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. 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.

The current subscription price per volume (March through December) is $70. Back volume prices are $50 per volume through vol. 49; $90 for vol. 50. Back issues can be purchased, as far as they are available. Back issue prices are $14 per issue through vol. 49; $27 per issue for vol. 50. Subscribers outside the United States and India must pay a postage surcharge of $8; subscribers in India must pay a postage surcharge of $13. Expedited delivery to destinations in North America $13; elsewhere $25. Subscriptions and orders for back volumes must be addressed to the American Mathematical Society, P.O. Box 1571, Providence, RI 02901-1571. All orders must be accompanied by payment. Other subscription correspondence should be addressed to the American Mathematical Society, P.O. Box 6248, Providence, RI 02940-6248. Quarterly of Applied Mathematics (ISSN 0033-569X) is published four times a year (March, June, September, and December) by Brown University, Division of Applied Mathematics, 182 George Street, Providence, RI 02912. Second-class postage paid at Providence, RI. POSTMASTER: Send address changes to Quarterly of Applied Mathematics, Membership and Sales Department, American Mathematical Society, Post Office Box 6248, Providence, RI 02940-6248.

©1993 Brown University

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 I and the prime ('), between alpha and a, kappa and k, mu and u, nu and v, etc 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, $\exp[(a^2 + b^3)^{1/2}]$ is preferable to $e^{(a^2 + b^3)^{1/2}}$.

Fractions in the body of the text and fractions occurring in the numerators or denominators of fractions should be written with the solidus. Thus, $\cos(x/2b)/\cos(a/2b)$ is preferable to $\cos x/2b/\cos a/2b$. In many instances the use of negative exponents permits saving of space. Thus, $\int u^{-1} \sin u \, du$ is preferable to $\int \sin u/\, u \, du$.

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, $(a + bx)\cos t$ 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 which 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.

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. LI, No. 2  June 1993

R. W. DickeY and J. J. Roseman: Equilibria of the circular elastica under a uniform central force field ........................................... 201

M. F. McCarthy, T. B. Moodie, T. S. Öncu, and R. P. Sawatzky: Propagation and reflection of one-dimensional waves in ferroelectric ceramics . 217

Selwyn L. Hollis: On the question of global existence for reaction-diffusion systems with mixed boundary conditions ............................. 241

C. A. Stuart: Estimating the critical radius for radially symmetric cavitation 251


M. Z. Wang, T. C. T. Ting, and Gongpu Yan: The anisotropic elastic semi-infinite strip .......................................................... 283

Massimiliano Lucchesi: Free-energy functions for elastic-plastic material elements ................................................................. 299

Xinzhi Liu: On attractivity for nonautonomous systems ......................... 319

W. W. Hackborn: On a class of Stokes flows inside a corrugated boundary . 329

C. Giorgi and G. Gentili: Thermodynamic properties and stability for the heat flux equation with linear memory ............................ 343

Johannes C. C. Nitsche: Boundary value problems for variational integrals involving surface curvatures ................................................ 363

Lawrence Turyn: The damped Mathieu equation ................................ 389

New Books .................................. 264, 282, 298, 328, 342, 388, 399, 400
NEW BOOKS


This is Volume 1390 of Lecture Notes in Mathematics. It is the proceedings of the second meeting on the title subject, held in Trento, Italy, February 1–6, 1988. There are 22 papers, including applications to subjects such as filtering theory, biological models, control theory, field theory in physics.


This is a volume in the MIT Press Series in Computer Systems. It is intended for computer and communication system designers who want to analyze the performance of their designs using simulation. It provides an introduction to discrete-event simulation, including model building and output data analysis, and presents a discrete-event simulation language called SMPL. It is divided into two parts, the first providing an introduction to discrete event simulation using SMPL, the second giving an overview of the SMPL environment.


This is the first paperback edition (with correction) of the book first published in 1987. It celebrates the 1687 publication of Newton's Principia and contains 16 papers by eminent authorities on Newtonian and Einsteinian gravity, with applications to cosmology.


This series of lecture notes presents the incremental theory of plasticity from a unified viewpoint advanced by W. Prager and D. Drucker in 1949/50. The notes also present a brief introduction to the deformation theory of plasticity.


This is a volume in the series Economic Theory, Econometrics, and Mathematical Economies. Whereas the first edition of this book was written mainly for audiences with physical science and engineering backgrounds, this edition has been largely rewritten to make it more accessible also to graduate students and professionals in the social sciences. The scope of this edition is apparent from the chapter headings: 1. Deterministic models and their control problems; 2. Stochastic models; 3. Stochastic control problems; 4. Time series and econometric models: examples; 5. Estimation; 6. Convergence questions; 7. Adaptive control systems and Bayesian optimal control problems; 8. Linear rational expectation models; 9. Approximations in sequential decision processes.

Continued on page 282

With this volume, including a cumulative index for all nine volumes, this ambitious decade-long project comes to a close and this distinguished encyclopedia is complete. It is truly an invaluable and quite unique source of information on statistics and its applications, for the expert and for the layman alike. More informally, it is a pleasure to browse through these volumes and read the articles just for pure enjoyment—they are invariably well written.


These are the proceedings of a conference in Sielpia, Poland, September 19–24, 1988. Special emphasis in the 21 papers printed here is on nonlinear systems (algebraic and geometric methods), optimal control and optimization (general problems, distributed parameter systems), linear systems (linear-quadratic problem, robust stabilization).


This is Volume 133 in the series Pure and Applied Mathematics: A Series of Monographs and Textbooks. It is based on the lectures given by the participants in a workshop on Finite Dimensional Controllability and Optimal Control, held at Rutgers University on May 18–22, 1987 (It also contains an additional chapter written by A. A. Agrachev and R. V. Gramkrelidze at the Editor's invitation). The purpose of the volume is to present an overview of recent results in the direction of using differential geometric control theory methods to attack problems such as the structure of optimal trajectories and optimal synthesis, local and global controllability, system invertibility, sampling, canonical forms, and the structure of reachable sets.


This is Volume 37 in the series Operator Theory: Advances and Applications. This book is an attempt to provide a treatment of *-algebras of unbounded operators in Hilbert space and of (unbounded) *-representations of general *-algebras.


These tables represent a new, revised and enlarged version of the 1957 book by this author entitled Tabellen zur Fourier Transformationen. Known errors have been corrected, apart from the addition of a considerable number of new results, which involve almost exclusively higher functions.

Part I of this book consists of 13 chapters, and deals with the concepts and techniques needed for modelling. Part II consists of three detailed case studies which bring all the material covered in Part I together in the context of model building. Part III deals with a large number of real-world problems which are suited for mathematical modelling and which are meant for use as modelling exercises.


This fourth (and, at least temporarily, last) volume of these reviews of progress in computer science has articles on supercomputers, reasoning under uncertainty, distributed file systems, complexity classes, number theoretic algorithms, instruction scheduling of superscalar architectures, engineering coordinated problem solvers, machine learning, and channel routing for integrated circuits. There is also a special topics section with papers resulting from a series of special workshops within the DARPA community to explore strategic directions for computer science research. The special topics discussed are: connectionist systems, intelligent training systems, knowledge-based systems, machine learning, natural language processing, prototyping, robotics, spoken language systems, ultra-dependable architectures, vision. The editors are suspending publication of these annual reviews of computer science since they feel establishment of this series was premature, partly because they were faced with a shrinking pool of willing authors for each succeeding volume.


This is Volume 205 of Series B (Physics) in the NATO Advanced Science Institute Series. It constitutes the proceedings of a NATO Research Workshop held at Les Houches, France, in February 1989. The workshop was motivated by important theoretical developments in transport equations which make it possible to relate microscopic descriptions of heavy ion collisions to nuclear matter theory and by the need to review the large body of data available on heavy ion collisions. The workshop consisted mostly of lectures on nuclear matter, transport equations, and the dynamics of heavy ion collisions. There are seventeen invited and fifteen contributed papers in this volume.


These are the proceedings of the 15th winter school of theoretical physics, held in Karpacz, Poland, 20 February–5 March 1989. The program of the school was concentrated around the string model as the fundamental unified theory of nature. There is an introductory lecture “Fun with Strings” by M. Kaku, and the other 26 lectures are arranged into four groups: 1. Strings: summing over surfaces; 2. Strings: field theory; 3. Functional integration and conformal field theory; 4. Quantization of constrained systems.
Continued from page 298


This is an English translation, by A. Buttigieg, of the textbook originally published in French by Masson, Paris, in 1982 and 1986. It is a volume in the Cambridge Texts in Applied Mathematics. Its purpose is to give a thorough description, and a rigorous mathematical analysis, of some of the most commonly used methods in numerical linear algebra and optimization and to show that these methods are remarkably efficient but also that they are interesting in themselves. Chapter headings: I. Numerical Linear Algebra: 1. A summary of results on matrices; 2. General results in the numerical analysis of matrices; 3. Sources of problems in the numerical analysis of matrices; 4. Direct methods for the solution of linear systems; 5. Iterative methods for the solution of linear systems; 6. Methods for the calculation of eigenvalues and eigenvectors; II. Optimization: 7. A review of differential calculus. Some applications; 8. General results on optimization. Some algorithms; 9. Introduction to non-linear programming; 10. Linear programming.


This is Volume 116 of Lecture Notes in Pure and Applied Mathematics. This volume contains 28 papers presented at the meeting, Trends in Semigroup Theory and Applications, held September 28 to October 2, 1987 in Trieste, Italy. The conference was devoted in particular to maximal regularity problems, interpolation spaces, multiplicative perturbation of generators, linear and nonlinear evolution equations, integrodifferential equations, dual semigroups, positive semigroups, applications to control theory, and boundary value problems.


This is Volume 117 of Lecture Notes in Pure and Applied Mathematics. It is a collection of 17 original research and survey papers invited to be presented at the International Congress on Orthogonal Polynomials held in Largo, Spain, September 7-12, 1987. It deals with advances in fields such as Fourier analysis, approximation theory, differential equations, Toeplitz matrices, numerical analysis, and applications to birth-death processes, integral transforms, best Padé approximations, etc.


This is Volume 118 of Lecture Notes in Pure and Applied Mathematics. It is a collection of papers presented at the EQUADIFF 87 Conference held at the Democritus University of Thrace, Xanthi, Greece, in August 1987. The EQUADIFF conferences were initiated in 1970 and seek to present a panorama of research in differential equations and to promote unification by bringing together mathematicians and scientists from many parts of the world who work on different aspects of the field. One conclusion has been that the traditional division of the field into ordinary, partial and functional differential equations has lost much of its meaning under the realization that these subareas share concepts, ideas, and techniques. There are 93 papers in this collection, and a useful subject index.

Continued on page 342

This volume offers an unusual collection of problems (with answers)—neither standard nor easy—in mathematical analysis. There are both classical and modern topics. Some are original problems on an advanced level that may lead readers to research projects. The topics covered are: real and complex numbers, sequences, series, functions of one and several variables, functional equations, real analysis (measure, integration), analytic functions, Fourier series, functional analysis.


The material covered in this text is that which the author considers a prerequisite for research in applied mathematics. The topics selected are apparent from the chapter headings: 1. Distributions; 2. Sobolev spaces; 3. Weak solutions of elliptic boundary value problems; 4. Introduction to semigroups and applications; 5. Some techniques from nonlinear analysis.


The format of this volume reflects the organization of the symposium held at Louvain-la-Neuve, Belgium, in January 1987. It is divided into three parts: 1. Game theory and mathematical economics; 2. Operations research; 3. Econometrics. Within each part, one or two invited survey papers to nonspecialists, and finally a collection of specialized research chapters provide examples of current research in the respective fields. The discussions that followed each survey paper are also given.


This is Volume 22 of The Institute of Mathematics and its Applications Conference Series, and is based on the proceedings of a conference organized by the Institute, held at the University of Bradford in July 1988. There are 26 papers on a wide range of topics, including control theory, optimization, statistics, economics, and biology as well as numerical linear algebra and matrix theory.


This is a volume in The Wadsworth & Brooks/Cole Mathematics Series. It is a systematic, self-contained introduction to a substantial part of the theory of holomorphic Hilbert modular forms, associated $L$-functions, and especially their arithmetic.

This is a volume in the series Universitext. It is an enlarged version of a set of lectures given in the spring of 1985 at the Ecole Polytechnique Federal de Lausanne and in June 1986 at the East China Normal University in Shanghai. Stochastic differential geometry ranges from diffusions on Lie groups and potential theory for Riemannian manifolds to Bismut's proof of the index theorem. These notes aim at introducing the reader to the Schwartz-Meyer theory, relating second-order geometry to stochastic processes. After two short chapters recalling some definitions from probability and geometry, Chapter 3 sets the stage by defining manifold-valued semimartingales and what plays the role of their quadratic variation; Chapter 4 then presents martingales and their main properties, and Chapter 5 is an elementary introduction to Riemannian stochastic differential geometry and Brownian motion on manifolds. Second-order geometry and stochastic differential equations are discussed in Chapter 6, integrals of forms along processes are introduced in Chapter 7, stochastic parallel transport and stochastic development in Chapter 8.


These two volumes contain the papers presented at the North American Conference on Logic Programming held in Cleveland, Ohio, on October 16–20, 1989. There are two invited talks, by E. W. Elcock (Adsys: The historical inevitability of logic programming) and J. Minker (Toward a function of disjunctive logic programming), and the other 68 papers are grouped under headings such as: constraint logic programming, proof theory, abstract interpretation, applications, nonmonotonic inference, parallel implementation, software engineering, constructive negation, concurrent logic programming, semantics, program transformation, performance of parallel systems, logic grammars, database, implementation topics, extensions to logic programming.


This text is designed for a two-semester course, for students with background in differential and integral calculus. There are many examples using real data, particularly from the health sciences. The text includes an introduction to linear models, to categorical data analysis, and to Bayesian methods and decision making.


This volume contains twelve articles by fourteen econometricians from six countries on four continents, leading off with L. R. Klein on the meaning and role of exogenous variables in structural and vector-autoregressive econometric models.


This is Volume 124 of Lecture Notes in Pure and Applied Mathematics. These proceedings consist of a collection of papers presented at the International Symposium in honor of Frank Olver, held in Winnipeg, Canada, in June 1989. There are 25 invited and 14 contributed papers, and a biographical sketch of Frank Olver by the Editor. Among other subjects, these papers discuss special functions, asymptotics of integrals, numerical analysis, asymptotic solutions to differential equations, singular perturbations, linear difference equations—all topics in Frank Olver's distinguished record of research contributions.


This is Volume 119 of Lecture Notes in Pure and Applied Mathematics. It contains the texts of 29 lectures delivered at the conference, held at the University of Rhode Island, including marvelous "Remarks and Personal Reminiscences" by Laurence C. Young (which alone make the book worth buying), as well as a Foreword by Jack K. Hale and a Preface entitled "Thirty Years of Modern Optimal Control" by the editor.


This is Volume 120 of Lecture Notes in Pure and Applied Mathematics. It contains the prepared texts of twelve lectures delivered at a special session on the title subject organized at the 830th meeting of the American Mathematical Society, held in Denton, Texas, October 31–November 1, 1986. They include survey articles as well as chapters on specific research applications, development and analysis of numerical algorithms, and performance evaluation of algorithms on advanced architectures.


This is Volume 121 of Lecture Notes in Pure and Applied Mathematics. These proceedings consist of a collection of seven papers, most of which are based on the lectures presented at a Special Session of the American Mathematical Society Regional Meeting, held at the New Jersey Institute of Technology in Newark, New Jersey, on April 25–26, 1987.

Continued on page 400

This is Volume 1396 of Lecture Notes in Mathematics. It collects part of the contributions to the Year of Quantum Probability organized by the Volterra Center at the University of Rome II, Italy, in 1987. There are 24 papers.


This is Volume 6 in the Australian Mathematical Society Lecture Series. A large number of sporting events contain the motion of a projectile. It is the aim of this book to present a unified collection of the many problems that can be tackled and of all the mathematical techniques that can be employed. Chapter headings: 1. Motion under gravity alone; 2. Motion in a linear resisting medium; 3. Motion in a nonlinear resisting medium; 4. The basic equations and their numerical solution; 5. Small drag or small gravity; 6. Corrections due to other effects; 7. Spin effects; 8. Projectiles in sport and recreation (shot-put and hammer throw, basketball, tennis, table tennis, squash, badminton, golf, cricket, baseball, soccer, rugby, Australian rules football, javelin, discus, frisbee, flying ring, long jump, high jump, ski jump, boomerangs, water jets, cars, cycles, seed dispersal).


This is Volume 21 in the series Monographs in Electrical and Electronic Engineering. It is intended as a systematic account of the fundamental principles of the subject.


This book is based on Bloch’s lecture notes, the first dating from 1949 and the most complete treatments occurring in the 1969 and 1976 versions. It assumes a fair degree of sophistication in classical mechanics, although the necessary material is developed in the text. It assumes a familiarity with the basic concepts of thermodynamics and quantum mechanics and, within this framework, should be accessible to anyone in the physical sciences. In developing classical statistical mechanics Bloch follows Gibbs’ approach utilizing the canonical ensemble, and quantum statistical mechanics is developed in direct analogy with the classical approach. Chapter headings: 1. Introduction and basic concepts; 2. Classical physics; 3. The statistical ensemble; 4. Thermal equilibrium and the canonical distribution; 5. Applications of classical statistics; 6. Quantum statistics; 7. Applications of quantum statistics. There are several appendices, on canonical transformations and Poisson brackets, a general proof of Liouville’s theorem, and other technical matters.


This is Volume 311 of Lecture Notes in Computer Science, and constitutes the proceedings of the Second International Colloquium, held in Cachan-Paris, France, November 24–26, 1986. The papers spanned a broad spectrum, from algebraic geometry to implementation of coding algorithms.