta, and E. Reynolds, respectively.

Predictability, Stability, and Chaos in N-Body Dynamical Systems. Edited by Archie E. Roy, Plenum Press, 1991. Published in cooperation with NATO Scientific Affairs Division, xii+601 pp., \$135.00

This is volume 272 of Series B: Physics, in the NATO ASI Series. It contains the proceedings of a NATO Advanced Research Workshop held August 6–7, 1990, in Cortina d'Ampezzo, Italy, which attracted 74 participants from 16 countries. Its main goal was the examination of the relationships between the title subjects, and among the systems studied were the solar system's planets and satellites, comets, asteroids, and meteors, and the dynamics of star clusters and galaxies. The 53 papers printed here are grouped into five parts: I. Aspects of chaos; II. Dynamics of asteroids, comets, and meteors; III. Dynamics of natural and artificial satellites; IV. The three-body problem; V. Selected topics in dynamics.

Convex Functions. Partial Orderings, and Statistical Applications. By Josip E. Pecaric, Frank Proschan, and Y. L. Tong, Academic Press, 1992, xiii+469 pp., \$84.00

This is volume 187 in the series *Mathematics in Science and Engineering*. It is divided into 17 chapters. The first chapter provides some definitions and fundamental results for various classes of convex functions. General inequalities for convex functions are in Chapters 2, 3, 5, 6, 7, 9, 10, 12; some classical applications of these inequalities are given in Chapters 4, 8, and 11. In particular, Chapters 2–4 contain results on various versions of Jensen's inequality and its reversals and refinements, while some of the following chapters contain classical results on moment-related inequalities. Chapters 13–17 concern corresponding results on inequalities for convex functions via partial orderings in probability and statistics. In particular, the last three chapters deal with arrangement ordering. The results given in this volume include classical results as well as many new results that have appeared recently in the literature.

Nonlinear Dynamics, Chaos, and Instability—Statistical Theory and Economic Evidence. Edited by William A. Brock, David A. Hsieh, and Blake LeBaron, The MIT Press, 1991, xiv+328 pp., \$32.50

The authors provide a unified and complete account of new statistical methods for testing for chaos in data sets, applying them to such areas of economics and finance as the changing structure of stock returns and nonlinearity in foreign exchange. They introduce and describe the BDS statistic, a test that detects the existence of potentially forecastable structure, nonstationarity, or hidden patterns in time-series data. The book's emphasis is on testing for nonlinearities that are either deterministically chaotic or fairly closely related to such nonlinearities. There are five chapters. Chapter 1 lays out the basic concepts of chaos theory, such as deterministic data generators and measurement of complexity of such generators. Chapter 2 shows how to use the difference between dimension plots of the original data and dimension plots of a purely random data set with the same stationary distribution to detect hidden dependence in data that looks random. Chapter 3 applies the BDS test to stock returns, and Chapter 4 to foreign exchange rates. Chapter 5 closes with a summary, a relation of the authors' work to other areas of nonlinear tests, and suggestions for future research.

Solids Far from Equilibrium. Edited by C. Godrèche, Cambridge University Press, 1992, xvi+588 pp., \$120.00

This is volume 1 in the Collection Aléa-Saclay *Monographs and Texts in Statistical Physics*. It is based on courses given at the 1989 Beg-Rohu summer school entitled: "Solids far from equilibrium: growth, morphology and defects". The subject involves the effect of the growth dynamics of solids on their shape, their crystalline quality, and consequently on their electronic and mechanical properties. This volume deals with the various facets of a general problem: shape and growth of crystals, instabilities and pattern formation. There are six sets of lectures: 1. Shape and growth of crystals, by P. Nozières; 2. Instabilities of planar solidification fronts, by B. Caroli, C. Caroli, and B. Roulet; 3. An introduction to the kinetics of first-order phase transition, by J. L. Langer; 4. Dendritic growth and related topics, by Y. Pompeau and M. Ben Amar; 5. Growth and aggregation far from equilibrium, by L. M. Sander; 6. Kinetic roughening of growing surfaces, by J. Krug and H. Spohn.

Random Walks. Brownian Motion and Interacting Particle Systems—A Festschrift in Honor of Frank Spitzer. Edited by Rick Durrett and Harry Kesten, Birkhäuser, 1991, ix+455 pp., \$68.00

This is a volume in the series *Progress in Probability*. It is dedicated to Frank Spitzer on the occasion of his 65th birthday and the articles are intended to demonstrate his major influence on probability: some of his seminal articles are reprinted in the volume. The authors of the twenty papers are: M. Bramson, L. Gray, D. Griffeath, J. T. Cox, R. Durrett, A. Greven, A. deAcosta, P. Ney, E. Nummelin, H. Dinges, R. Dobrushin, F. Sokolovskii, H. Kesten, G. Lawler, E. B. Dynkin, T. E. Harris, R. Holley, J.-F. Le Gall, T. M. Liggett, N. Madras, S. C. Port, W. E. Pruitt, D. W. Stroock, O. Zeitouni, N. Terrin, M. S. Taqqu, and M. Yor.

Trends in Applications of Mathematics to Mechanics. Edited by W. Schneider, H. Troger, and F. Ziegler, Longman Scientific and Technical, copublished in the United States with John Wiley and Sons, 1991, 356 pp., \$130.00

This is a volume in the *Interaction of Mechanics and Mathematics* series. It constitutes the proceedings of the eighth symposium on the title subject held under the auspices of the International Society for Interaction of Mechanics and Mathematics in Hollabrunn, Lower Austria, which was attended by 84 participants from 17 countries. The presentations are divided into the following five sections: I. Numerical methods in non-linear continuum mechanics (5 papers); II. Dynamic systems and bifurcation (8 papers); III. Asymptotic theory of viscous flow (5 papers); IV. Material science and thermodynamic aspects of continuum mechanics (12 papers); V. Free section: Significant interactions of mathematics and mechanics (13 papers). The papers are dedicated to Professor Emeritus Ekkehart Kröner of the University of Stuttgart on the occasion of his 70th birthday.

Perturbation Methods. By E. J. Hinch, Cambridge University Press, 1991, viii+160 pp., \$59.00 cloth, \$24.95 paper

This is a volume in the series *Cambridge Texts in Applied Mathematics*. It is concerned with the art and science of obtaining analytic approximations to equations when some parameter of the problem is small. No attempt has been made to make all arguments fully rigorous, but rather to explain why the results are correct. The eventual goal of the book is to present the method of matched asymptotic expansions and the method of multiple scales. The book is based on a series of lectures given to first-year graduate students at the University of Cambridge. Chapter headings: 1. Algebraic equations; 2. Asymptotic approximations; 3. Integrals; 4. Regular perturbation problems in partial differential equations; 5. Matched asymptotic expansions; 6. Method of strained co-ordinates; 7. Method of multiple scales; 8. Improved convergence.

Random Graphs. Volume 2. Edited by Alan Frieze and Tomasz Luczak, John Wiley and Sons, 1992, x+285 pp., \$125.00

This volume is based on the Fourth International Seminar on Random Graphs and Probabilistic Methods in Combinatorics, held in Poznan, Poland, in August 1989. There were 67 participants from 17 countries. This volume contains the texts of 19 lectures, on subjects such as: random mappings and permutations, quasirandom graphs, random walks on trees, small and large subgraphs of random graphs, randomly weighted graphs, degree sequences, random binary trees, random matroids, random signed graphs, central limit theorems, percolation, and random subgraphs of the n -cube.

Infinite Electrical Networks. By Armen H. Zemanian, Cambridge University Press, 1992, xi+308 pp., \$64.95

This is volume 101 in the series *Cambridge Tracts in Mathematics*. It is addressed both to engineers and to mathematicians. Almost all of the massive literature on electrical networks since Kirchoff is devoted to finite networks. This is the first book to present a general theory of infinite networks in a coherent exposition. In addition to its intellectual challenge, the theory of infinite networks has practical applications; for instance, discretized models of partial differential equations in infinite domains—such as when a wave is propagated into an exterior region—are infinite electrical networks. The jump in complexity is comparable to that in going from finite- to infinite-dimensional vector spaces. The basic tools are graph theory and functional analysis and the reader is assumed to have a basic knowledge of these subjects; however, principal results are stated and references given. The first half of the book presents existence and uniqueness theorems for both infinite-power and finite-power voltage-current regimes, and the second half discusses methods for solving problems in infinite cascades and grids. The last chapter is a survey of applications to exterior problems of partial differential equations, random walks on infinite graphs, and networks of operators on Hilbert spaces.

Viability Theory. By Jean-Pierre Aubin, Birkhäuser, 1991, xxv+543 pp., \$94.50

This is a volume in the series *Systems & Control: Foundations & Applications*. In the author's words, viability theory is a mathematical theory that offers mathematical metaphors of evolution of macrosystems arising in biology, economics, cognitive sciences, games, and similar areas, as well as in nonlinear systems of control theory. In particular, the author is concerned with three main common features: a nondeterministic engine of evolution, providing several opportunities to explore the environment; viability constraints that the state of the system must obey at each instant under "death penalty"; an inertia principle stating that the "controls" of the system are changed only when viability is at stake. Chapter headings: 1. Viability theorems for ordinary and stochastic differential equations; 2. Set-valued maps; 3. Viability theorems for differential inclusions; 4. Viability kernels and exit tubes; 5. Invariance theorems for differential inclusions; 6. Regulation of control systems; 7. Smooth and heavy viable solutions; 8. Partial differential inclusions of tracking problems; 9. Lyapunov functions; 10. Miscellaneous viability issues; 11. Viability tubes; 12. Functional viability; 13. Viability theorems for partial differential inclusions; 14. Differential games.

Partial Differential Equations: An Introduction. By Walter A. Strauss, John Wiley and Sons, 1992, ix+425 pp., \$49.95

This text is designed for juniors and seniors who are science, engineering, or mathematics majors. The main prerequisite is multivariate calculus and small amounts of ordinary differential equations and linear algebra. The presentation is based on the principles: motivate with physics but then do mathematics; focus on the three classical equations; do one dimension before going to two and three; do problems without boundaries before bringing in boundaries; present some facts without proofs, but present the most critical proofs; provide introductions to some important advanced topics. Chapter headings: 1. Where PDE's come from; 2. Waves and diffusions; 3. Reflections and sources; 4. Boundary problems; 5. Fourier series; 6. Harmonic functions; 7. Green's identities and Green's functions; 8. Computation of solutions; 9. Waves in space; 10. Boundaries in the plane and in space; 11. General eigenvalue problems; 12. Distributions and transforms; 13. PDE problems from physics; 14. Nonlinear PDE's.

Regression with Graphs: A Second Course in Applied Statistics. By Lawrence C. Hamilton, Brooks/Cole Publishing Company, 1992, xv+363 pp., \$54.00

The author's aim in this book is to present graphical and regression methods as forming a natural partnership, providing a general, flexible, and powerful approach to data analysis, including exploratory data analysis. Least squares regression is introduced in the first four and one half chapters and more advanced topics are treated in Chapters 5–8. Chapter headings: 1. Variable distributions; 2. Bivariate regression analysis; 3. Basics of multiple regression; 4. Regression criticism; 5. Fitting curves; 6. Robust regression; 7. Logic regression; 8. Principal components and factor analysis. There are four appendices giving some statistics and matrix algebra background, tables, and an introduction to computer-intensive methods such as Monte-Carlo simulation and bootstrap methods.

Self-Organization, Emerging Properties, and Learning. Edited by Agnessa Babloyantz, Plenum Press, 1991. Published in cooperation with NATO Scientific Affairs Division, xix+300 pp., \$65.00

This is volume 260 of Series B: Physics, in the NATO/ASI Series. It contains the proceedings of a NATO Advanced Research Workshop held in March 1990, at Austin, Texas. It was held within the program of activities of the NATO Special Program on Chaos, Order, and Patterns. Broadly speaking, self-organization describes the ability of systems comprising many units and subject to constraints, to organize themselves in various spatial, temporal, or spatiotemporal activities. The subject matter of self-organization extends over several fields such as hydrodynamics, chemistry, biology, neural networks, and social sciences, key concepts being common to all these different disciplines. The self-organization processes in these fields are generally described in the framework of nonlinear dynamics. There are 21 papers in this volume, reporting on representative research from many related fields. The areas of investigation comprise self-organisation, dynamics of interacting elements, and theoretical modeling of networks of neuronal activity, and the investigation of the role of dynamical attractors in cognition and learning.

Advanced Topics in the Theory of Dynamical Systems. Edited by G. Fusco, M. Iannelli, and L. Salvadori, Academic Press, 1989, ix+266 pp., \$29.95

This is volume 6 in the series *Notes and Reports in Mathematics in Science and Engineering*. It consists of the proceedings of an international conference held at Villa Madruzzo, Trento, Italy, June 1–6, 1987. There are papers devoted to finite-dimensional systems with special emphasis on analysis of the existence of periodic solutions to Hamiltonian systems. Other contributions deal with infinite-dimensional systems; they are concerned with recent developments of general methods for proving existence and with the qualitative theory, both in general and in particular application areas. There are 20 papers.

An Introduction to Mathematical Physiology and Biology. By J. Mazumdar, Cambridge University Press, 1989, 208 pp., \$49.50 cloth; \$16.95 paper

This is volume 4 in the *Australian Mathematical Society Lecture Series*. It is addressed to mathematically sophisticated students who have not previously encountered applications of mathematics to physiology and biology, and uses mathematical rigor to elucidate physiological and biological phenomena. Much of the necessary mathematics is explained in the text. Chapter headings: 1. Dimensional analysis in mathematical physiology; 2. The mathematics of diffusion; 3. Population biology; 4. Biogeography; mathematical analysis of wildlife reserves; 5. Pharmacokinetics: drug distribution in pharmacology; 6. Biological fluid dynamics; 7. Analysis and applications of arterial flow dynamics; 8. Analysis and applications of left ventricular mechanics; 9. Analysis and applications of heart valve vibration; 10. Medical devices.

Sparse Distributed Memory. By Pentti Kanerva, A Bradford Book—The MIT Press, 1989, ix+155 pp., \$24.95

In this monograph, the author presents a mathematical theory of human long-term memory. It begins with background material from mathematics, computers, and neurophysiology; this is followed by a step-by-step development of the memory model. The concluding chapter describes an autonomous system that builds from experience an internal model of the world and bases its operation on that model. Close attention is paid to the engineering of the memory, including comparisons with ordinary computer memories. The monograph aims to provide an overall perspective on neural systems and the model described in it is designed to be able to aid in understanding human memory and learning. The memory model is expected to be applicable to the creation of adaptive systems for signal processing, speech, vision, and motor control, and to robots in general. The realization of the memory with neural-like components resembles the cortex of the cerebellum. Chapter headings: 0. Introduction; 1. Mathematical foundations; 2. Background material from computers; 3. Background material from idealized neurons; 4. Neurons as address decoders; 5. Search of memory for the best match; 6. Sparse memory; 7. Distributed storage; 8. Storage and retrieval of sequences; 9. Constructing distributed memory; 10. The organization of an autonomous learning system.

Bayesian Statistics 3—Proceedings of the Third Valencia International Meeting. Edited by J. M. Bernardo, M. H. Degroot, D. V. Lindley, and A. F. M. Smith, Oxford University Press, 1989, xi+805 pp., \$125.00

This meeting, the third in a series on Bayesian statistics held in Valencia, Spain every four years, took place on June 1-5, 1987. It consisted of 31 invited papers, all of which are contained in these Proceedings, together with contributed papers, of which a selection of 33 refereed ones is printed here. They encompass a wide range of theoretical and applied research in Bayesian statistics. Authors of the invited papers are: R. E. Barlow, S. Wechsler, and F. Spizzichino; G. A. Barnard; M. J. Bayarri and M. H. DeGroot; J. O. Berger and A. O'Hagan; J. M. Bernardo and F. J. Girón; D. A. Berry; A. P. David; P. Diaconis; W. H. DuMouchel; S. Geisser; S. Geman; P. K. Goel; M. Goldstein; B. M. Hill; J. B. Kadane and C. A. Hastorf; R. E. Kass, L. Tierney, and J. B. Kadane; C. E. Kim and M. J. Schervish; D. V. Lindley; C. N. Morris; A. O'Hagan; L. R. Pericchi and K. Pötzelberger; D. B. Rubin; H. Rubin; J. E. H. Shaw; A. F. M. Smith; T. M. F. Smith; D. J. Spiegelhalter and L. S. Freedman; G. Wahba; M. West; A. Zellner.

Logic-Based Knowledge Representation. By Peter Jackson, Han Reichgelt, and Frank van Harmelen, The MIT Press, 1989, 255 pp., \$35.00

This is a volume in the MIT Press Series in *Logic Programming*. The research described in it is an investigation into the usefulness of logic for the representation of knowledge and the control of its application to problem solving. The long-term goal was to design and build an environment for specifying knowledge-based systems that was based upon the use of logic as (i) a representation language for domain-specific knowledge, and (ii) a metalanguage for describing task-specific control regimes. The basic idea was that a user should be able to produce a prototype simply by describing both the object-level knowledge of the problem domain and the meta-level knowledge for performing the task. The declarative description language would then be procedurally interpreted to generate the desired behaviours. The monograph is divided into two parts, the first (four chapters) providing an abstract knowledge-based architecture (called "Socrates") which is capable of being specialized and configured for particular applications, and the second reporting some novel research that enlarges current theorem-proving technology.

A Handbook of Fourier Theorems. By D. C. Champeney, Cambridge University Press, 1989, ix+185 pp., \$17.95

This handbook is intended to assist those scientists, engineers and applied mathematicians who are already familiar with Fourier theory and its applications in a non-rigorous way, but who wish to find out the exact mathematical conditions under which particular results can be used. Only a traditional (English) first-year university course in mathematics taken by physical scientists and engineers is assumed. Chapters 1-5 are an introduction to the necessary additional mathematics, and Chapters 6-16 consist of rigorous statements of the most important theorems in Fourier theory, together with explanatory comments and examples.

Sparse Matrix. By U. Schendel, Halsted Press: A division of John Wiley and Sons, 1989, viii+115 pp., \$39.95

This is a volume in the Ellis Horwood series in *Mathematics and Its Applications*. It is a translation from the original German edition first published in 1977 by R. Oldenbourg, Munich. It developed from lectures held at the Free University and the Technical University of Berlin. The emphasis is on classical procedures that have proved their efficiency in practical applications. Chapter headings: 1. Introduction; 2. Storage techniques; 3. Systems of linear equations; 4. Computation of the inverse; 5. Block matrices; 6. Iterative algorithms; 7. Graphs and matrices; 8. Eigenvalues and eigenvectors; 9. Parallel numerical algorithms.

Structural Equations with Latent Variables. By Kenneth A. Bollen, John Wiley and Sons, 1989, xiv+514 pp., \$49.95

This is a volume in the Wiley series in *Probability and Mathematical Statistics*. It is a comprehensive treatment of the general structural equation system known as the LISREL model. One purpose of the book is to demonstrate the generality of this model. Rather than treating path analysis, recursive and nonrecursive models, classical econometrics, and confirmatory factor analysis as distinct and unique, the author treats them as special cases of the general model. Other goals of the book are to emphasize the application of these techniques—empirical examples are discussed throughout—and the crucial role played by substantive expertise in most stages of the modeling process. Rather than going from the general to the particular, the author starts with the simpler regression/econometric and factor analysis models and presents them from the perspective of the general model. Chapter headings: 1. Introduction; 2. Model notation, covariances, and path analysis; 3. Causality and causal models; 4. Structural equation models with observed variables; 5. The consequences of measurement error; 6. Measurement models: the relation between latent and observed variables; 7. Confirmatory factor analysis; 8. The General Model, part I: latent variable and measurement models combined; 9. The General Model, part II: extensions.

Linear Algebra and Its Applications; Volume 2: More Advanced. By D. H. Griffel, Halsted Press: A division of John Wiley and Sons, 1989, x+223 pp., \$49.95

This is a volume in the Ellis Horwood series in *Mathematics and Its Applications*. It is the second of a two-volume work, describing modern applications of linear algebra and its fundamental role in physics. The volume is divided into three parts (of two chapters each): 1. Matrix representations and diagonalisation; 2. Inner product spaces and self-adjoint operators; 3. Further developments (i.e., least squares, pseudo-inverse, duality).